The Real-Time Database Application in Transformer Substation Hotspot Monitoring System

Feng Zhao*, Qiao Sun**, Jingyu Zhan***, Ling Nie***, Zhiqiang Xu***

*Department of Electrical Engineering and Automation, (China Electric Power Research Institute)

**Department of Communications &Information Engineering, (Beijing GuoDianTong Network Technology Co., Ltd)

***(Beijing GuoDianTong Network Technology Co., Ltd), China

feng_zhao@sgepri.sgcc.com.cn, sunqiao@sgepri.sgcc.com.cn, zhanjingyu@sgepri.sgcc.com.cn, nieling@sgepri.sgcc.com.cn, xuzhiqiang@sgepri.sgcc.com.cn

***Abstract*— Because of using relational database, there exists difficulty in real-time data processing and data analysis in traditional transformer substation hotspot monitoring system. And even some important functions are not implemented, such as real-time alarm and real-time statistics. In this regard, this paper introduces real-time database to transform the traditional system. The use of real-time database achieves fast and real-time storage of temperature data, as well as intelligent data processing and analysis. And external display and real-time alarm functions are also achieved, which strengthens the safety management of substation.**

***Keywords*— Transformer substation, Hotspot monitoring, Wireless interface, Real-time database, Relational database**

I. INTRODUCTION

Substation hotspot monitoring system is a real-time temperature monitoring system based on wireless sensor network (WSN) technology[1]. A number of radio base stations are laid in right place, and at the same time a plurality of wireless temperature sensors are laid on the electronic devices which temperature is needed to monitor. Then a wireless temperature sensor network is constituted, which can be used to monitor the temperature of different locations inside the cabinet. The main function is to monitor the abnormal temperature of electrical equipment due to overload, tighten loose and poor heat dissipation. The traditional substation intelligent monitoring system is divided into three parts, including the management center, data transmission base stations and wireless temperature sensor points[2]. Current management center control console uses a relational database to manage and analyze temperature sensing data. Because of this, real-time data acquisition is not satisfied. In addition data analysis function is imperfect and the means of system visual display is not rich enough, lacking dynamic display similar to SCADA system. This article is mainly to improve the aspect of management center. The article is intended to achieve functions of real-time data acquisition, display, statistical analysis and alarm through the use of real-time database.

II. REAL-TIME DATABASE INTRODUCTION

There are a variety of standard access interfaces in real-time database, enabling a wide range of data acquisition. The collection frequency can be up to milliseconds and especially more suited to the occasion of collection volume continuous change with time. System administrators can also set the appropriate compression ratio for a single collection volume according to the range of collection volume and the actual needs of the scene, which can save storage space and achieve mass data storage capabilities in the premise that no data is lost. The real-time database not only has its own real-time database management tool but also have rich peripheral components which can be easily used to draw the logical picture of site production processes, make data reports, show real-time data trends and web publishing, etc[3].

In substation Intelligent hotspot monitoring system, temperature sensing data is constantly changing with temperature changes in the environment, and the system is needed to achieve real-time display of temperature data, alarms, as well as historical data analysis, trend analysis, curve inquiry, correlation analysis and other functions. Because real-time database is suitable for processing rapidly changing data and transaction processing with time constraints, the use of real-time database can better achieve substation intelligent hotspot monitoring system.

III. SYSTEM DESIGN

A Architecture Design

Traditional hotspots monitoring system is divided into three parts, including the management center, data transmission base stations and wireless temperature sensor points. Manage center of the hotspot monitoring system consists of a control console and configuration software. Control Panel provides a complete software function management platform that integrates a variety of

communication protocols, graphic interactive interface and a complete and stable database. This project is mainly to improve management center. Management center control console currently uses relational database to unified manage and analysis data. The project plans to use real-time database technology to achieve data management, display, statistics, alarms, and analysis[4]. System architecture is shown in Figure 1.

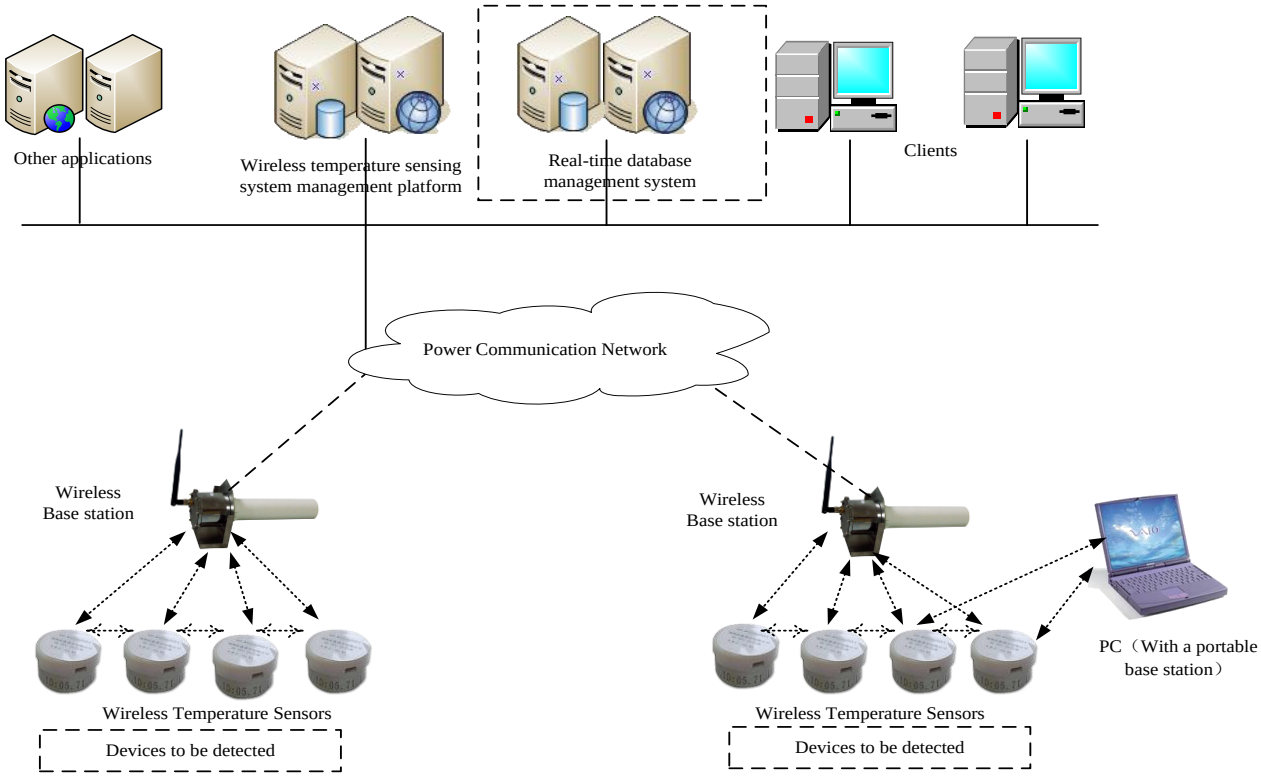

Figure1. System Architecture

B Design of Data Acquisition and Processing

Data acquisition and processing module is divided into three parts: including the device virtualization layer, communications and routing equipment components and data processing layer.

Device virtualization layer: the actual hardware device is abstracted as virtual logical device. This layer is the data base of the whole monitoring system. Input data is from a variety of different hardware devices (including status, data, alarms, etc.). Output data is in line with the system (platform) communication protocol and can be identified by monitoring system (platform). This layer provides data interface components for different peripherals and different hardware devices of different brands types which are linked into the system. Interface components are consistent with equipment. Components can be changed, added or reduced[5] .

Communication components: they are responsible for data communication components of the entire system between different layers. In addition, when the control device and the client is more than one in the background, they also provide equipment routing function. Communications and routing adopt the system-defined protocol.

Data processing layer: The data from the virtual layers device (status, data, control signals) can be automatically recognized and processed. Depending on the actual circumstances, the data is distributed to the storage, data synchronization, pre-alarm, the automatically device maintains module.

C *Interface Design*

The traditional substation intelligent hotspot monitoring system uses a relational database for data storage. Wireless temperature sensors are communicated to data transmission base stations through digital RF (2.45GHz). The 485 bus is used to communicate between base stations. Wireless temperature sensors and the ambient temperature sensors transmit temperature data to the base station through 2.45 GHz radio channel, which will be saved and recorded in the base stations. Host will regularly poll each station via RS-485 bus (or CAN). The base station will transmit the temperature data to the host, the host will process and store temperature data [6].

After the real-time database replacing the relational database, it is needed to develop data interface between API based wireless base stations and real-time database API in order to achieve real-time substation temperature data collection. The interface converter is shown in Figure 2.

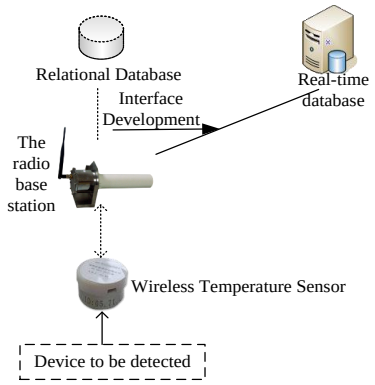

Figure2. Interface Converter

After real-time database is deployed, the mapping relationship should be built between substation temperature data and real-time database. And then move the historical data which is stored in a relational database to the real-time database. Develop data interface between wireless base station and real-time database. Then transmit temperature data from the wireless base stations to the real-time database. The replacement of relational database is finished[7].

IV. SYSTEM IMPLEMENTATION

A Real-time database deployment and data migration

First install the real-time database server and client software on one or more servers. Client software includes management tools, configuration tools, reporting tools, web display tools, etc.

The substation hotspot temperature data and ambient temperature data are named according to certain rules. Create a point list of substation hotspots monitoring data in an Excel spreadsheet. And then export the list to the real-time database using reporting tool which embedded excel and store in the real-time database by the form of real-time measurement points, The work of mapping between temperature sensor monitoring data and real-time database measuring points is finished[8].

The historical data stored in a relational database are transmitted into real-time database through the developed interface between relational database and real-time database, as shown in Figure 3.

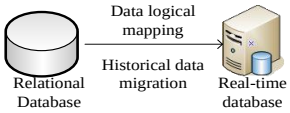

Figure3. Deployment and data migration of the real-time database

After the above steps, the work of deployment of real-time database, measuring points creation and historical data migration have been completed.

B Performance improvement

1) Real-time data acquisition

After the installation of newly-created substation hotspot monitoring system, the real-time ability of the system is tested using synchronous emulation device. The test result is shown below in Figure 4, in which the starting time is 12:29:27.844 and the end time is 12:29:27.878, 34. During this time, 34 data points were collected. It is concluded that the collection interval is up to 1 ms. Compared to the previous second-class collection frequency, the real-time ability of the system has been greatly improved.

Figure4. Test Chart

2) Data compression and storage

Because there generates a large number of temperature data in the operation of substation, it is needed to compress the data before storage. The real-time database has the function of data compression, so large amounts of data can be stored using a very small space around the premise that important data is not lost. The most common data compression of real-time database is the screw gate compression, through which the data can be compressed to 2% of the original data capacity. The data storage space is equivalent to 2% of the original data storage space after using the real-time database.

3) Graphical interface display

The site production flow chart can be drawn to achieve the graphical display of substation equipment using the real-time database configuration tool. The real-time data points can be configured on the configuration diagram, and then connect the real-time points to the dynamic map to implement the graphical display of real-time data points. At the same time, real-time database provides an Active X tool to publish the graphics on IE and the real-time data on the graphics can be displayed on running state. Compared to the graphical display of the original system, the way of implementation is more efficient.

After completion of the above, you can create upper applications based on real-time database.

The main interface of the system consists of two parts including the left administrative areas navigation and the upper function menu navigation shown in Figure 5. The upper function menu navigation includes real-time data, alarm information, query statistics, device management, user settings, help information[9].

Figure5. The main display

Alarm module includes real-time alarm and alarm recording.

Real-time alarm: The system automatically monitors hotspot device temperature value. Abnormal automatic alarm happens if the temperature is out of the normal range. Alarm levels includes ultra-high temperature, medium-high temperature, high temperature, medium-low temperature, low temperature, ultra-low temperature. And it also can maintenance alarm threshold in the device information; alarm processing: When an exception occurs , it can be processed on the abnormal alarm, but also can ignore the alarm.

Alarm records: Through query conditions, running status of the hotspot device can be checked within a period of time, and you can view the historical trend curve[10], as shown in Figure 6.

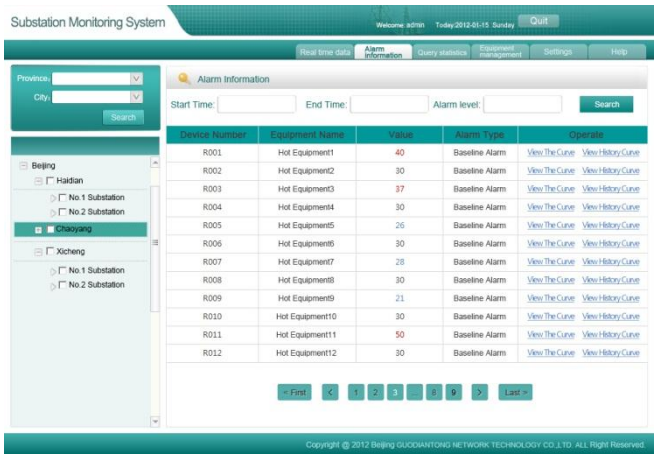

Figure6. Alarm information

V. CONCLUSION

The introduction of real-time database breaks the traditional relational database management model of substation monitoring system. Because the real-time database has the characteristics of powerful performance, high availability, ease of use, reliability etc. and as well as has rich peripheral products (configuration tool, alarm tools, reporting tools, analysis and calculation tools, etc.) for system implementation, real-time database can help to save time and reduce costs, improve efficiency and provide better decision support for the operating personnel.

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Feng Zhao: He was born in 1980.10.14, Hengshui city, HeBei province. and graduated from Beijing University of Posts and Telecommunications, master, majoring in automation .and now he is a PHD student in China Electric Power Research Institute., majoring in Electrical Engineering and Automation.

Qiao Sun : He was born in 1978.12.19, Dalian City, Liaoning province and graduated from University of Sheffield, Master, majoring in communication and information system, England,Sheffield. Now he is working in Beijing GuoDianTong Network Technology Co.,Ltd, as a general manager.