International Journal of Hybrid Information Technology
Vol. 9, No.10 (2016), pp. 229-238
http://dx.doi.org/10.14257/ijhit.2016.9.10.23

The Research of the Oil Drilling Materials Information Management System Based on RFID

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Abstract

In the present drilling materials supplies management informationization level is low, which lead to low efficiency of management in the Chinese oil enterprises. This paper presents an effective solution combined with RFID and web technology for oil enterprise information service platform system, and studies several key technologies in the design. The system has taken the advantages of RFID and web services in the practical application process, the enterprises can use this RFID solution to enhance the logistics management efficiency in the oil-drilling materials supplies. At the end of the paper we proposed technical barriers is one of the reasons for RFID popularization.

Keywords*: drilling materials supplies; RFID; web services; tracking and tracing*

1. Introduction

In recent years, the fluctuation of the international oil price has brought great pressure to the production cost of Chinese oil enterprises. How to control inventory effectively and reduce the cost of materials supplies, has become the subject of drilling materials supplies must be considered.

There is the main problems that the enterprise informatization lever is low in the Chinese oil enterprises.

Firstly, in many situation drilling materials management operations are still manual operation. Manual bookkeeping methods, storage, delivery, receipt and other aspects of the site by the staff manual registration, and then in the inventory table to carry out the necessary changes, the information is difficult to achieve real-time updates. If the staffs of materials management are not timely to send and receive information to change, and even the omission, the stock information is not timely and accurate response to the current actual inventory, the accounts does not conform to the actual situation. Due to large number of drilling materials, such as kinds of drill pipes, drill collars, screws, they are difficult to achieve a single tracking management without informatization management, even only the batch quantity management, the accurate number of material is easily not sure.

Secondly, the drilling materials dispatch command by point-to-point communication, lack of unified materials dispatch. The lack of effective communication between the

ISSN: 1738-9968 IJHIT

various inventory points, all inventory points between the lack of effective means of communication, each material information between the company supplies is difficult to achieve the reasonable allocation, so material utilization has the low efficiency. On the drilling enterprise management layer, repeat purchase, and unnecessary work caused by the waste of resources, production stop loss is bigger.

In view of the above problems, this paper provides an effective solution combined with RFID and web technology, using J2EE to develop a set of oil-drilling materials logistics tracking and tracing platform based on RFID. The core of the logistics chain: manufacturers, the third party logistics, warehouses，well fields, the use of the B/S structure of the well field to online tracking management with RFID tags, all users can query the historical and real-time information of oil drilling materials. This RFID solution can greatly improve the logistics management efficiency in the practical application.

2. Business Flow of Oil Drilling Materials Management System

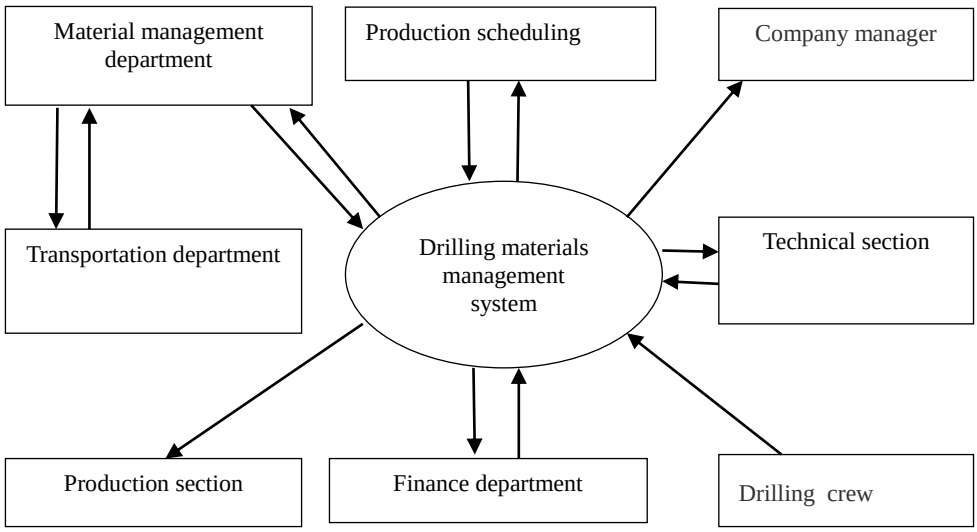

Figure 1. Business Flow of Drilling Materials Management System

As shown in Figure 1，the system provides real-time information for management staff queries, so that managers can always understand the dynamic number and use information for drilling rigs, drilling tools and accessories, casing and casing accessories, screw drill in grassroots units and well teams. Materials are mainly drilling rigs, drilling tools and accessories, casing and casing accessories and screw drill.

Materials transfer service adapted to the requirements of the object, forming a complex with its own characteristics of materials circulation process.

Drilling tool single management can effectively avoid the problems existing in the batch management. Single management is based on breakthroughs of the tool number identification technology，due to the drilling tool used in harsh environments (high temperature, high pressure, strong magnetic, erosion, corrosion), identification technology is an international problem. We have identified drilling tools with laser engraved mark and radio frequency identification method which can meet the basic requirements in the logistics.

RFID is the most widely used in accessing to goods and inventory, it can achieve inventory and pickup automatically. In the entire warehouse management, the supply chain planning system of the receiving plan, pickup plan and shipping plan combined with RFID technology, able to efficiently complete all kinds of business operations, such as stacking specified area, shelves/pickup and replenishment, *etc*.

The biggest advantage of RFID technology is that managers can achieve a single management in the bulk materials, real-time query information and dynamic management of materials, thus improving circulation efficiency, as well as providing decision-making information to enterprises by accurate, timely and effective manner.

Screws use a single management mothed. Each of the screw has its own number, transfer status of its life cycle to be tracked separately, and each of its usage information will be recorded.

3. Design of RFID System Framework

We have established the drilling materials information management system based on RFID(Radio Frequency Identification Devices), which includes a complete business scene of drilling materials supplies chain (including manufacturers, the third party logistics, warehouses, well fields);system hardware (including electronic tag, reading and writing implement, antenna, server, *etc*.);software (middleware, application system, database), solution (the network security, the goods anti-counterfeiting).

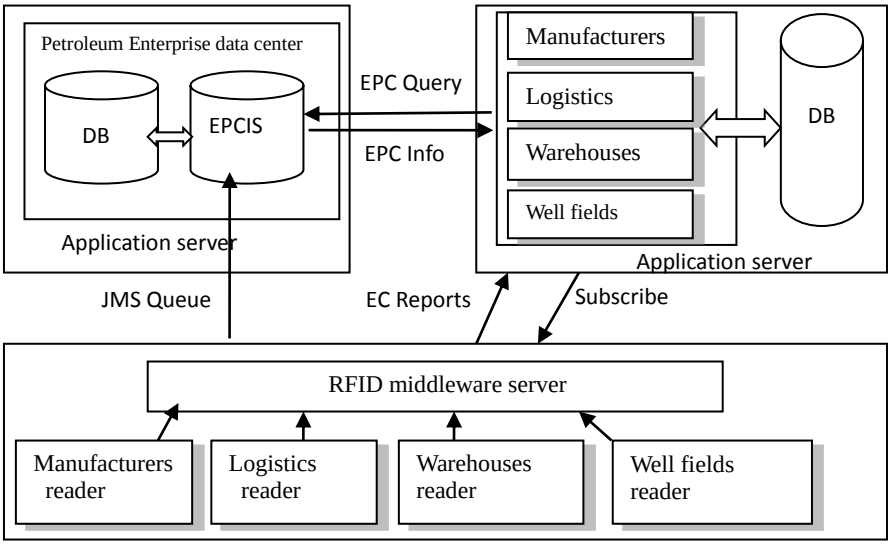

Figure 2. Summary System Design of Oil Material Management Based On RFID

As shown in Figure 2, the whole platform can be divided into three modules: RFID middleware services and the underlying hardware modules, oil enterprise data center module, the oil enterprise application module.

RFID middleware service manages their RFID readers, when the products with RFID tags pass each readers, the first, readers read information on the electronic product code (EPC) to verify, if condition is triggered, it can change or update information of electronic tags according to a certain rules .In addition, RFID middleware service also plays role of the information filtering, logic EPC judgment, transmit, and communication between enterprise data center and business module .

Business module uses B / S structure designed, points four characters: manufactures , the third party logistics, warehouses, well fields , these are the most basic four roles in the oil drilling materials supplies chain.

These four characters have their own special database and RFID middleware services. Each role subscribe to their own RFID middleware service to read the tags ,which will immediately send EC reports with EPC information to the each role of the DB(Data Base). Warehouse managers place an order to manufacturers, manufacturers put information into products, when readers read products with RFID tags, if it has no error,

model and the number of products contrast to DB, then system begin to write information into RFID tag. When the products are transported by the third party logistics, the reader networks begin to real-time tracking products and send EPC information in real time. At last products go to the well field, readers scan products information in tags to verify information in tags and update EPC information, the process of the entire supply is complete. Each role (including the end user) can get information of the products from prime to finally, including users real-time and historical information from the oil enterprise data center in EPCIS (Electronic Product Code Information Services) calls, to realize tracking and traces of products and achieve the target of automation management.

4. Degisn of the System Hardware Deployment Architecture

The hardware architecture of the system is shown in Figure 3, from left to right are: the underlying reader network, including the antenna, fixed readers, handheld readers, mobile terminals. The middle shows network systems and deployed in IDC's (Internet Data Center) EPCIS and database, the central servers. On the right shows the end-user business operations through the normal PC connected to the system.

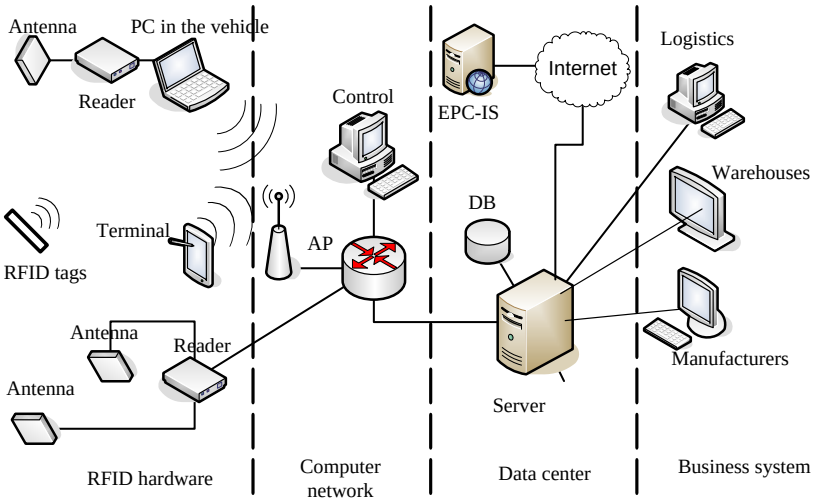

Figure 3. System Hardware Deployment Architecture

The main hardwares are as follows:

The handset. the handset is PDA with RFID reader module, GPS module and GPRS module, mainly to carry by the operator to complete the information area of the electronic tag is automatically collected in a certain area, and these data stored into the PDA or forwarded by 802.11b / GPRS to the back-end systems; can also be done automatically under the security control of the specified data is written to the tag within the region, while also embedded with a camera and GSM phone functions.

Fixed reader. UHF RFID Reader has a data storage and processing capabilities, RFID frequency range is 800MHZ-960MHZ; RJ-45 connector. The reader can connect 4-8 antennas, antenna using a coaxial cable connected with the reader.

Electronic tags. To comply with EPC Class Gen2 standard of passive electronic tags. Every piece of goods and vehicles have RFID tags, embedded EPC code. Operating modes: passive reader; storage capacity: serial number capacity 16,96bit EPC, effective memory storage space 192,224bit; operating frequency 860-960MHZ; standard ISO 18000-6B \ C, EPC Class1 Gen2; reading distance 1-5 m; data rates 640kbit / s or more.

The software platform are as follows: Operating System: Windows 2003 Server; WEB application servers: Tomcat 6.0, Weblogic9.22; database management systems: SQL

Server 2005, Oracle 9i; GIS map service: MapXtheme 4.8.0; network environment: public Internet network access, effective GPS service, GPRS and other information and communication medium.

5. Process Design on RFID

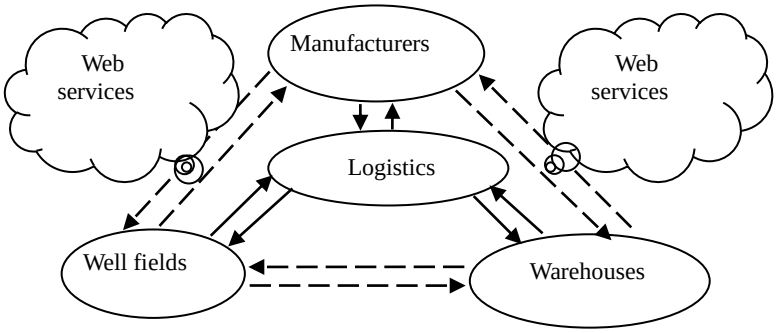

Figure 4. Business Process on RFID

As shown in Figure 4, the typical business process summary system as follows:

Well fields send orders to the manufacturers through the web services network.

Manufacturers make products based on orders, at the same time, to generate and print EPC tag, attach to the product packaging for each product;

Manufacturers send the goods to the third party logistics, when the products pass the readers in the exit of storage, the EPC information is sent to EPCIS to save;

Manufacturers send shipment notification to the third party logistics through the web services network , at the same time send to the warehouses, the third party logistics and the well fields receive delivery notice;

The logistics receive products, when products pass the readers of storage, the EPC information is collected, and then sent to EPCIS to save;

The logistics deliver drilling goods to the well fields;

The logistics send shipment notification to the well fields through the web services network, at the same time send to manufacturers, the warehouses and manufacturers receive delivery notice;

Warehouses receive products, when products go into storage, EPC information of products is collected by readers, and then send to EPCIS to save.

It is clearly seen web services which is a link between the communications from the above process, and EPCIS plays a role of data warehouse.

6. Key Techonolgies in the Design

6.1. Web Services

Web services is the key module for communication in the system. Web services is a bridge of the enterprise information system, warehouses, manufacturers, the communication amid the third party logistics providers: send orders, delivery note, change the state of the goods, all is to use web services to achieve .Web services is a kind of interface, it can be able to communicate with the information and sharing information from each the isolated site. Web services is based on XML and HTTP, SOAP (Simple Object Access Protocol) is used to realize cross-platform message, greatly enhance the interoperability between heterogeneous applications and platforms.

SOAP is the simple object access protocol, it is a used to disperse and communication protocol of distributed network information exchange based on XML, it was put forward by Microsoft, and widely used to a new generation of cross-platform and cross-language distribution calculation of an important part of web services. Normally, the SOAP = HTTP (Hyper Text Transport Protocol) +RPC(Remote Procedure Call) + XML(Extensive Markup Language). HTTP is the underlying communication protocol of SOAP, RPC is interactive manner, XML is the format of data transfer .The server create a WSDL (Web Services Description Language) file (an XML document) according to the requirements of itself by programming, a WSDL defines the format of client message, demands of the parameters, the ways of sending messages, *etc.*, then the server will publish this WSDL to the application server, make different development platform (Windows, Linux, Mobile environment, *etc.*), the different languages (J2EE or .net) to access the WSDL file through HTTP .

The client create the client program according to the WSDL , call running environment to create a SOAP request message, sent to the server through HTTP. Server-side running environment will parse the contents of XML in SOAP after receiving request message of SOAP, then invoke the service interface to implement class, after getting the results, it will create a response message of SOAP to the client. As shown in Figure 5.

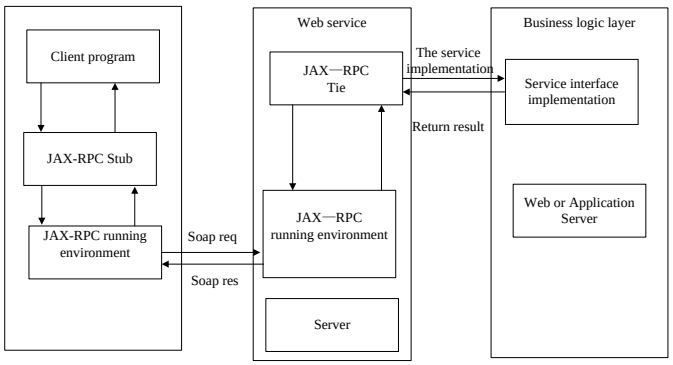

Figure 5. Principle of Web Services under J2EE Platform

6.2. RFID Middleware Event Management Module Design

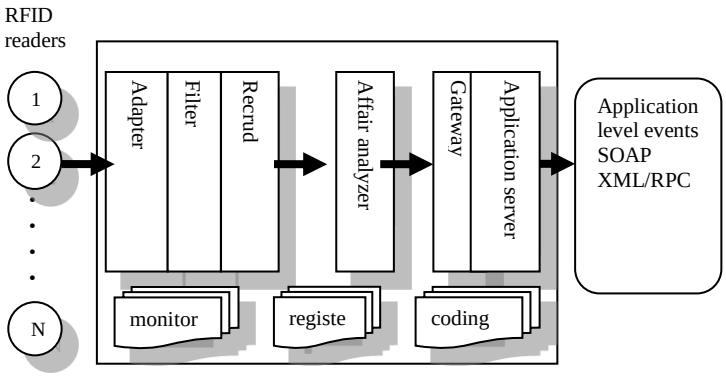

Figure 6. Middleware Event Management Module

In the RFID middleware services, RFID EMM (Event Manage Module) is the most important component, its function is collecting tags and reading event, communicating with readers, managing event flow of readers sending. RFID EMM general structure as

shown in Figure 6.

Its functions description are as follows： it allows different reader to adapter; collects EPC data from reader in a standard format; allows setting filters to smooth or remove EPC data; allows writing to all kinds of documents, such as writing EPC data to the database log, recording EPC data broadcast to remote server event HTTP/JMS/SOAP network log; buffering register, filter and adapter for events, so that they are not interfere with each other in operation. RFID EMM help RFID middleware services to collect, buffer, smooth and organize from information from readers.

Readers can upload hundreds of events per second. Every event can be buffered, filtered and recorded appropriately based on the disposing of the middleware request .RFID EMM is a high performance system. Different kinds of reader can work in different protocol, RFID EMM support various reader protocol , RFID EMM support EPC reader with different protocol. Events of RFID EMM can be filtered in the middleware requirements.

Events of acquisition will eventually be appropriately disposed , such as storing in the database as the permanent memory; it will store in storage data structures, such as real-time memory event database (RIED); it will send to a remote server through the HTTP, JMS or SOAP protocol broadcast ;RFID EMM support various of "event recorder".

Adapter, filter, affair analyzer, the gateway, application server, they have function modules with collection, filtering and recording, the program work in separate thread

RFID EMM can start treatment unit in different thread, and be able to buffer event flow between units.

6.3. GIS Module Design

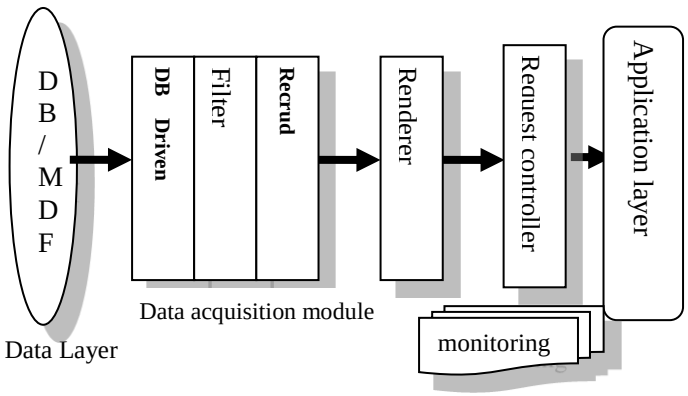

Figure 7. GIS Module

GIS (Geographic Information System) module is an important part of data transmission and monitoring module. In GIS services, the most important components are three: data acquisition module, rendering device and request controller; their role is to acquire the underlying map data, rendering control to generate the map, the management control of the upper system sends the request. The structure is shown in Figure 7.

The data acquisition module obtains the basic data from the underlying database or MDF (Map Data File). The rendering device contains various image control algorithms and libraries. It responds to the request of the controller. The controller is a module of the GIS system. The render device contains a variety of image control algorithms and libraries, it responds to the request of the controller issued by the image rendering; request controller is the GIS system has been monitoring the operation module, it can at any time to respond to the upper system image control, display request.

6.4. System Tracking and Tracing Module Design

Tracking and tracing module is designed as an independent subsystem, the role of the supply chain, consumers, regulators can query the system to query the information of products, the system will feedback real-time product status information to provide product tracking function; at the same time, the system can feedback all the historical information of the product to achieve the tracking function. The design structure of the module is shown in Figure 8.

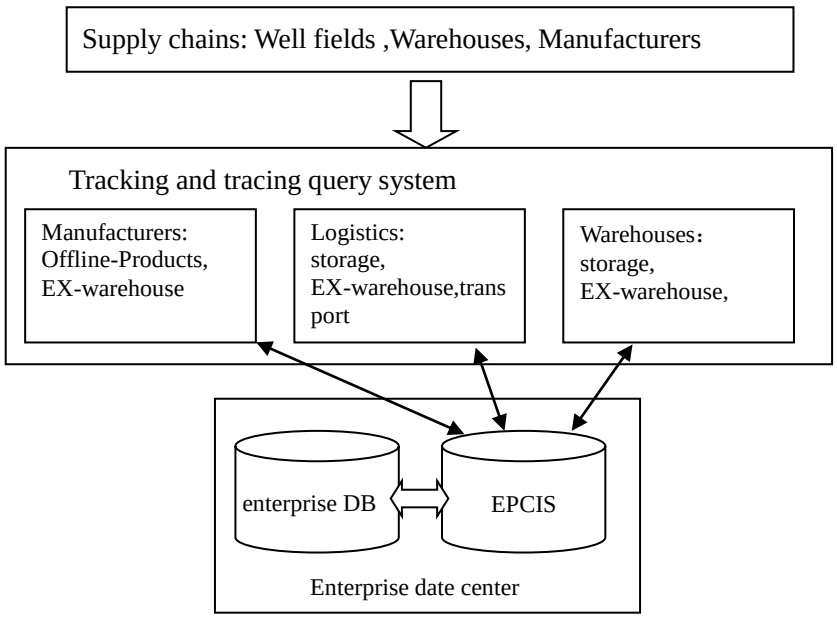

Figure 8. Tracking & Tracing Module Architecture Chart

The function of enterprise data center is all business data collection and exchange center, all registered RFID middleware services in the supply chain will send EPC information from reader to EPCIS by using the message queue. Enterprise data center is essentially a data warehouse and EPCIS, data warehouse is responsible for storing EPC information, this storage is unidirectional, not be modified and deleted after the stored, it cannot directly query, only call EPCIS interface to query and return the result to the application system. Continuously updated product status only through constantly inserting a new record (the difference between the two records is probably different status and timestamps) to achieve. This module uses the BEA's solutions: data warehouse using BEA's PointBase, EPCIS use BEA's Weblogic RFID Enterprise Server.

Any product entered the supply chain which will automatically stores a history of all changes in their status DB enterprise data center, these records constitute the complete life cycle of the product "e-pedigree."

6.5. Design Method

The design of the system uses MVC design pattern, SSH (Struts +Spring + Hibernate) framework construction the whole platform based on J2EE .Hibernate take charge of Object Relational Mapping to database(ORM ,M work), Struts (Web) take charge of trying and showing (V work), Spring take charge of business of control (that is C work).Using this frame, the system of data control, view, all business logic, can be stripped each other, system fully reduces coupling among various modules, make the maintenance system greatly enhanced.

7. Conclusions

At present, the main system development has basically completed, the front takes RFID UHF technology, electronic tag, and RFID hardware have made full verification testing. The system started running in an oil drilling materials Supplies Company.

1. The paper introduced an standard business operation process of the track and trace system applying oil enterprise based on RFID technology， the main roles of supply chain: manufacturers, warehouses, well fields are communicating with web services, the whole logistics process is sharing real-time information of exchange goods by using RFID technology.

2. Because of technical barriers between the various oil companies, currently electronic data format standard is difficult to unity between the various manufacturers, the oil companies is not a unified data format, kinds of business data exchange problem involves in the each roles, the data from the source to the field work uniform is also very difficult, these problems create obstacles for the RFID technology promotion. In order to promote the popularization of the RFID technology, some organizations are studying the above problem; this is the one of main research direction in the future.

Acknowledgements

This paper has been supported by the Collaborative Innovation Center of Unconventional Oil and Gas in Hubei Province Fund (Grant NO: HBUOG - 2014-1).

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