Research on Key Technology for Building High-Efficiency Informational Supervision Platform to Realize Global Logistics

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Abstract: - The paper focuses on building key technology of global logistics on high-efficiency informational supervision Platform, such as common sharing of global information in the process of production, transportation and storing or withdrawal based on internet technology, collection of real time information about goods and vehicles by ZigBee node, the connection of nodal operation and logistical management platform by the network and common sharing of internet to realize the intelligent management process in the goods production, transportation and delivery center, namely the goods tracing in the global logistics system..

Key-Words: - high-efficiency logistics; ZigBee *; Wireless Network Platform ;key technology; informational supervision platform; global goods tracing system*

1 Introduction

The developing process of logistics abroad has experienced four stages since the 1950s, and currently it is on the fourth stage with its information, networking and intelligentization. It is no doubt that the modern logistical service and operation should be realized by modern logistical operation, but its operation should be based on modern high-efficiency logistical system. The general trend of modern logistics is the realization of information, automazation, networking and intelligentization of the logistical system and the satisfaction of growing needs of social production.

Uniting production enterprise, logistics enterprise and users to share resources, promote logistics speed, reduce logistics cost, supervise and manage logistics enterprise in the whole process is the developing objective of global logistics. In the operation of modern logistics, clients will enquire the producing situation in each order; The receiving party needs to know the exact position of goods in transportation and estimate arrival time[3]. The goods-delivering party of the dispatching center wants to know the goods position in storehouse in order to make further strategic decision and answer users' questions. It's popular to bring information management technology into logistics management, but technologies on timing track of goods and vehicle in the global logistics and emulating the track of the whole goods through computers are still comparatively scarce. The research on high-efficiency logistical system is to base on the characteristics of logistics and to provide high-efficiency and fast service to manufacturers, suppliers and clients by building global goods tracing informational system. It is a key technology to be solved in modern logistical field to realize the track of goods production in manufacturing companies, in the process of transportation and the intelligentization of management process in the delivery center by the use of ZigBee wireless communicative technology.

2 The setup of global goods tracing informational Platform that takes the whole situation into account

The general trend of modern logistics is the realization of information, automazation, networking and intelligentization of the logistical system and the satisfaction of growing needs of social production. The setup of goods tracing informational Platform that takes the whole situation into account is to build national and regional logistical networks and promote the common sharing of resources, data, and information between logistical enterprises, manufacturing companies and the users and provide preconditions for the smooth and high-efficiency communication of logistical information. The development of global logistics is to put manufacturing enterprises, logistical companies and the users in one system to achieve common sharing of resources, improve logistical speed, reduce the cost and enforce global

supervision and management to logistics companies, constructing electronicalized logistics network, conforming traditional logistics enterprises and offering opportunities and means for their quality enhancement through the development, research and promotion of the logistics management system. The global logistics informational Platform can enforce the cooperation between logistics enterprises and the up-and-down stream enterprises, making the production enterprises, logistics enterprises and the users have the same pace, share resources and fulfill the highly efficient modern logistics system. Establishing global logistics informational Platform can form and optimize the supplying chain in the logistics process, offering all kinds of logistics service[2]. This is beneficial to improving the proper use of a great deal of unused social logistics resource, adjusting social logistics resource, optimizing social supplying chain, arranging economical chain and creating good economic and social benefits. The enforcement of the global informational Platform can make logistics enterprises maximally offer the optimized design of logistics procedure and one-station overall logistics service for manufacturers or suppliers, maximally fulfill the high-efficiency and authority of the third-party logistics service, saving logistics cost for customers, realizing the high-efficient operation of logistics. This platform mainly includes:

(1) the Third Party Logistics Management System

This system includes three subsystems: client service management subsystem, business management subsystem and union management subsystem. The comprehensive business management of logistics enterprise, the procedure of the electronicalized logistics business and one-station overall client service can be efficiently realized through these three subsystems. The functions of the client service management subsystem mainly includes: public information service, quotation service and agreement price service, comprehensive logistics entrust of clients, the response of client service dictation, document management, bill inquiry, timely tracing, stock report and management, finance inquiry and statistics, matched service etc. Business management subsystem is a functional module for managing business and operation. Its main functions are: user management, archive management, operation management, client information management, finance management, data analysis, and code management. The function of the union management subsystem mainly includes: information service, receiving and inquiring dictation, tracing information record and management, bill inquiry and data analysis.

(2) Storage and distribution Management System

This system has strong storage management functions. It simultaneously supports several kinds of storage, the operation of several companies or storehouses, unique virtual warehouse management, several kinds of charging modes, advanced bar codes technology, several kinds of measuring units, reliable alarm system, overall diary records and simulated pictures of storehouse position. It contains the functions like cross docking management, client and commodity management, delivery management, automatically goods complementation, picking goods, planning order, processing appreciation, controlling storage, adjusting conveyance, optimizing lines and tracing etc. It can integrate with other modules, offer WEB operation interface or making data interface for clients and realize long distance goods management according to the requirement of clients.

(3) The information supervising and processing system of goods and vehicle

This system mainly includes functions like vehicle management, transportation vehicle tracing, document management, union vehicle management, goods station management etc. It can connect GPS, GIS systems to inquire the status of vehicles and trace the transportation of vehicles.The informational monitoring system of goods and vehicles has a strong function for handling the timely track of comprehensive logistics. It not only can track goods with various transportation modes, but also offer multi-dot operation, the in-store or under-way status of goods with multi-grade delivery and the detailed information about the goods being tracked by customs, commercial examination and so on according to the requirement of users.

3 The Key Technology for Tracing Goods on the Basis of ZigBee

3.1 The Goods Tracing Process of the Global Logistics System

With the fast development of IT technology, a wireless brand-new net correspondence technology with low speed is born-ZigBee[8]. It contains these characteristics: less power needed, shorter time,

easy to work, high credibility with large net capacity, low cost for setting, installation and maintenance, simple agreement, audio-collocation, more compatible, highly secure etc. These features are rather suitable for the complex logistics system. Therefore, we realize the goods tracing process in the global logistics system via ZigBee technology here. How does this technology be applied in the three processes of global goods tracing? See the following part:

(1)The design is based on ZigBee reading and writing unit (it is composed of the sensor and the data receiving-dispatching module), and has constituted a ZigBee network. It has established a position network system with reading and writing unit as its network nodes in places which need to confirm the goods positions, such as the cargo fields of cars, containers and large goods, the storehouse of small commodities. Then it uses the concept of pole position to trace goods. Each positioned node can be taken as "the post of coordinates" and supervising point.

(2)In the production enterprise, by using the node of ZigBee wireless sensor to track the core module of products and according to the production flow of products, users can learn the completion state of goods production plan to timely oversee and urge the producing schedule of the production enterprise to obtain needed products at an early date[9].
(3)The goods information collected by the delivery center and ZigBee reading and writing unit is transmitted to the management center through ZigBee wireless network. When users fetch goods or the delivery center sends goods, they can conveniently trace and position the place of goods in the cargo field through the logistics managing system according to the indenture number and the information correspondence of ZigBee nodes.

3.2 The Design of Goods Tracing Project in ZigBee Wireless Network System

The constitution of ZigBee wireless network system is shown in Fig.1. This system adopts the gateway of embedded processor S3C4510B with 32 positions of the ARM framework. Goods and containers are controlled through the expanded control module MSP430 and the receiving-dispatching data module CC2420 of the gateway. The gateway also communicates with all child nodes of the network via its wireless module[10].
The sensor node in the system has adopted MSP430 as its core controlling module. The constitution of MSP430 hardware is shown in Fig.2.MSP430 has rich memory resource. With 5MHz working frequency, the energy waste of MSP430 is about 1.5mw and this minor-controller has several power saving modes available to choose. Apart from rich memory resource and several power saving modes, MSP430 has several AD interfaces and I/O data lines which make it easy to use software to program. These interfaces can also be used as the interface for connecting sensor. The function of the corresponding module of the node of sensors is fulfilled through CC2420 RF transceiver. CC2420 has completely compositive controlled oscillator and it can work in the frequency band of 2.4GHz with rather little peripheral circuits such as antenna and 16MHz crystal. CC2420 only offer one SPI interface to connect with micro-processor MSP430 to complete setting and data receiving and dispatching. CC2420 can be used in very cheap equipments because of the simple peripheral circuit and processor interface.
MSP430 and CC2420 correspond with each other through SPI mode. MSP430 uses pricipal mode, CC2420 adopting subordinate mode. The data transmission mode between MSP430 and CC2420 is shown in Fig.3.

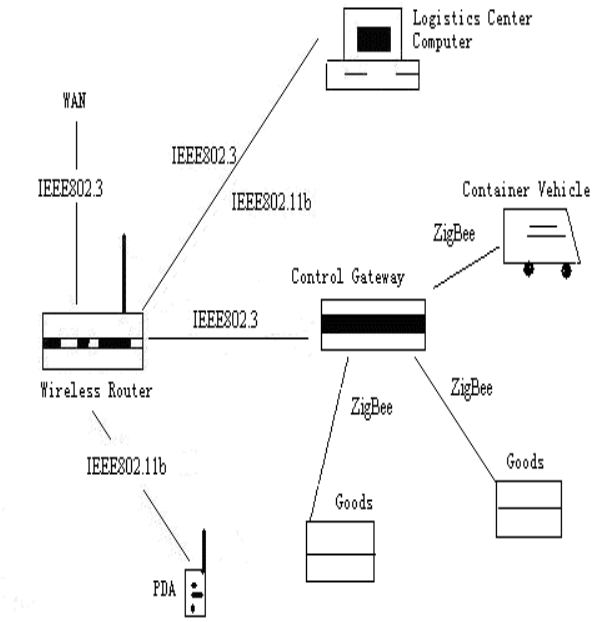

Fig.1 Logistics ZigBee Wireless Network Platform

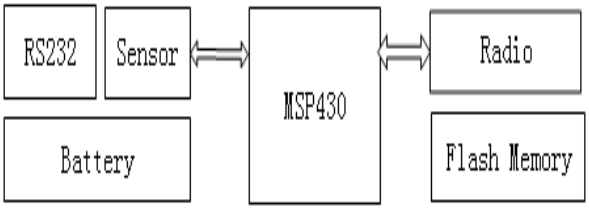

Fig.2 Structure of MSP430 Hardware

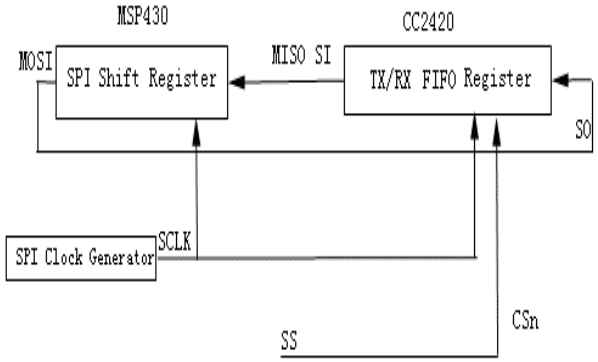

Fig.3 Data Correspondence between CC2420 and MSP430

3.3 Building Goods Tracing Platform of Global Logistics

Remote measurement and control system of goods and vehicle in global logistics usually comprises three parts: measurement and control module, network communication module and applicaiton program module of client port. Measurement and control module is for collecting timing signal of goods and vehicle in the process of global logistics; Network communicaiton module is responsible for exchaing data between the server port and client port based on certain network communication agreement; Application program module of client port responds to the instruction of remote clients and shows measuring data.

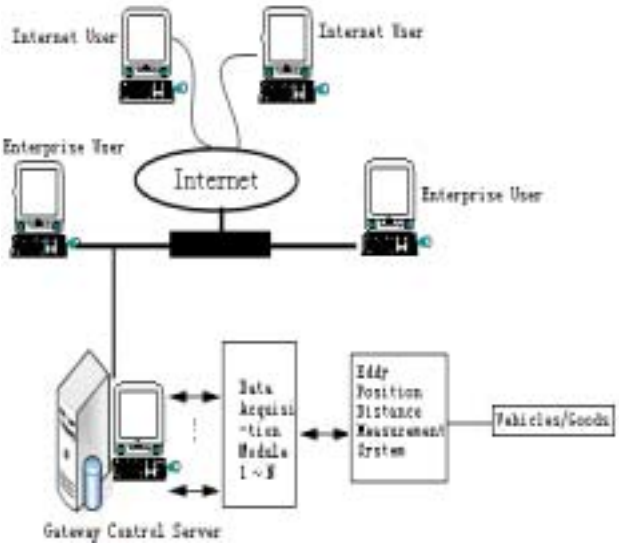

Fig.4 tracing platform of global logistics

Fig.4 shows the goods tracing platform of global logistics built in this paper, its remote locating and range-measuring system of goods is based on the range-measuring principle of eddy current sensor. On such basis, users can control an eddy current sensor to locate and measure the distance of objects and vehicle in real time through internet; When the eddy current sensor moves to the position of object, the export voltage amplitude value of sensor will change a lot. By calculating the distance between the peak values of voltage variation values, the displacement of objects can be determined; Data collection and control module collects the data extracted by eddy current sensors through the establishment of gateway and network nodes.

4 Network communication and signal collection of the tracing platform of global logistics

4.1 Hardware realization of network communication

ZigBee wireless network system conducts design and installation with the logistics enterprise or production workshop as the unit. Each unit establishes a gateway, several wireless read-write node networks based on ZigBee technology. The gateway and each child node of reading and writing unit corresponds data through a wireless data receiving and sending module. This system adopts the gateway of embedded processor S3C4510B with 32 positions of the ARM framework.See the gateway structure in Fig.5. Goods and containers are

controlled through the expanded control module MSP430 and the receiving-dispatching data module CC2420 of the gateway, receiving and delivering data module CC2420, collecting displacement data extracted from those sensors placed on objects and vehicle, thus, realizing the track of goods and vehicle.

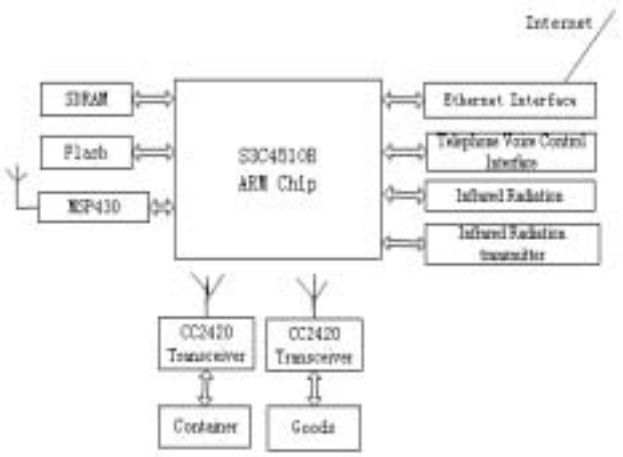

Fig. 5 Hardware module of network communication

4.2 The constitution of network communication software

The software of the locating and range-measuring system of remote eddy current sensor collects signals, extracting tiny signals by correlation methods and results showing and recording modules on the basis of LabVIEW platform.

4.2.1 The composition of software functional modules

Mainly includes:

(1)Signal-colletion module. It is completed by using the simulating input channel of LabVIEW.

(2)The module of signal extraction by correlation method. According to the principle of signal extraction through correlation method, the amplitude value and phase of measurement signal can be acquired through certain calculation between measurement signal and a reference signal with the same frequency; Correlation method can't be realized by icons in LabVIEW, therefore, CIN interface of LabVIEW is used. CIN is the interface of imaging program language of LabVIEW and C language.

(3)Results showing and recording module. In this measurement system, the exact position of objects and vehicle is determined by recording measurement voltage in various positions and in accordance with the relevant position among peak values.

(4)WWW service module. LabVIEW platform provides powerful webpage-issue tools and web server programs. It can use the webpage in HTML format to issue the ready-made local measurement and control LabVIEW program so that it may be more convenient for remote users to use.

4.2.2 The design principle of eddy current sensor

See Fig.6: In the eddy current sensor, when metal conductor is in the changing magnetic field or moving in the magnetic field, it will produce induced current. The induced current line becomes a closed loop, forming "eddy current". The effect of eddy current is relevant to those parameters like the resistivity of metal conductor ρ, permeability μ, thickness H, exciting current angular frequency of coil ω, and the distance between coil and metal x etc.. If some parameters are fixed, for example ρ, μ, ω, H, the eddy current sensor can use the eddy current produced from the metal conductor to measure distance x. If sine alternating current I_1 with f frequency (namely ω angular frequency) flows to the coil which is over metal conductor, the space around coil will produce sine alternating magnetic field H. If this coil L is put near metal conductor, there will be eddy current I_2 on the surface of metal. This eddy current will form a reversed magnetic field H_2. It makes alternating magnetic field lose power, changing the inductance of coil, increasing spared power, reducing the Q value of loop. As H_2 and H_1 are opposite in direction, the effective resistance of coil is changed. The resistance of coil loop Z is relevant to the distance x of the conductivity P of the measured material. Among permeability, exciting frequency f, sensor and the measured object, namely: a： $Z = f(\rho, u, f, x)$, if parameter P and f are fixed, the single-valued relation between resistance Z and x can be calculated.

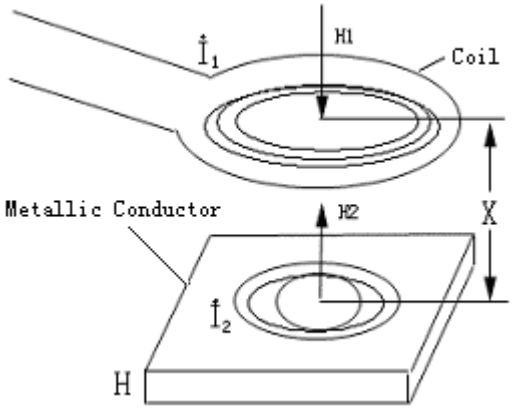

Fig.6 structure of eddy current sensor

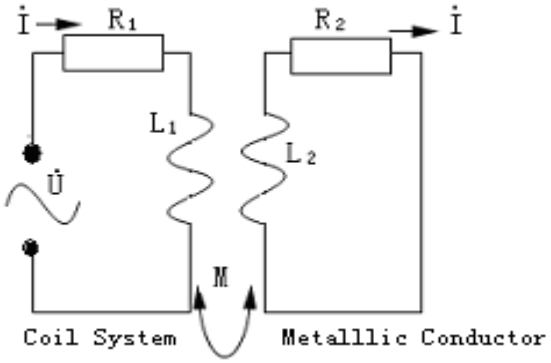

Fig.7 the equivalent circuit of eddy current sensor and the measured object

When displacement x is 1/3 — 1/5 of the linearity of the outside diameter of coil, the relationship curves of Z and x are linear. Fig.7 is the equivalent circuit of eddy current sensor and the measured object. In the diagram, the eddy current sensor is the coil with alternating current I1. This coil is called sensing coil as well. Its resistance is R1. Its inductance is L1; the eddy current of metal conductor I2 is equivalent to the short-circuit current in a short-circuit coil; the resistance and inductance of short-circuit coil are respectively R2 and L2. Sensor and short-circuit coil are connected by mutual inductance M which increases while the mutual distance x is decreasing. According to the Kirchhoff law, we can get the following equation:

$$R_1 \dot{I}_1 + j\omega L_1 \dot{I}_1 - j\omega M \dot{I}_2 = \dot{U}$$

$$R_2 \dot{I}_2 + j\omega L_2 \dot{I}_2 - j\omega M \dot{I}_1 = 0$$

Via simultaneous solving, equivalent resistances are as follows:

$$Z_{eq} = R_1 + R_2 \frac{\omega^2 M^2}{R_2 + (\omega L_2)^2} + j\omega[L_1 - L_2 \frac{\omega^2 M^2}{R_2 + (\omega L_2)^2}]$$

$$R_{eq} = R_1 + R_2 \frac{\omega^2 M^2}{R_2 + (\omega L_2)^2}$$

$$L_{eq} = L_1 - L_2 \frac{\omega^2 M^2}{R_2 + (\omega L_2)^2}$$

$$Q_{eq} = \frac{\omega L_{eq}}{R_{eq}} = \omega[L_1 - L_2 \frac{\omega^2 M^2}{R_2 + (\omega L_2)^2}] / [R_1 + R_2 \frac{\omega^2 M^2}{R_2 + (\omega L_2)^2}]$$

Therein, Z_{eq} is the equivalent resistance after the sensor is affected by metal conductor. Therefore, the equivalent resistance R_{eq} of coil, inductance L_{eq} and quality factor Q_{eq} can be known as follows: Judging from the above formulations, the output electrical parameter of sensing coil has four kinds: Z_{eq}、R_{eq}、L_{eq}、Q_{eq}. All of them are the function of M, namely the function of distance x. Using this kind of eddy current effect, the change of distance x can be converted to the change of electric quantity. Thus, a sensor which can measure displacement, swing and thickness can be built.

4.3 Virtual instrument collects node information

Virtual instrument is a digitalized measurement and test instrument based on computer system. On full-use of current computer resources and with uniquely designed instrument hardwares and special softwares, it has all functions of common instrument and some special functions which can't be realized by common intrument. It uses data collection module to complete the data collection function of common measurement and test instruments and utilizes computer system to finish data analysis and output display functions of common measurement and test instruments.

LabVIEW is the most typical imaging program developing platform in the field of virtual instrument. It is one of the data collection and control developing environments which is broadly used and first recommended in the international society at present, mainly used in fields like instrument control, data collection, data analysis and data display. Here, access of node information of goods

and vehicle into computer is completed by the virtual instrument technology of the assistant input passage provided by LabVIEW. Therein, code interface node CIN is the interface of LabVIEW and C language. CIN transfers data between two languages through input and output ports. When LabVIEW program runs to CIN node, data is transferred to C source code diagram through CIN input port while LabVIEW program changes to execute C source code. When code execution is completed, the attained data result is returned to LabVIEW by the output port of CIN.

Therefore, CIN node is employed to facilitate the drive of the data collection clip with LabVIEW. The procedures are as follows:

(1)Install CIN node and set up the input and output parameters and data type: CIN has only two ports in the original situation – an input and an output ports. Ports can be increased by enlarging the frame of the node or by right clicking the ports and choosing Add Parameter. As the ports of CIN node which are set in pairs, transfers pointer, the parameters can be both input and output.

(2)Create C source file: choose Create.c FILE from the shortcut menu of CIN Node to make *.C file; then fill the collection program of C language in the *.C file to get C source code file.

(3)Translate *.C file into lsb file: edit the *.C file in VC++ and get the lsb file.

(4)Load the lsb file to CIN node, and begin the debug of the collection program after the executable file is loaded.

Tracing platform of global logistics is designed with S3C4510B as the core gateway and CC2420 as the data collection module , and through them to control and collect displacement signal of objects and vehicle extracted by eddy current sensor, the main data receiving and sending programs between them are respectively shown as follows:

ExpComponent.java、AppTest.java：

```
*/file ： ExpComponent.java, receiving data from nodes and sending results from the same node

import drc1.comp.Component;

import drc1.comp.Port;

public class ExpComponent extends Component

{

 protected Port expPort=addPort("exp_a");

 protected void process(Object data,Port inport)

{

  if(inPort==expPort)

{

//receiving data a, x from ports and returning calculation results

if (data instanceof ExpContract)

{

ExpContract expContract=(ExpContract)data;

expContract.setResult(Math.exp(expContract.getx()*Math.log(expContract.getA())));

expPort.doSending(expContract);

}

}

else{super.process(data,inPort);

}

}

public Port getExpPort()

{

return expPort;

}

public void setExpPort(Port expPort)

{

this.expPort=expPort;

}
```

```
}

*/file name：AppTest.java，sending test data to test nodes

import drc1.comp.Component;

import drc1.comp.Port;

public class Apptest extends Component

{

 protected Port testPort=addPort("test");

 protected void process(Object data,Port inPort)

{

 if(inPort= =testPort)

{

 //receiving data from ports and showing calculation results

    if(data instanceof ExpContract)

    {

   ExpContract expContract=(ExpContract) data;


system.out.println("exp("+expContract.getA()+"
,"
+expContract.getX()+")="+expContract.getRes
ult());

    }

}

   else{super.process(data,inPort);}

}

 public Port getTestPort()

{

return testPort;

}

 public void setTestPort()

{

this.testPort=testPort;

}

 public static void main(Sting[] args)

{

AppTest appTest =new AppTest();

  ExpComponent expComponent=new
ExpComponent();

//appTest component and expComponent are
bound thorugh ports
appTest.getTestPort().connect(expComponent.g
etExpPort());

  ExpContract expContract=new ExpContract();

  expContract.setA(5.0d);

  expContract.setX(3.0d);

//sending data to ports
  appTest.getTestPort().doSending(expContract);
}
}
```

ExpComponent.java receives the data from the node and sends the result from the same node to implement the collection and transmission of data); AppTest.java sends testing data to the testing node to finish the setup of the node environment; in this way, data is received through the collection node, and meanwhile the environment setup information of the testing node can be modified through the interface. The binding of AppTest and ExpComponent through the interface ensures the effective collection of the data node signal in this network platform. The flow of the signal collection simulation system is illustrated in Fig.8.

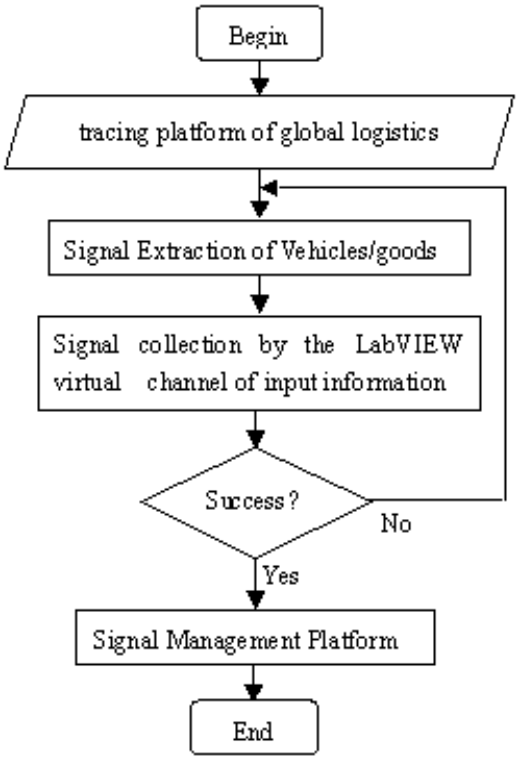

Fig8 Signal collection simulation System FlowChart

5 The Key Link of the Global Goods Tracing Informational Platform for Realizing High-efficiency Logistics

The "goods tracing" of the logistics management and the delivery centers in the global logistics are the two key links of the global goods tracing informational Platform for realizing high-efficiency logistics.

5.1 Establishing Position Network System in Logistics Management

See Fig.9:ZigBee wireless network system can conveniently position goods and containers. The concrete analysis is as follows:

- The system reads data through long distance and all reading and writing units of the system constitutes a ZigBee wireless network. It establishes a position network system with ZigBee reading and writing unit as its network node to read long distance data in places where need to confirm goods positions, such as the cargo field of cars, containers and large goods, and the storehouse of small articles and markets.
- When a container or a car with read-write labels goes through any signal domain of the reading and writing unit set in the door of goods transfer station or the city enter-exit transportation crossing and the cargo field, the reading and writing unit will automatically record the identity code of the container or truck and the time when they pass this place and at the same time transmit this information to the logistics controlling center through internet.
- One ZigBee read-write node is set every other distance to build a low-cost wireless controlling network in the customs controlling area and the container piling area of the port. Each node can be taken as "a post of coordinates" and a supervising point. It covers a rough position area. With the connecting and transmitting function of this network and by using our software of network controlling management, we are able to supervise packing cupboards and vehicles which have installed our electric labels in real time. When inquiring packing cupboard and goods, we only need to type the identity code of the packing cupboard or the name or number of goods in the controlling computer. For the trucks which enter the supervising area of the customs, we can record their positions and parking time in the whole process and the siren will automatically be aroused if overtime.

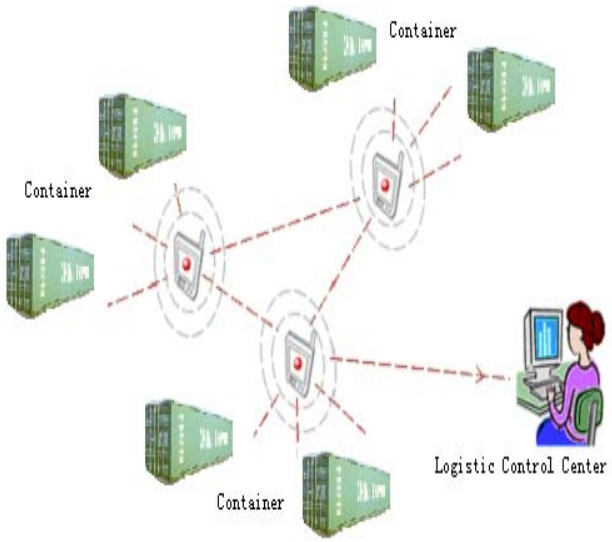

Fig.9 Application of Position Network System in the logistics management

5.2 Goods Tracing Management in the Warehouse of the Delivery Center

Goods can be swiftly found out through the position of articles which can be read by ZigBee reading and writing unit. ZigBee microwave read-write system

suits the occasion with large bulk, high read-write flexibility and long read-write distance. In several application occasions of the logistics system where wireless data transmission and position are required, ZigBee system has its unparalleled advantages.

6 Conclusion

Global goods informational Platform has established a shortcut passage for the chink-less platform connection among the production enterprise, the third party logistics enterprise and users. The goods production course of the manufacturing enterprise, the goods advancing journey of the traffic transportation and the goods intelligent access process of the delivery center in the global logistics system can be traced by using ZigBee wireless correspondence technology to construct a wireless network platform and collecting the timely information of goods and trucks in the logistics system through ZigBee nodes, then utilizing the constructed gateway to control nodes, connecting the gateway and the main controlling computer of logistics management to share information with internet. Only through the combination work of the global logistics informational Platform and the wireless network controlling system on the basis of ZigBee technology can the real modern logistics system be successfully established.

7 Acknowledgments

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