Research and Design of Intelligent Management Platform for Ship Oil Spill Emergency Equipment Depots Based on Internet of Things

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Research and Design of Intelligent Management Platform for Ship Oil Spill Emergency Equipment Depots Based on Internet of Things

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Abstract. Due to the low efficiency, informatization and decision-making ability of the traditional ship oil spill emergency equipment depots, an intelligent management platform for ship oil spill emergency equipment depots based on the Internet of things technology is proposed. The paper designs an intelligent management platform for the ship oil spill emergency equipment depots, which adopts the idea of modular design, constructs from the aspects of framework structure, platform function, and technical route. The platform could realize intelligent dynamic tracking and management of the entire process of equipment entering, storing, using, maintaining, and exiting the depots, which can greatly improve the level of informatization of equipment depots, the management efficiency of ship oil spill emergency equipment depots, the accuracy and speed of equipment operations and emergency response capabilities.

1. Introduction

In 2007, the "Layout Plan for the National Water Traffic Safety Supervision and Assistance System" compiled by the National Development, Reform Commission and the Ministry of Communications was approved by the State Council. With the gradual implementation and development of the plan, the coastal and Yangtze River trunk lines have been developed in the past decade, and a large number of oil spill emergency equipment depots have been built and put into use[1]. The oil spill emergency equipment depot is a reservoir for oil spill emergency materials used to combat oil spill accidents, which includes the main equipment for oil spill cleaning and related equipment. It is mainly used to deal with large-scale oil spill accidents and participate in international and national emergency response coordination. In large-scale emergency operations, equipment is frequently used and consumption is huge. The oil spill emergency equipment bank must provide accurate equipment and material support in a timely manner [2]. However, the construction of the oil spill equipment depot in China started late and the supporting technology was relatively weak[3]. The management of the equipment depots is basically still suitable for the traditional depots management mode. The management mode has low level of informatization, working efficiency, and economy. There are mainly the following problems:

1) The traditional depots management mode is still dominated by manual operations, with a low degree of informatization and a high error rate. Once the information registration fails, the information verification work after it is rather difficult; due to the low level of informatization and the shortage of informatization talents, the storage efficiency is low and the management efficiency needs to be improved at present.

2) The degree of application of information technology in depots is not close enough to the management tasks, resulting in a disconnect between information management and different managers such as depots supervisors, business personnel, shift attendants and custodians. It is difficult for depots leaders and business agencies to have a real-time, scientific and comprehensive grasp of depots conditions. Management decision-making is mainly based on experiences, and the decision-making level needs to be improved[4].

Internet of Things technology is an emerging technology in the information industry in recent years under the tide of informatization. It is generally accepted that the Internet of Things refers to the use of various information sensing devices, such as radio frequency identification devices, infrared sensors, and the connection of any object to the Internet in accordance with the agreed agreement[5] for the exchange information and communication. It is a network that can realize intelligent identification, positioning, tracking, monitoring, and management, whose basic features can be summarized in the following three aspects: comprehensive perception, reliable transmission, and intelligent processing[6].

Therefore, this paper puts forward the design plan of "Intelligent Management Platform for Ship Oil Spill Emergency Equipment Repository Based on the Internet of Things", which is different from the traditional depots management mode. It implements intelligent dynamic tracking management of the whole process of equipment in depots, storage, use, maintenance, and out of depots, which greatly raises the information level of equipment depot, improves the management efficiency of oil spill emergency equipment, and enhance the accuracy and speed of equipment operations and emergency response capabilities.

2. Total system design

2.1 Platform framework design

The intelligent management system of ship oil spill emergency equipment depots mainly composed of Internet of things background, bluetooth electronic label, bluetooth gateway, wireless communication network, Internet of things gateway, etc. Each emergency equipment is equipped with an electronic tag bluetooth terminal (here in after referred to as the electronic tag). When the electronic tag enters the coverage range of the bluetooth gateway node, it can be detected by it and send its own information to the bluetooth network node. In this way, emergency equipment can be located by bluetooth, and location-based management services can be carried out for emergency equipment. The bluetooth gateway node will regularly submit the detected electronic tag data to the Internet of things gateway, and then it will upload the data to the background of the physical network. Finally, our business system -- emergency depots management system can obtain the electronic tag data through the API provided by the background of the Internet of things. The platform framework structure is shown in *Fig. 1*.

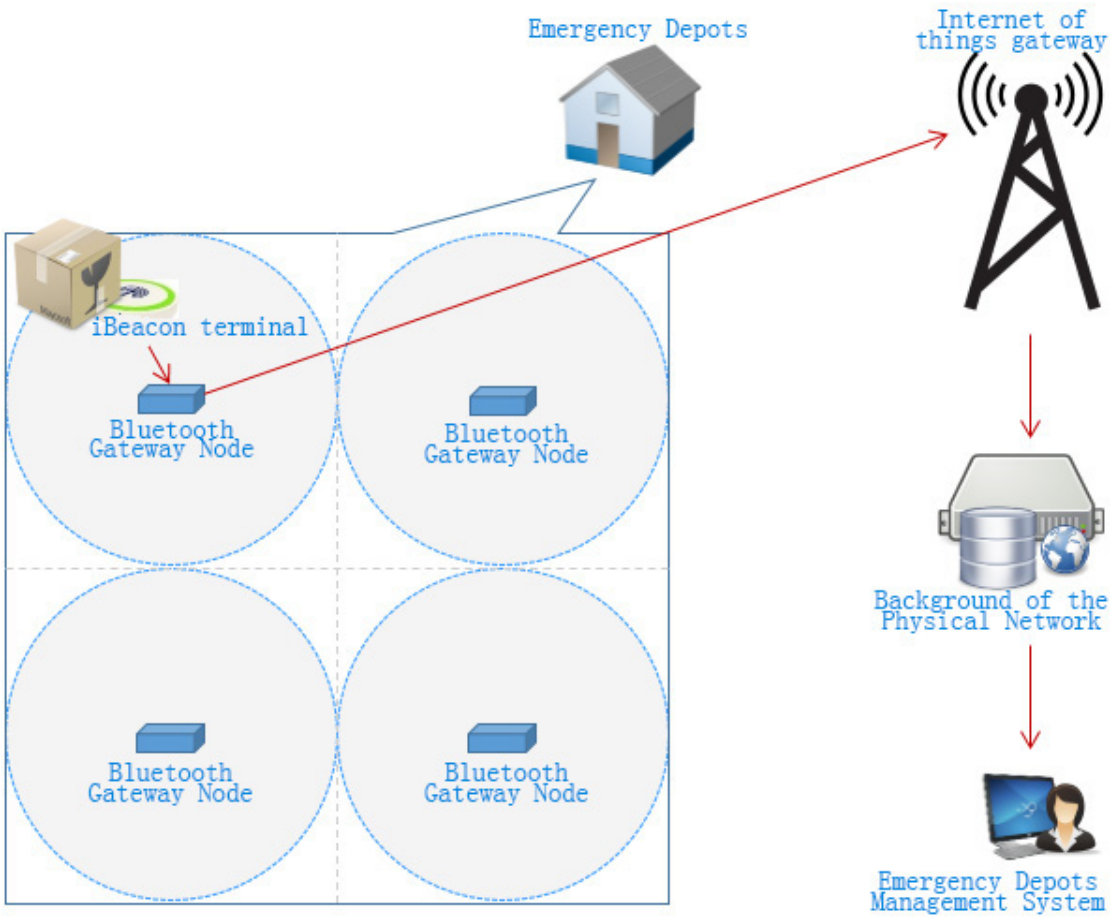

Figure 1. Frame of Intelligent Management System for Ship Oil Spill Emergency Equipment Library

2.2 Platform architecture

The intelligent management platform architecture of ship oil spill emergency equipment depots mainly consists of device interface layer, platform data access layer, platform business service layer, platform service interface layer and application layer. Multi-layer extendable system is adopted to improve the flexibility of the system, deployment and application development. The platform architecture is shown in *fig. 2*.

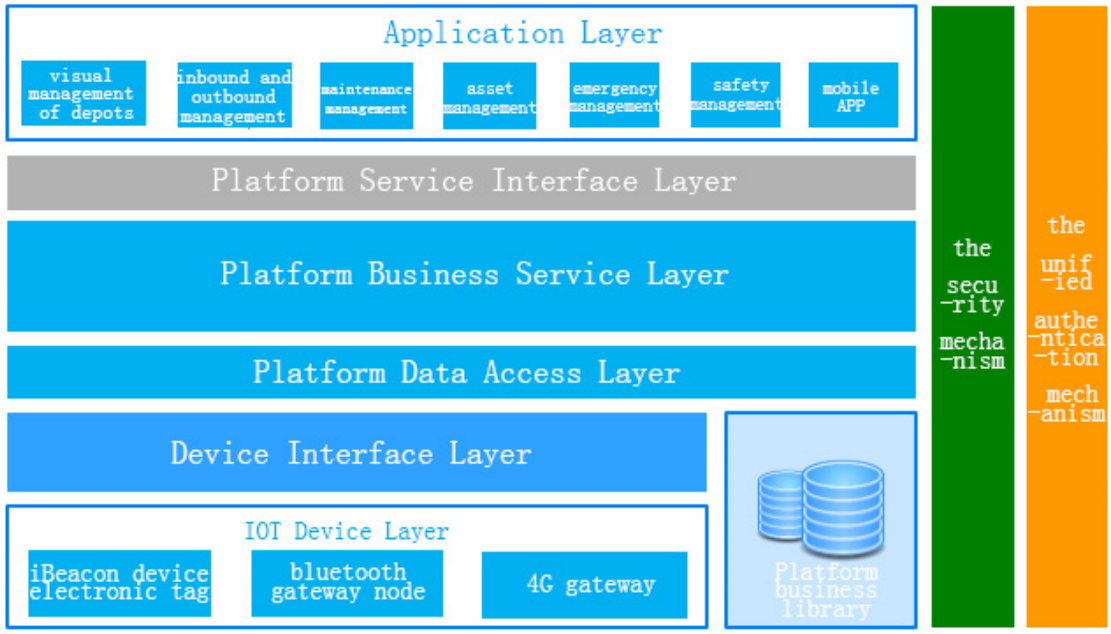

Figure 2. Intelligent management platform architecture of ship oil spill emergency equipment depots

1. At the bottom is the IOT device layer, which consists of electronic tags hanging on storage equipment and materials, bluetooth gateway nodes in the depots and 4G gateway deployed outdoors. The electronic tag sends data to the indoor bluetooth gateway in the form of bluetooth broadcast, and then the bluetooth gateway sends data to the outdoor 4G gateway through microwave signal. Finally, the outdoor 4G gateway sends data to the Internet of things access server through 4G network.

2. The Internet of things access server provides the device interface to ensure that the device can send data up and provide the upper layer with data acquisition and control functions of the device.

3. There are mainly two types of data in the system, one is the data submitted by the equipment, and the other is the business data. Device data can be entered into the database through the device interface layer, and the business data can be directly read and written from the database by the data access layer. Its advantage is that the separation of data operation and business can achieve good scalability.

4. The business service layer of the platform mainly realizes the business logic, which is the core part of the system, including equipment depots management, equipment management, Internet of things terminal management, business flow management, emergency capacity analysis, configuration, authority, resources, accounts, users and other business modules.

5. The platform service interface layer provides REST API calls of various business logic, provides interfaces for specific applications on the upper layer, which effectively realizes high cohesion of business logic modules and low coupling between modules, and provides access capability for a variety of application terminals.

6. Application layer, mainly realizing various specific application functions, such as visual management of depots, inbound and outbound management, maintenance management, asset management, emergency management, safety management and mobile APP functions.

7. Provide the unified security mechanism and authentication mechanism of the system, ensure the security of operation and data from the perspective of functional permissions and data permissions, and ensure the security of the network layer by HTTPS transmission.

3. System hardware design

As shown in *Fig. 3*, the system is mainly composed of hardware devices and data management platform. The hardware part mainly includes device electronic tag, indoor location gateway, depots gateway and various mobile gateway. The device electronic tag takes the initiative to upload various

status information of the device to the indoor location gateway. The indoor gateway will upload the collected device status information and the location information of the device to the depots gateway. The depots gateway will upload the received information to the cloud through the wired/wireless network to complete all information collection processes. The data management cloud platform realizes the unified management of all devices and gateway data at different levels, deploys development and application platforms, and provides services at different levels and purposes for different users.

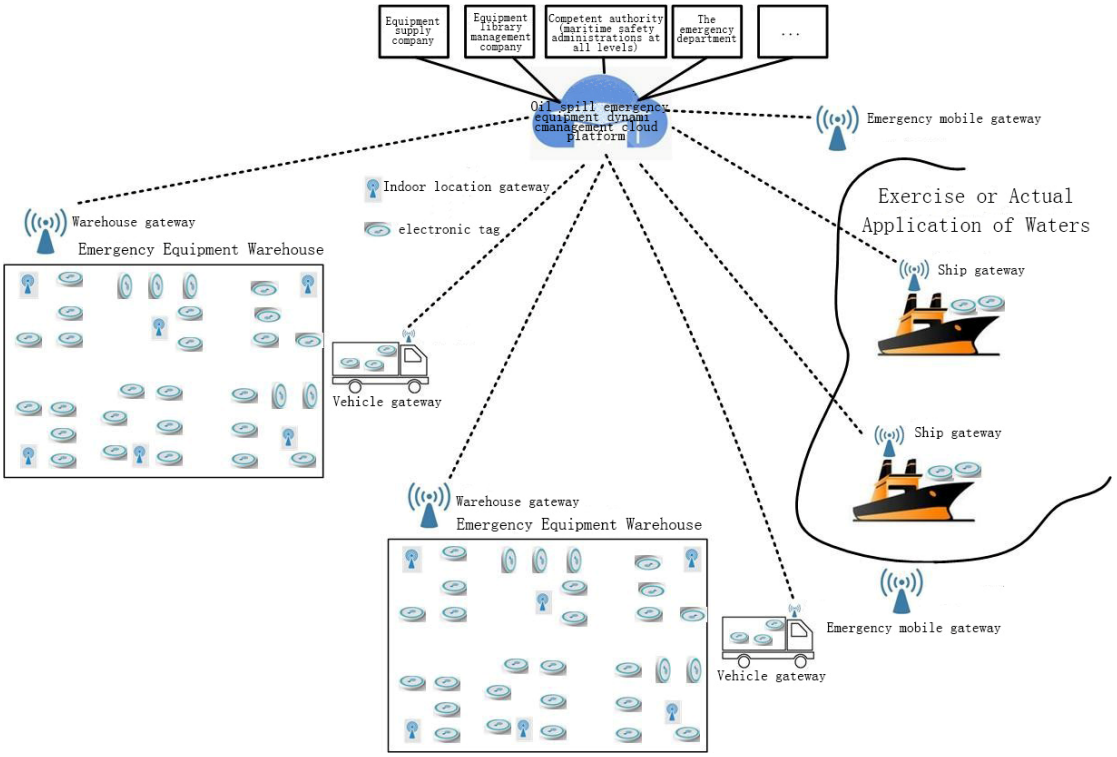

Figure 3. Hardware module of intelligent management platform for ship oil spill emergency equipment depots

4. System software design

4.1 Service Oriented Architecture (SOA) Software Architecture Model

The implementation of SOA can combine the original system business functions according to requirements and compose them into new business systems and data structures, thus it can meet the demand of new business, providing business and servicing innovation. SOA can also decrease costs and increase the efficiency of resource use, reducing the maintenance work, potential risk, management and supervision of investment while keeping the data consistency, integrity and timeliness. The whole information service platform system establishes the SOA software architecture model, and the distributed technology system of WEB services is supreme. The platform system takes WEB services as the standard service interface of the system, which can provide metadata reporting, query and reuse conveniently.

4.2 Encryption Technology Based On Secure Sockets Layer (SSL)

Secure socket layer (SSL) is a set of encryption technology that provides authentication confidentiality and data integrity. In the whole user system, it is necessary to use the authentication mode of user permissions. For different roles, it allocates the access permissions to different modules or programs to ensure the security of access.

4.3 Application Of Enterprise Service Bus (ESB) Technology

Enterprise service Bus (Enterprise service Bus, ESB) is the infrastructure of SOA, and it is a combination of traditional middleware technology and XML, WEB services and other technologies. As SOA design patterns, the ESB provides the message mechanism which is developed and based on the standard. The ESB as a smart, distribution, and the transport layer, used to connect with other systems and data Services which is necessary to build a platform. It applies services to interactions between other components through standard adapters and interface providers. ESB is an intermediate medium to realize intelligent integration and management of servers. Its purpose is to integrate the interaction of different hardware, systems, databases and interaction of programming languages and to provide SOA with service communication, collaboration and combination based on network distributed bus.

4.4 Internet Of Things Framework And Its Application Based On LoRaWAN

According to the characteristics of large number of oil spill emergency equipment warehouse, the maneuverability of application and deployment, the system adopts the Internet of things architecture based on LoRaWAN.

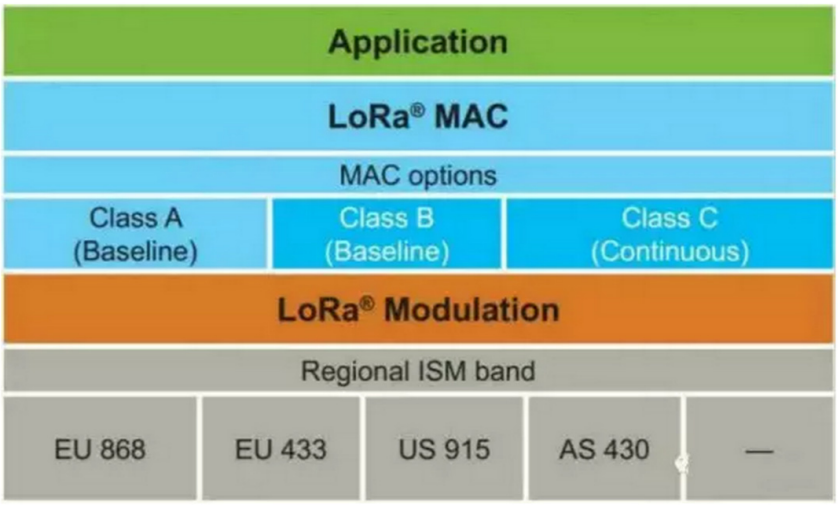

Figure 4. Protocol hierarchy of LoRaWAN

LoRaWAN is a low power wan specification, based on the MAC layer definition, facing Internet of things applications (*fig. 4*). The specification mainly uses LoRa modem to support most Internet of things applications. LoRaWAN is a specification that addresses challenges of market security, energy efficiency, roaming and on-boarding for Internet of things. It fully considers various factors including the node power consumption, network capacity, QoS, security and network application diversity in the protocol design and network framework. Its main features include:

Bi-directionality: it is critical that any LPWA technology provides full bidirectional communication; any device can report to network (called the UpLink message) and could be controlled by network (called the DownLink message) which makes sense in many ways, such as on-boarding of devices, network management, and many other applications that need to use acknowledgement or device actuators.

Security: LoRaWAN uses the generation mechanism of intelligent key similar to the financial industry to provide data authentication and end-to-end payload encryption.

Easy debugging: under the LoRaWAN protocol, a wide range of devices can be used to seamlessly configure on-boarding without requiring the distribution of SIM cards.

Geolocation: LoRaWAN uses the free GPS geographic position function to seamlessly plan device roaming inside and outside the network at a reasonable cost.

Scalability: LoRaWAN supports scalable connection of terminal devices from thousands of to millions or even billions .

Standardization: Through LoRa alliances, wide range of ecosystem partners use the same standards to create networks.

5. Conclusion

With the rapid development of economy in our country, the increase of domestic demand for oil has promoted the prosperity of shipping oil import and export industry, and ship trade volume in the port also increases rapidly, while it also brings the serious risk of marine oil spill pollution. Therefore, the requirement of emergency equipment depots for marine oil spill and demand for its function is also higher and higher.

This article designs the intelligent management platform of the ship oil spill emergency equipment bank from both hardware and software, with the application of the modern Internet of Things technology, build a unified data resource management cloud platform by using remote electronic label and indoor positioning technology to collect the emergency equipment position, parameters and state information in real time. on the basis of centralized access of IOT equipment, dynamic management of warehousing equipment and materials should be carried out to realize automation and procession of daily management such as warehousing, outgoing, returning, maintenance and scrapping of equipment. Through the combination of web and APP, mobile command and scheduling coordination tools are provided for a variety of users, including competent authorities, regulatory authorities, depots management departments, equipment suppliers, etc., so as to realize integrated supervision and one-stop application. It greatly improves the informatization degree and management efficiency of the ship oil spill emergency equipment depots, and provides a guarantee for the timely treatment of emergency accidents.

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