The Design and Development of Intelligent Warehouse Management System

based on .NET and Internet of Things

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Abstract—With the developing of logistics industry,the warehouse requirements of management become higher and higher,but traditional warehouse management has many problems,such as identifying product difficultly,getting the real-time information of product hardly,low degree of automation and so on,traditional warehouse management can't meet the requirements now.Aim at this problem,the paper combines the Internet of things and cloud computing,using RFID technology to achieve automatic product identification,using technology of Internet of things to get information of product and warehouse,to design a perfect intelligent warehouse management system.

Keywords—Internet of things,warehouse management system,RFID,RFID middleware

I. INTRODUCTION

Our country total logistics cost accounted for about 17.8% of GDP in 2011, the cost of product's delivery that leave to customer from factory account for 50% of product's price,these indicate that technology and management of our country's logistics have many places which need to be improved.After investigation, we find that main problem is that the system framework can't meet requirements.

To improve system framework of warehouse,we can use technology of Internet of things.Internet of things is connecting everything to web of things through the sensor and according to agreed protocol,exchanging information in order to achieve intelligent identification,locate,track, ,monitor and manage. We use technology of internet of things to warehouse's management, to achieve intelligence,automation of warehouse,so increase efficiency of warehouse management.

II. RFID TECHNOLOGY

A. *RFID Technology Introduction*

RFID is the abbreviation of radio frequency identification,also known as electronic tag. RFID is a automatic identification technology starting to rise in 1900s,it achieves unable contacting using RF signal to pass the space of coupling(Alternating magnetic field and The electromagnetic field), and achieve other destinations using the signal. RFID electronic label for object, to achieve highly efficient and flexible management, is one of the key technologies of Internet of things.

1) The working principle

The working principle of RFID has two modes,one is RFID reader sends a RF signal to a certain range, when the RFID electronic tag is in the radio frequency field of RFID reader.,tag antenna will achieve induced currents, provide energy for the RFID chip,the chip will transmit the RF signal in the form of information stored in the chip to the reader through the internal antenna,the reader demodulates received signal and decoding, and send data to server by wired or wireless for data processing; Another is electronic tag has energy, can take the initiative to launch a frequency of RF signal, the reader device can receive signals directly and then transmitted to the computer for processing. As shown below.

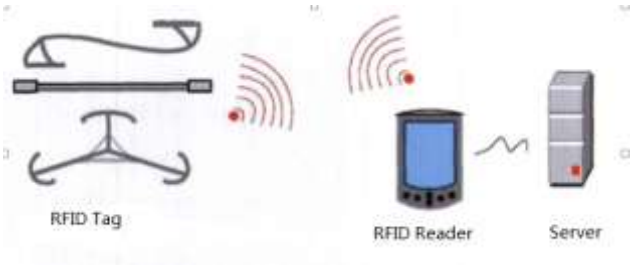

Figure 1 RFID device working principle

2) Radio frequency identification system composition

Radio frequency identification system at least includes two parts,one is the reader, another is electronic tag(or called RF card,transponder and so on, generally called electronic tag). In addition, it also includes antenna,host and so on.When using RFID system, composition of system is different based on different destination and environment. But from the perspective of the working principle of the RFID system, the system generally consists of signal transmitter, a receiver,launching and receiving antenna.

B. *The RFID Middleware*

1) Introduction of RFID middleware

The middleware is a kind of program to realize data transmission, filtering,data format conversion between hardware and application system,it can import various

data information of the reader into enterprise management information system through extracting decrypting,filtering, format converting. And response on the program interface through the system,so operators can browse,select,modify and query. Middleware technology reduces the difficulty of application development, makes the developers not to directly face the underlying architecture, instead of calling the middleware.

2) RFID middleware design model

The RFID middleware designed is divided into three levels,they are edge server layer, message system layer,data interface layer from bottom to up. Edge server is located in the bottom of the RFID middleware in charge of the collection label information pasted on the items; Up is the message system layer, it handles events and data from the edge server layer; The top is the data interface layer,provides the required RFID information.

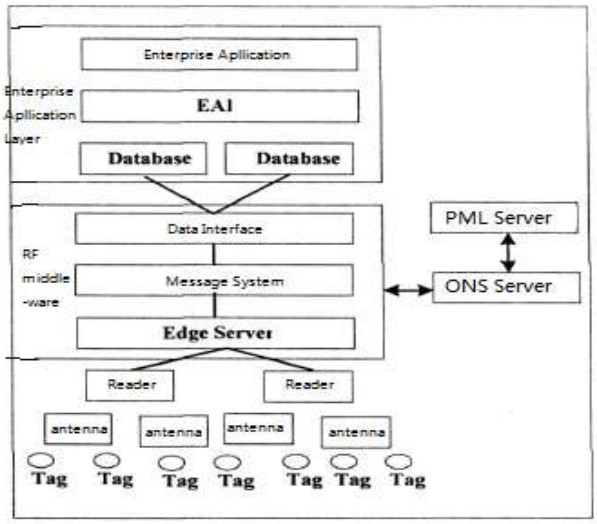

Figure 2 RFID Middleware Architecture

a) Edge server layer

Edge server architecture describes as shown in figure2. As the figure 2 shows, the reader interface completes data collection and data processing adapter; Data validation unit is to complete the checking of data from the reader interface;Data packet unit passes the RFID data from data validation unit to the message system, the RFID data is packaged into different message on the basis of the data content.

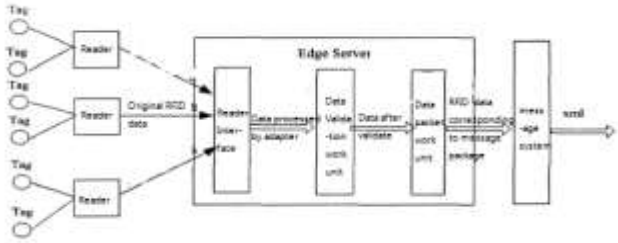

Figure 3 Edge Server

b) Message System Layer

Message system is on the middle of the middleware,as shown in the figure three. Edge server generate events and delivers the events to message system, the message system determines how to pass the event data to corresponding application system, the process is described below: the message system first caches all kinds of messages on the message server, then classifies these messages based on message content, makes similar messages in the same queue,finally messages which are well classified are stored separately into the corresponding XML temporary files, these temporary XML files will be finally send to data interface for further processing.

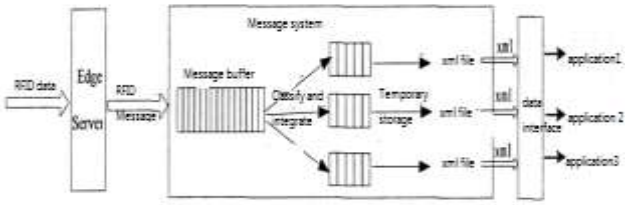

Figure 4 message system

c) Data interface layer

The structure of data interface as shown in figure 4. By calling the data filter module first, the data storage module will filter repeated RFID data out, and translate the filtered RFID data into center database. At the same time, the data access interface module of data interface provides access to the center database; Data query and data update interface provide services for enterprise application and remote application.

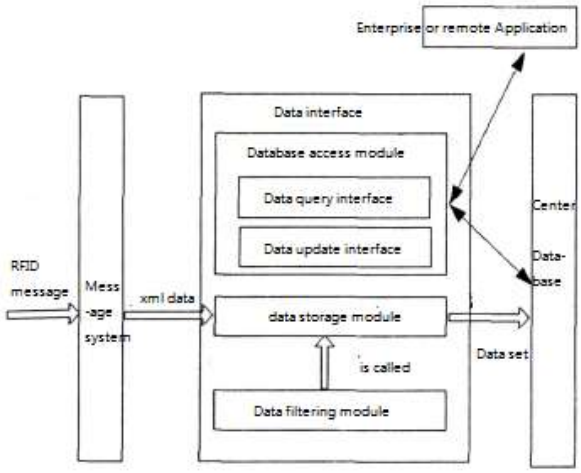

Figure 5 Data Interface

d) Functional Communication Mechanism between the Layers

Data transferring between edge server and message system uses message queue MSMQ, the message format is the object type--Class typ. First of all, classify RFID data from edge server according to user needs, and then based on the result of classification ,package RFID data into different message and pass to the message system for further processing. The carrier of data transfer between message system and data interface is XML disk file. Messages from the message system can be in the form of MSMQ XML directly provided to application, can also be stored in the form of an XML file into a disk file through the thread of receiving message, for the use of data interface. Here,we use the second method,the purpose is,on the one hand, we can cache data and also filter

cached data which is XML file out, on other hand,we need bulk warehousing processing, rather than do warehousing operation for each pair of RFID data, minimize waste expensive resource because of connecting and disconnecting.

III. CLOUD COMPUTING

Cloud computing is the cornerstone of the Internet of things development, and it promoted the implementation of the Internet of things from two aspects. First , cloud computing is the core of realization of Internet of things.It makes it possible to calculate in the Internet of things of the real-time dynamic management and intelligent analysis of all kinds of goods.The Internet of things through the radio frequency identification technology, sensor technology, nanotechnology and other new technology fully apply in various industries and through wireless network will be collected all kinds of real-time dynamic information service of computer processing center for summary, analysis and processing.The second,cloud computing is to promote the Internet of things and the intelligent integration of the Internet, so as to build a smarter planet.The fusion of Internet and the Internet, it is necessary to a higher level of integration.It also need to rely on efficient, dynamic, can be extended large-scale technical resources processing capacity and this is just what the cloud computing model is good at. At the same time,cloud computing of innovative service delivery model, simplify the delivery of services, strengthening the Internet of things and the Internet and its internal connectivity between.Rapid innovation can implement the new business model.In the Internet of things and the intelligent integration of the Internet.

IV. WAREHOUSE SYSTEM DESIGN

A. *System Architecture*

1) *I Information collection system*

The warehouse management system based on Internet of things uses EPC code as a unique identification code of a product, EPC code is a kind of coding standards applied to electronic tag from Auto-ID research center., it makes all the goods in the world has a unique identification, its biggest characteristic is can be used to identify the item. Each product has a electronic tag with EPC code as a unique identification of a product. Information collection system is made up of electronic tag, reader, computer installed software about information collection, mainly complete product identification and EPC code collecting and processing. When electronic tag with EPC code pass sensitive area of reader,EPC code will automatically captured in the reader, so as to realize automatic product identification and EPC information collection. Install reader in the warehouse entrance, to identify passing product automatically.Through handheld reader and car reader, to read stock and location of goods, and transmit EPC code to information collection software through data collection interface for further processing, complete data proofreading ,data filtering,data integrity check,and so on,for the upper application management system.

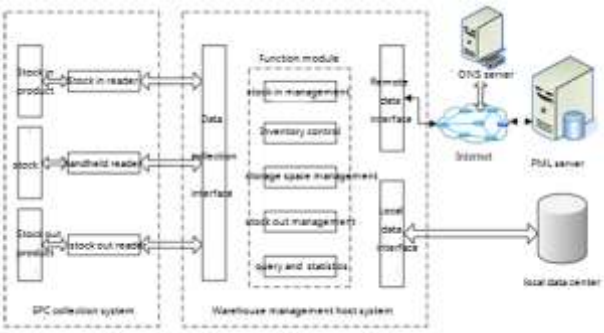

Figure 6 system architecture

2) *PML server*

PML(physical markup language) server is s product information server established and maintained by product manufacturers. IT is based on the standard XML, provide the detailed information of the product such as product name, product category, manufacturer, date of production, product description, etc.PML server's role is to provide the product details for automatic generation of product inventory list, and allow to query product information using product's EPC code. The advantages of PML server is its shielding the heterogeneity of product's data storage, in a uniform format and interface to provide transparent information services to the client.

3) *(Object Naming Service (ONS) and Application management system*

ONS creates a link between PML server and the information collection points, thus implement mapping between product' s EPC code and product information described by PML. Application management system gets product EPC information through interface with information collecting software (e.g.,Savant), and find product' s PML information server through ONS, so as to obtain the product details to realize application function such as warehousing management, product path tracking and so on.

B. *System developing framework*

System page development use Kendo UI framework, Kendo UI is a powerful framework for rapid HTML UI development.Based on the latest HTML 5 and CSS 3 and JavaScript standard.Kendo UI includes everything of development of modern JavaScript, JQuery framework , including: powerful source of gm's Drag (Drag - and - Drop) functions, templates, and UI controls.

System uses the MVC 3.0 programming Model, MVC is a kind of model using the MVC (Model View Controller Model View Controller) to design and create a Web application:he Model (Model) is the core of application (such as a database record list).The View (View) display data (the database records).The Controller (Controller) process input data(write to the database records).

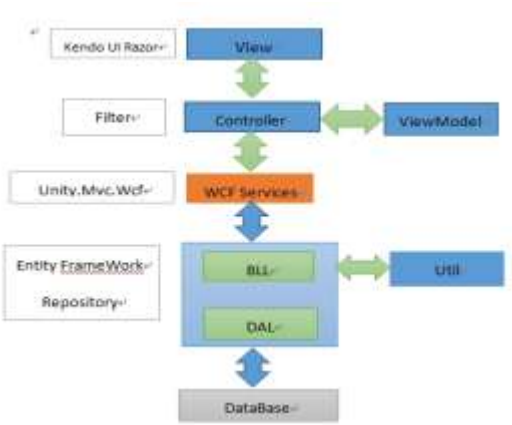

Figure 7 developing framework

System also apply the Windows Communication Foundation (WCF),WCF is a composite layered architecture of service-oriented programming.At the top of the architecture is called Service Model Layer (the Service Model Layer), the user with the least amount of time and experience to build their own software products and the model of connecting with outside world.It enables developers to build a cross-platform safe, reliable and transactional solution, collaborate and compatible with existing systems.

V. SUMMARY

The Internet of things and cloud computing technology is applied in warehousing industry, will greatly improve the efficiency of warehouse management, make it have a qualitative leap.Through test results of system running, proves the rationality and effectiveness of the system design and development, the improvement of system in the future, will be in the choice of technology standards and improve the system scalability aspects of performance and functionality.

REFERENCES

[1] Yang Gang,Chen Peiyi,Zheng Chunhong, Internet of Things ,Science press.,2010
[2] Zhang Feizhou,Yang Dongkai,Chen Zhi, Introduction to the Internet of Things Technology,Electronic industry press,2010
[3] Baidu Encyclopedia http://wenku.baidu.com/view/7cf1ea7f27284b73f24250df.html
[4] Sun Qibo, Liu Jie, Li Shan, Fang Chunxiao, Sun Juanjuan,The Internet of things: Concepts, Architecture and Key Technology Research Review, Journal of Beijing university of posts and telecommunications,2010
[5] E.W.T. Ngaia,,Karen K.L. Moonb,Frederick J. Rigginsc,Candace Y. Yib，RFID research: An academic literature review (1995–2005) and future research directions,ScienceDirect,2008
[6] Zhou Xiancheng, He Caihong, Shi Biao, Xu Ge,Intelligent logistics warehouse management system based on Internet of things，International Conference on Remote Sensing (ICRS)，2010
[7] Zhang Renbin, Warehouse Management System Research based on Internet of Things, Zhengzhou university master's thesis，2012
[8] Baidu Encyclopedia, http://baike.baidu.com/subview/2818115/11117908.htm?fr=aladdin
[9] Li Quanlin, Guo Longyan,Review the RFID technology and its application field,Expert BBS, 2006, 1
[10] Zhang Hang, RFID technology research for the Internet of things，Donghua university, master's thesis, 2011
[11] Deng Haisheng, Li Junhuai,Research and design on the RFID middleware, The computer technology and development，11, 2008
[12] Hector Gonzalez Jiawei Han Xiaolei Li Diego Klabjan,Warehousing and Analyzing Massive RFID Data Sets,University of Illinois at Urbana-Champaign, Urbana, IL 61801, USA