Design of OPC/DDP-Based Remote Monitoring System for Environmental Protection of the IoT

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Abstract. With the acceleration of industrialization and the increasingly serious environmental problems, environmental protection of internet of things (EPIoT) has been recognized as an efficient way for developing green industries. By analyzing the OPC protocol for the data acquisition and the DDP communication protocol for the data transmission, this paper designs and implements an OPC/DDP-based monitoring system, including automatic monitoring on environmental data, efficient data acquisition, remote scheduling of devices, remote and real-time data visualization. Furthermore, the system uses a reverse proxy technique in data processing to achieve cross domain management and keep the session. The system effectively solves the problem of collecting data and visually displaying data under severe environment. In addition, the design process is optimized by the remote control. Finally, the system provides a reliable support on the decision for environmental management.

Keywords: Environmental protection of Internet of Things · OPC · DTU · Data collection · Data transmission · Visualization

1 Introduction

Behind the tendency of rapid economic development, the environment problems, such as sewage from factories and ecological deterioration, become very tough. In the field of environmental protection, the construction and application of the Internet of Things (IoT) has become an important way to promote the upgrading of environmental management. The IoT-based application can further foster and develop a new strategic environmental protection industry, and has great impact on promoting the development of environmental protection in China.

In the environmental monitoring, the application of the IoT has become the trend technique for deployments [1]. Most of the traditional systems of environmental protection only involve a single data collection mode, and hence, the reliable data acquisition and transmission is not achieved. Moreover, the collected data can not be efficiently and visually displayed in those traditional systems. In order to solve these drawbacks, we propose an automatic monitoring system based on open platform communication (OPC)/DTU & DSC communication protocol (DDP) for environment of things. Based on the reliable data collection and transmission of OPC/DDP, the system involves smart collection, transmission storage and visualization of data generated by various automatic

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environmental detection equipment. It divides into four stages, including environment sensing, data transmission, data center and payment. In addition, the system can support reliable decisions based on the data analysis.

In this paper, the OPC/DDP-based monitoring system is designed to allow various types of environmental perception elements and highly reliable data transmission using multi-protocol and multi-target. The system uses B/S platform to remotely coordinate various equipment with the aim of completing the effective control of environmental parameters, and visually display of the monitoring data.

The rest of the paper is organized as follows. Section 2 reviews the related work of environment protection of the IoT. The implementation of the proposed system is detailed in Sect. 3. Section 4 concludes this paper.

2 Related Work

Environmental protection of Internet of things refers to the traditional environmental protection industry to introduce automation and information technology to achieve scientific management of environmental protection system network, to build all-round, multi-level, full coverage of the ecological environment monitoring network [1]. To promote the efficient and accurate transmission of environmental information resources, through the construction of massive data resource center and unified service support platform to promote the ecological civilization construction and environmental protection scientific development goals [2].

At present, the Internet of Things at home and abroad has played a great role in environmental protection such as pollution prevention, ecological protection and so on. As of the first half of 2015 the country has 32 provinces, autonomous regions and 9,567 key sources of pollution to implement automatic monitoring. Jiangsu Province has completed the construction of heavy metal monitoring in Suzhou, Taihu Lake cyanobacteria, ammonia nitrogen, total nitrogen monitoring [3]; Wuxi focus on pollution sources and all key radioactive sources automatic monitoring system; Shanxi Province in more than seven hundred key enterprises set up intelligent monitoring Inner Mongolia Autonomous Region has also built a concept of environmental protection based on the concept of environmental monitoring platform to achieve a mobile device based on the environmental emergency and law enforcement applications [5]; Jiashan County, Zhejiang Province, the implementation of environmental monitoring, monitoring, monitoring, Also has completed the “environmental decision-making integrated information system”, “intelligent pollutant total control system” and other sets of environmental protection system of things [6].

3 System Design and Implementation

3.1 Remote Monitoring System Components

Environmental protection equipment Remote monitoring system is a combination of hardware and software systems. It is necessary to have the functions of collecting, real-time online communication, alarm management, remote control, data storage, device data query, system log, setting and so on for monitoring data and running parameters generated by automatic monitoring equipment. At the same time also need to have strong anti-jamming capability, fault fast processing, data transfer and other functions.

The system consists of equipment layer, network layer, application layer composed of three levels. Environmental protection equipment remote monitoring system framework shown in Fig. 1.

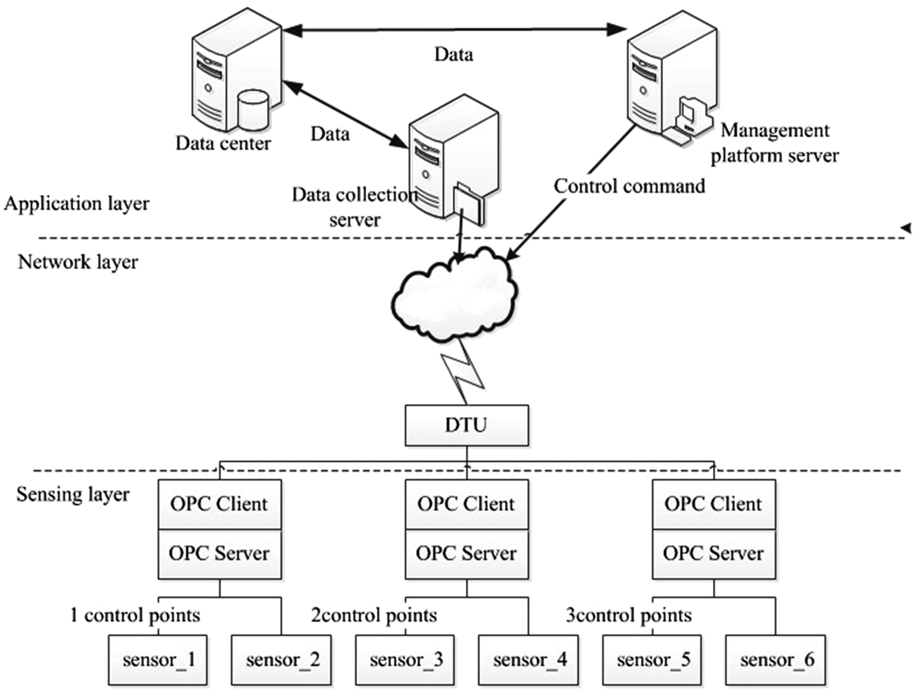

Fig. 1. Environmental protection equipment remote monitoring system frame diagram

3.2 Data Acquisition Based on OPC Client Function Design

Data acquisition based on OPC client development, the structure is shown in Fig. 2.

Data collection the client is mainly composed of three parts. Responsible for data acquisition of OPC client, the data real-time processing of data management module, and RS232 agent for sending data.

The realization of the detailed below two parts:

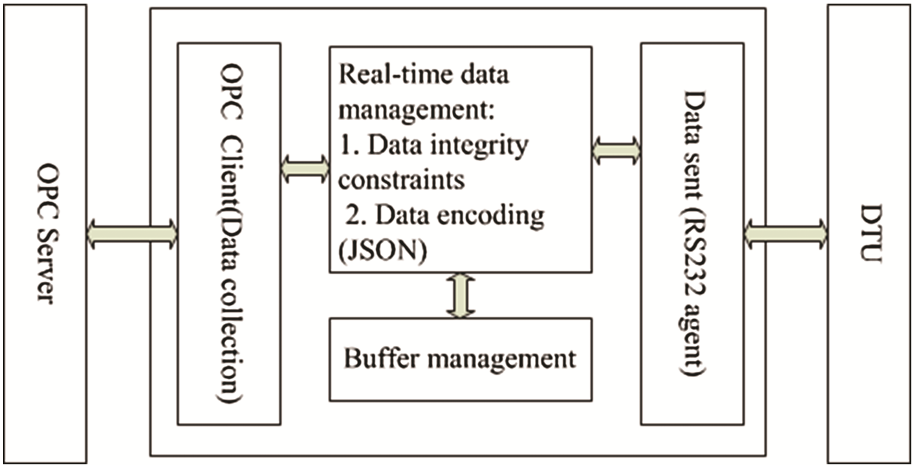

Fig. 2. Data acquisition client structure

The OPC Client. Data acquisition client using C# programming, the realization of OPC client process generally includes the object's statement, the server connection, add group and a data item and read data. Client implementation steps:

1. The OPC client initialization.
2. The OPC object statement with the server connection, the object of declaration is the required data items are defined. To connect to a remote server, you must have the remote server's IP address (opcServerIp) and remote server name (opcServerName), and then connect to the OPC server via opcServer.Connect (config.opcServerName, config.opcServerIp).
3. Create a group and add data item. First create the group with the code opcGroups = opcServer. OPCGroups; opcGroup = opcGroups. Add (OPCGROUPNAME); then set the group properties, including group activity status, group update time, and so on. Finally add data items, code opcItems = opcGroup.OPCItems.
4. The OPC data read. Mainly through the Group's KepGroupDataChange event trigger to achieve.

The Realization of the RS232 Agent. Data acquisition client data needs to be sent by the network layer DTU to the data center, data acquisition client via a serial port to send data to the DTU.

1. Initialize the port function.
   Parameter Description: rs232Config: portName: "COM3", baudRate: 57600, dataBits: 8, stopBits: 1, parity: 0.
2. Handshake signal control.
3. Send data. public MessageSender (OpcServerConfig config, RS232Proxy rs232) this.config = config; this.rs232 = rs232.

3.3 DDP Protocol Design

DDP (DTU & DSC Communication Protocol) Communication Protocol is DTU (Data Transfer Unit) and DSC (Data Service Center) between the Communication Protocol. DTU (Data Transfer Unit), it is specifically designed to convert serial Data to IP Data or converts IP Data to serial Data transmission through wireless communication network of wireless terminal equipment [7]. DTU are widely used in meteorology, hydrology and water conservancy, geology, environmental monitoring, etc. [8]. (1) Its core function is the internal integrated TCP/IP protocol stack. (2) To provide two-way serial data conversion function. (3) Support automatic heartbeat, permanent online. (4) Support parameter configuration, permanent preservation. (5) support user serial port parameters Settings, etc. [9]. DSC (Data Service Center) is used to manage the DTU and DTU Data sending and receiving service software, it needs to be done through the dynamic library development kit and DTU communication between. Dynamic library includes and DTU communications required for all API functions, including the start of the service, service

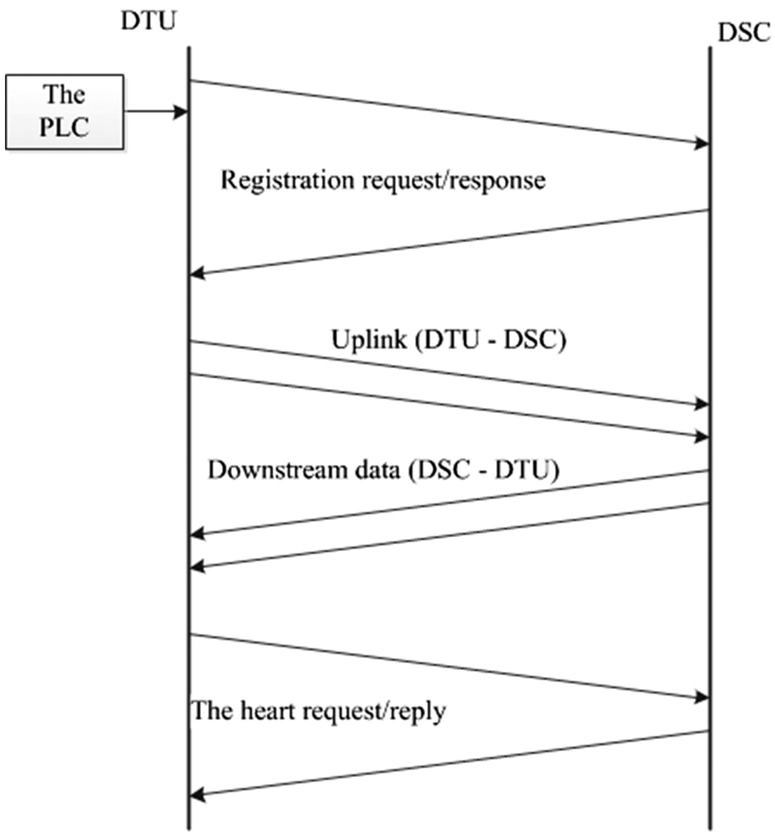

Fig. 3. DTU shake hands with DSC communication process

to stop sending, data receiving, data, parameter configuration, parameters in the query, etc. [10]. DTU with DSC communication process as shown in Fig. 3.

At this point DTU as a client, on-site PLC equipment to establish a connection with the DTU first, through the serial port to send data to the DTU, DTU and the data center to establish the connection through the registration package protocol to complete the connection process. After the connection, DTU and DSC data transmission between the transmission process, if there is disconnection and other circumstances, the heartbeat packet protocol to complete the disconnection automatically reconnect, automatic redial and other functions. To ensure the effective transmission of data.

3.4 Realization of the Function of the Cross-Domain and Keep the Session Based on the Reverse Proxy

Reverse Proxy (Reverse Proxy) is a proxy server to accept the connection request on the Internet, and then forward the request to the server on the internal network; and the results obtained from the server to return to the Internet request to connect the client, this When the proxy server on the performance of a server [11]. The usual proxy server, only for the proxy internal network connection request to the Internet, the client must specify the proxy server, and would have to be sent directly to the Web server http request sent to the proxy server. When a proxy server can proxy a host on an external network and access the internal network, this proxy service is called a reverse proxy service [12].

1. Cross-domain functions based on the reverse proxy.
   Cross domain is yes the script for the browser cannot perform other web sites, it was caused by the browser's same origin policy, is a browser security restrictions on javascript. In this paper, using NGINX reverse proxy cross-domain. Configure NGINX, multiple prefix in a server configuration for forwarding the HTTP/HTTPS requests to multiple real servers. All the URL on the server is the same domain name, protocol and port, for the browser, these urls are homologous, thus there is no limit to the cross-domain.
2. Session to maintain function based on reverse proxy.
   The client and the server often need to interact through many times of complete interaction at a time. Due to the interaction with the user's identity is closely related, therefore, related to the client application requests, often needs to be done forwarded to a server, and can't be load balancer forwarded to a different server for processing. So we need to keep on the load balancing configuration Session (Session Persistence) mechanism. The principle of Cookie session remains as shown in Fig. 4.

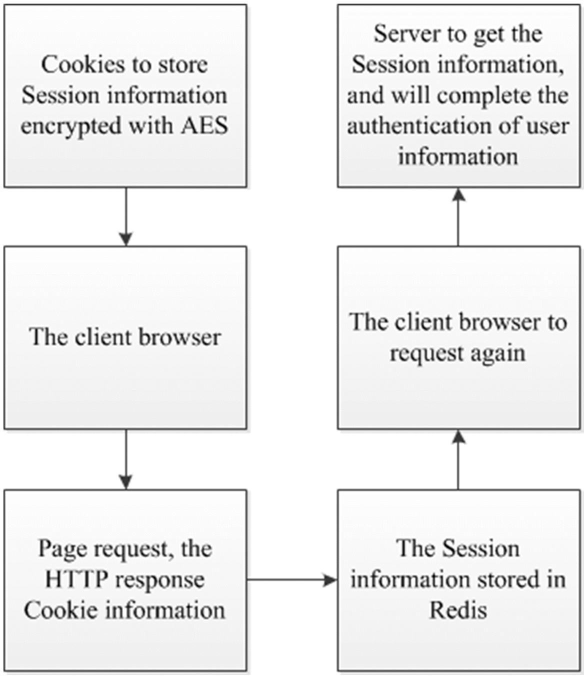

Fig. 4. The session workflow

3.5 The Implementation of Remote Monitoring System

Remote monitoring system to realize the function of remote monitoring of environmental data, it completed the real-time collection of field data, the security of the data transmission, data storage, data processing, data management, and other functions. In the process of data collection, using OPC architecture to complete real-time data acquisition; Communication protocol by DDP, terminal equipment and data center for the customer to build a wireless communication link, sends the data to the Kafka, ensure the safety of the data sent to the data center.

In the realization of the function of management, adopts B/S structure, using the bootstrap front-end framework for equipment, DTU, OPC client, data visualization, etc. Using a reverse proxy technology solves the problem keep the session, add the authentication. Server when the user login to set a cookie information encrypted with AES, at the same time will be the value stored in Redis, when a user request again, will bring back the cookie information parsing, if the server can parse correctly, remove the user information, the user authentication through, and then query the user's role, through the role of user menu list and interface permissions, validating the user interface of the current request permissions. Management platform management interface includes device management, protocol management, DTU management, project monitoring, system management. In the main interface shows the DTU status information, all the environmental monitoring points of the data statistics, abnormal circumstances such as real-time alarm information. Figure 5 is a real-time monitoring of the state of the enterprise production line, the figure shows the real-time data for each collection point, the abnormal situation of the alarm information, while silane can wash the various parts of the remote control system, the basic data analysis, To provide decision makers with accurate scheduling support.

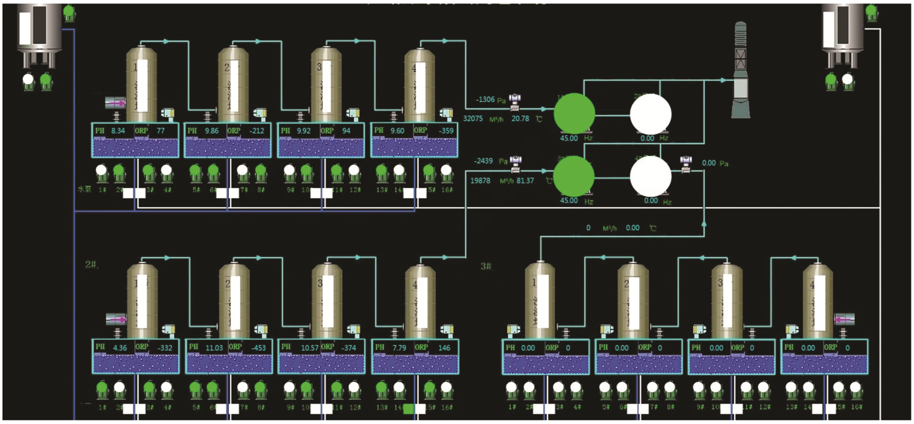

Fig. 5. An enterprise production line state of real-time monitoring

4 Conclusion

This paper designed and implemented a remote monitoring system based on OPC/DDP for environmental protection. The system not only has the "cross domain management, keeping the session, WEB publishing" properties, but also has a remote control, authority management, warning processing, visual display, etc. However, The completeness and security of data transmission is still an open question since the data transmission in DDP is transparent, which is left as a future study.

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