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An Electric Power System Protocol Conversion Method Based on Embedded Platform

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***Abstract*—In the electric power systems, there are many different types of equipment with a variety of different functions. They need to communicate with each other through all kinds of hardware interfaces and software protocols. With the construction of electric power data network and the improvement of automation, remote control system in general will be replaced by dispatching automation system, which merges with computer, protection, control, communication network and other technology. And all kinds of information collect systems will also plug into it. However, there are many kinds of interfaces and protocols used in the collection of information. There is no uniform standard for all kinds of communication, which hinders the interconnection between systems and devices. Protocol conversion technology is an important method to solve this problem. In this paper, we present a new protocol conversion method based on embedded platform. Our method provides a modular function for setting up all kinds of communication interfaces; provides another modular function for all kinds of communication protocols; and provides interactions with the two modules. Our method has been successfully applied to a number of electric power monitoring systems, which proves the practicability of it.**

Keywords-electric power system; protocol conversion; embedded platform

I. INTRODUCTION

In the electric power systems, there are many different types of equipment with a variety of different functions. They need to communicate with each other through all kinds of hardware interfaces such as RS-232, RS-485, RS-422, Universal Serial Bus (USB), Ethernet, Controller Area Net (CAN) and Local Interconnect Network (LIN). They also need to use all kinds of software protocols such as Modbus, IEC60870-5-101(IEC101), IEC60870-5-103(IEC103), IEC60870-5-104(IEC104), IEC61850 and IEC61400-25. Along with the development of electronic technology, all kinds of instrument are more and more used in automatic control equipment and monitoring system [1-5]. With the construction of electric power data network and the improvement of automation, remote control system in general will be replaced by dispatching automation system, which merges with computer, protection, control, communication network and other technology. And all kinds of information collect systems will also plug into it. However, there are many kinds of interfaces and protocols used in the collection of information. There is no uniform standard for all kinds of communication, which hinders the interconnection between systems and devices. Protocol conversion technology [6-8] is an important method to solve this problem. A fully functional protocol conversion module comprises a data receiving unit, a data conversion unit and a data transmission unit. The data receiving unit and the data sending unit receive / send a private protocol data by different communication protocols. The data conversion unit converts private protocol. The data of different protocols is received by the data receiving unit. After being converted, the type of the data is changed into another one, and then it is transmitted through the data sending unit. When there are many kinds of private protocols, the protocol conversion module needs to have a good scalability to support the increase of the data of different protocol types. The current protocol-converter systems mostly make one-on-one protocol conversion, and have single function, limited processing capacity and low scalability as illustrated in Figure I.

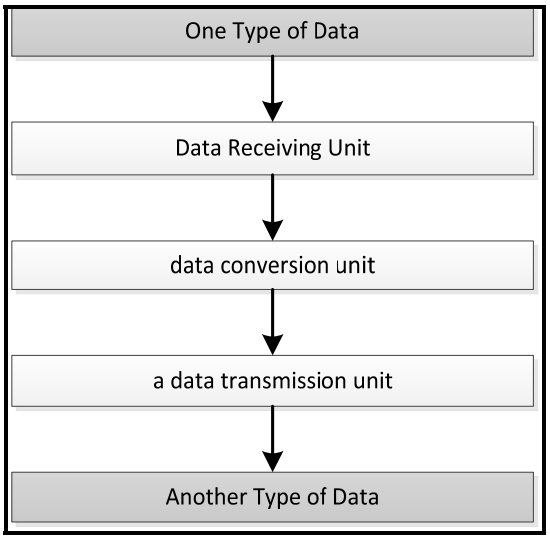

FIGURE I. CURRENT SYSTEMS FRAME

In this paper, we present a new protocol conversion method based on embedded platform.

II. SYSTEM FRAMEWORK

A. Composition

With the progress of the embedded technology [9-12], a complete embedded platform was used to make a protocol conversion device, which had a processor module, a communication module, and a memory module. The embedded platform is very rich in resources, including a variety of communication interface and a Microcontroller Unit (MCU) whose processing capability is improving. Our protocol conversion device based on embedded platform can

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handle various communication protocols and data processing as illustrated in Figure II.

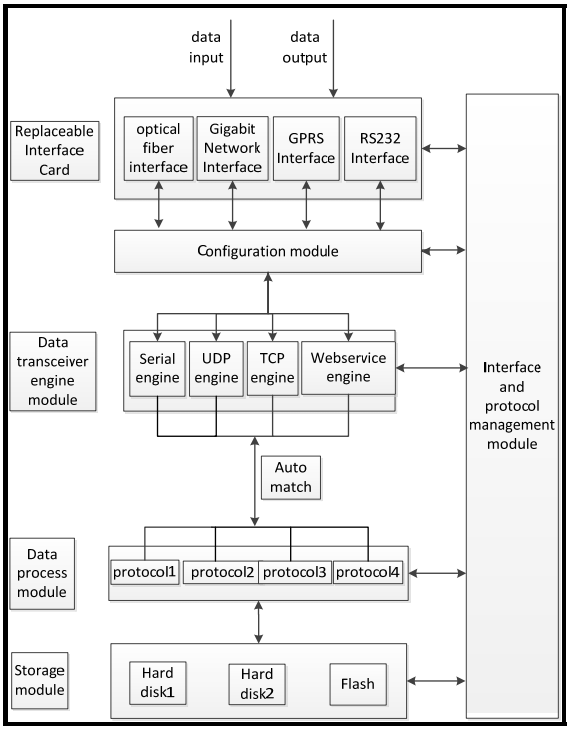

FIGURE II. COMPOSITION

We provide a protocol conversion method based on embedded platform. The method established one data transceiver engine module for each of communication protocols to support the expansion of communication protocols; established one data process module for each of business protocols to support the expansion of business protocols.

The method also provides real-time monitoring of the device signal. According to the monitoring device's own heartbeat information, it can achieve the status and alarm of the device by remote monitoring. And it can make remote network management include equipment timing, parameter setting, reset operation, restart operation and so on.

Each module and its corresponding functions are as follows:

(1) Replaceable Interface Card: Provides interface with other devices, supports power, optical interface, and can be extended. It completes the signal to send and receive.

(2) Data transceiver engine module: In charge of data receiving / sending and data distribution, it contains a data buffer to receive the data sent by other functional modules.

(3) Data process module: Automatic matching of the corresponding data transceiver module, data processing and conversion. It also comprises a data buffer for receiving data from the data receiving and sending module.

(4) Configuration module: Create a configuration file for all the data configuration data transceiver module and data processing module.

(5) Interface and protocol management module: Provide management and control of the physical and logical modules of the device, connect the PC network management client, and provide online data and chart analysis and remote maintenance control function.

(6) Storage module: Establish a database for time series to save the monitoring data, and can choose according to the hard disk or Flash mode.

B. Data Flow

Let us suppose that there is a protocol conversion between protocol 1 and the protocol 2. The data flow of the protocol conversion method is shown in Figure III.

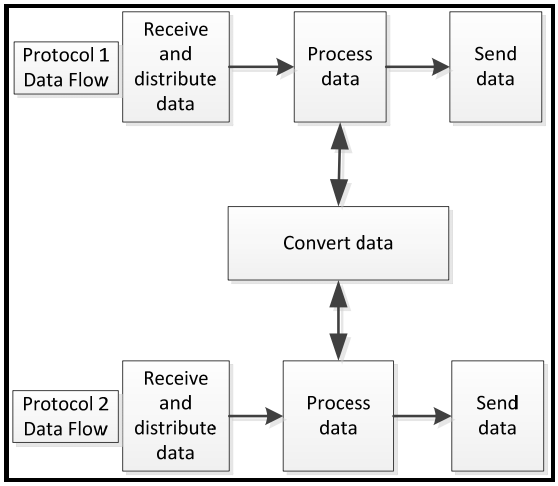

FIGURE III. DATA FLOW

First off, the data of protocol 1 is received through communication interface of the embedded platform. Then, according to the protocol type, the data is distributed and processed. By the result of processing, the data may be converted into the data type of protocol 2 and then starts the process of protocol 2; or the data may do other processing. The data flow of protocol 2 is similar to that of protocol 1.

C. Modules

Our method is realized by the cooperation of data transceiver module and data processing module. The data transceiver module is matched one-to-one with each communication interface, such as serial communication, UDP, TCP and Web Service. It provides transceiver function for each communication interface. So if the communication interface is changed, we only need to add a new data transceiver module; if it is not changed, we can use the same data transceiver module to receive the new data. The data transceiver module also needs to distribute the data: making a simple analysis for the data received and sending the data to the data processing module.

The data processing module is matched one-to-one with each business protocol, such as IEC101, IEC103 and son. So if the business protocol is changed, we only need to add a new data processing module; if it is not changed, we can use the same data processing module to process the new data. The data processing module needs to process and convert the data: judging the data validity, making a complete analysis for the data received, responding data and turning the data and sending data to the data transceiver module.

In the case of using different communication protocols to access the different types of data, the reuse of functional modules makes the system easy to implement. Just configure the corresponding data transceiver module and data processing module for the new data; you can achieve the protocol conversion of the data.

In order to realize the mutual transformation of various communication protocols, the data processing module in the device adopts the parallel processing mode, and each data conversion is carried out simultaneously.

D. Implementing Ways

The implementation of our protocol conversion method depends on the hardware resources of the embedded platform and the function modules of the software method. It establishes the main control framework for the entire protocol conversion program, responsible for the program's entry, exit function module loading as well as other functions such as watchdog and so on. An independent data transceiver module is established for each communication protocol, and it contains a data buffer to receive the data sent by the other function module. An independent data processing module is established for the each business protocol, the data processing module also contains a data buffer to accommodate the data sent by the data transceiver module. A configuration file is created for the data transceiver module and data processing module of each protocol conversion.

III. APPLICATION INSTANCE

In the program, Research on the Business System Architecture Based on Distributed Technology, our method was applied to the protocol conversion projects in several power systems, such as transformation equipment monitoring system, transmission equipment monitoring system, wind farm system and so on, as illustrated in Figure IV.

The basic design idea of this system is using a number of different types of communication interface to receive signals from the monitoring device and unifying all the different professional format of the monitoring information into a standard format. The signal is being processed, at the same time it provides the function of on-line monitoring data collection, comprehensive analysis, fault diagnosis, monitoring and early warning, data storage, standard data forwarding and remote network management and maintenance. These communication interfaces include: optical fiber interface, network port, serial port, GPRS interface, etc. It is used in between the monitoring device and the main station monitoring system, the controller receives the monitoring information, will be converted into the standard data, through specific interface is transmitted to the master system, and transmitting control instruction can receive real-time master system of monitoring device for operation. The controller sends the information of network management to the central management computer through Ethernet, and completes the network management function.

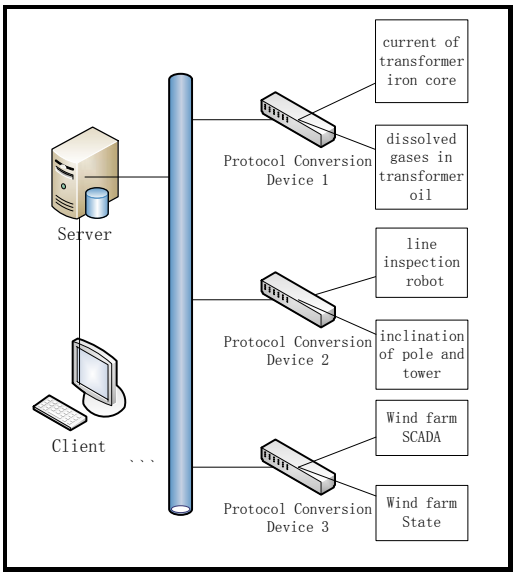

FIGURE IV. APPLICATION INSTANCE

IV. SUMMARY

The demand for data exchange between the different data acquisition equipment and control equipment has been on the increase in recent years. The protocols used by different equipment are not the same. Using a single communication protocol to complete all of the data exchange has some difficulties in the current application situation of complicated protocol. Communication protocol conversion system is the current popular solutions. Existing communication protocol conversion systems are characterized by task centralized processing, high integration degree and high hardware requirements. They cannot satisfy the increasing of protocol conversion requirements. A new communication protocol conversion method is proposed and implemented in this paper. The new method adopts the modular design, which is divided into three parts: the implementation framework of communication protocol conversion system, the configuration tool and the protocol executable program. The user can choose different protocol executable program to build in line with their needs of the available system. That can effectively solve the existing communication protocols conversion problem faced by the system. The system development related to technology was described in detail. In view of the embedded system technology is relatively mature, and the stability is high, a scalable communication interface more and more, the cost is low, easy to deploy, so this paper chooses embedded devices as the protocol conversion device software and hardware platform. In this paper, several communication protocols which are common in current control and communication field are selected to test the protocol conversion. These protocols are very market prospects of the

communication protocol, and there are large differences in the working mode and frame structure, represent a large number of different communication protocols. So it is of strong model significance to converting them. The operation effects of the realization of the communication protocol conversion are displayed and analyzed. The performance of the system, including system resources occupancy rate, stability, protocol conversion reliability and system can scalability is measured.

Test results show that the proposed communication protocol conversion system can effectively solve the problem of system performance bottleneck in the case of increasing the size of the protocol conversion, and it can meet the requirements of the actual production.

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