

Customized Distribution Automation System based on Wireless Ad-hoc Network

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Abstract. Aimed at the shortcomings of the existing single-function management systems of electric power marketing management at present, the energy acquisition and operation management system based on the integrated services distribution automation terminal is proposed, through using wireless ad-hoc networks and wireless mesh networking technology to solve the ‘last mile’ problem in the distribution automation system. As an instance of a wireless sensor network (WSN), it provides a highly reliable, real-time on-site intelligent network with strongly adapting to environment. This paper describes the structure of the energy acquisition and operation management system. The system seamlessly integrates power on-site management system, distribution transformer management system and automatic meter reading system to replace the previous single-function systems.

1. Introduction

With the development of the distribution network and power marketing management, the construction of distribution automation systems is in full swing. The successful cases of the power on-site management system, distribution transformer management system and automatic meter reading system within a certain region are often reported[1]. However, the above-mentioned single-function systems operate independently with little information sharing, duplication of development, resulting in a great deal of overlapping investment and the difficulty of operation and maintenance of the systems [2][3][4].

The communication channels of the distribution automation system includes the uplink channels between the host station system and the integrated services distribution automation terminals and the downlink channels among the terminals, the energy collector and the energy meter[5][6]. The uplink channel technologies, such as GPRS, CDMA, wireless network and so on, have become more sophisticated, but the ‘last mile’ problem is solved inevitably to face a series of questions: a large number of users, on-site complex and harsh environment, low-quality media and cost requirements.

According to the development of electricity marketing management, a lot of communications modes of the distribution automation system are analyzed and the wireless networking technologies of Ad-Hoc, Wireless Mesh Network, Wireless Sensor Network, Cross-Layer Optimization are studied[7][8]. The intelligent terminal with integrated services on the wireless ad-hoc network technology is developed to build a uniform power system solution, integrating of distribution transformer monitoring, automation meter reading, networking meter to replace the previous single-function systems.

2. Customized Distribution Automation System

The system focuses on an integrated services distribution automation terminal used for a variety of systems of distribution transformer monitoring, automation meter reading, networking meter, and reactive power compensation. The terminals use a low-frequency wireless ad hoc network technology with a proprietary protocol and high reliable mesh topology to build on-site communication network.

The energy acquisition and operation management system mainly consists of computer information management host station system, integrated services terminal, energy collector and

energy meters. The architecture of the customized distribution automation system is shown in Fig. 1. The uplink channel can be divided into: GPRS, CDMA, fiber, etc. Furthermore. The downlink channel uses wireless ad hoc network technology and wireless mesh topology to solve the ‘last mile’ problem.

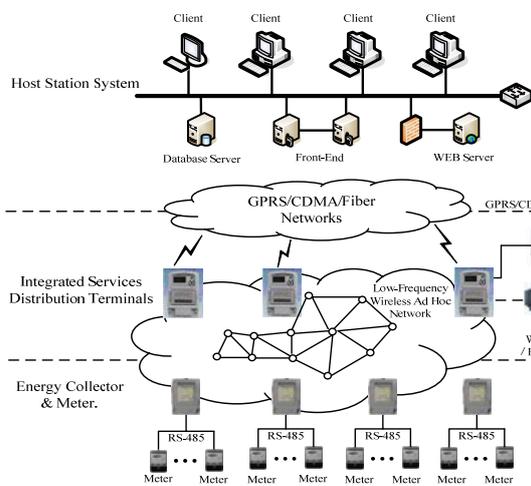


Fig. 1 Architecture of the Customized Distribution Automation System

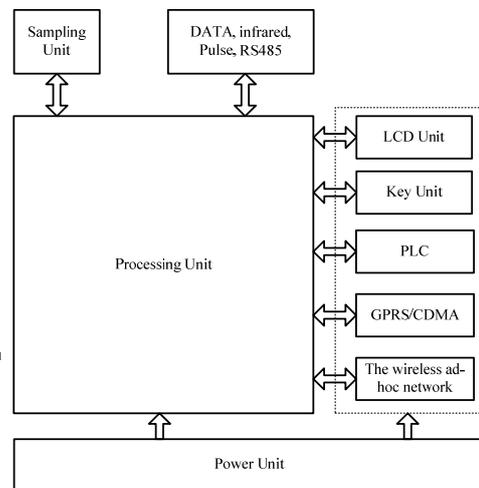


Fig. 2 Meter Collector 32-bit embedded microprocessor systems

- The host station system: The power data can be read by the host station system from the integrated services terminals through the GPRS, CDMA, optical fiber communication channel. Then, the distribution transformer monitoring system and the demand side management system will response, monitor, analyze these data. The host station system can provide load curve, distribution transformer monitoring data and line loss analysis.
- Terminals: The terminal is based on the file and mandated to collect meter reading data, after a downlink channel (low-frequency band for wireless ad hoc networks, Power Line Carrier, RS485, etc.) communicating with the energy collector to collect reading information, and analysis of the information of all meters, and through GPRS, CDMA, optical fiber uplink channel, all data is reported to the Computer Information Management master. Through its own RS485 interface, the terminal can also be copied from Reading station area and the overall table data could be achieved Taiwan area electricity on-site management. Distribution transformer to concentrate on the terminal built-energy metering functions can directly measure low-voltage distribution transformers and the measurement of power supply, and electricity sales.
- Energy meter collector: the Taiwan District, along with centralized server as a node, needs to build a high reliability, low-band wireless ad hoc networks, wireless sensor networks WSN. Watt-hour Meter Acquisition via RS485 or power line carrier collects information on residential power meter, and meter reading the data to report to Taiwan server.
- Portable device palm copy: portable meter reading device as a Pocket PC equipped with a dedicated program, portable meter reading device independent of the energy consumption data collector will work on data collection, centralized records and save them, and bring into the room after transferring to the management center computer.

3. Key Modules

3.1 The Master Station System

Master station system consists of database servers, front-end, WEB publishing server and the client computer component. Through the analysis of statements and curves to the site distribution monitoring the operation status of the unusual circumstances of the scene the system take corresponding measures to improve system reliability, reduce line losses.

Master station software provide a good interface, complying with the relevant standards, including the majority of 3 management software, front-end software and Web publishing system.

The communication front-end conversion program, which directly connected with the communications equipment, is responsible for data transmission with the terminal. Backstage management software is responsible for maintaining the system, files, data collection and data processing and analysis applications. Among the components, it is relatively independent, between the front-end and back, through the TCP/IP protocol, multi-background can simultaneously communicate with the front-end, ensuring the system characteristics of distributed applications.

Background management software includes CCMS system management master station, Distribution Transformer Monitoring Management master station, distribution transformer monitoring and analysis software, distribution transformer monitoring.

CCMS system administration master Zhao main is to collect real-time measuring a household electricity consumption information, and the curve data and other functions; system management master includes channel management, operators management, system files and file management terminal, the terminal parameter settings and query, data collection, real-time alarms, etc.; detection analysis software key features include curve and statistical data analysis, reporting and other functions; distribution transformer monitoring software is the maintenance of automated data that when reporting the data, communications, maintenance of data, alarm data, automated warehousing and processing functions; database collects data in the storage place for distribution transformer monitoring and analysis software.

3.2 Terminals

Intelligent distribution transformer based on the terminal is clearly a key component of this system, including integration of real-time distribution transformer monitoring, meter reading, network meter, as well as reactive power compensation and other functions into one.

Fig.2 illustrates distribution transformer terminals which are designed for the modules including a sample module, processing module, GPRS, CDMA communication module, the small wireless communication module, key processing module, power module, display module, power line carrier modules and a number of peripheral hardware interfaces. Among them, the power module provides the necessary independent DC power supply, and achieves DC AC signal input to the work of the module electrical isolation to ensure safety at work of each module; through the sampling module, we can collect the secondary side voltage, current, power and frequency conversion so that processing module completes the analysis, calculation and storage; processing module is the core part of high-speed 32-bit embedded microprocessor; master communication module can remotely be carried out through real-time, historical and other data recall.

The terminal for a variety of distribution automation system communication is emphasized. We propose and design an adaptable GPRS, CDMA, RS485, wireless ad hoc inquiry and power line carrier China Netcom Communications to meet the distribution automation system data communication requirements. The terminal as a wireless ad hoc networks as a gateway node, through the downlink channel to the net, all kinds of collector and energy meter for meter reading, management, and remote on-off and other operations, and by the uplink channel and the background connects with the main station.

3.3 Energy Meter Collector

Electric energy meter collector for real-time collection of information can be used in industrial three-phase energy meter electricity, urban and rural households in single-phase energy meter real-time collection of information. Meter Collector 32-bit embedded microprocessor systems, modular design includes the processing module, GPRS communication module, a small wireless communication module, infrared interface, RS485 interface, power supply modules, display modules, and may be increased as needed GPRS or CDMA modules, power line carrier modules and other means of communication as shown in Fig.2. Watt-hour meter communication interface for the flexible design, by hearing wireless ad hoc Netcom centralized server module with the Taiwan Area Network constitutes a wireless ad hoc exchange of electric energy data.

3.4 Portable Device

A portable meter reading device as a Pocket PC equipped with a dedicated program, portable meter reading device with RF Wireless (small wireless) or infrared interface will work independently

of the power of their data collection device energy consumption data collection. The central records and saves up and then is carried into the room by the staff after the transferring to the management center computer. It has an RS485 interface and data acquisition devices or computers to connect. The system can be used in situations in unexpected back-up communications.

4. Conclusion

The project in distribution automation and wireless networking technology is based on wireless ad hoc networks technology for intelligent terminals with different concentration of services, building the sales side of a unified energy information collection platform system-level solution. System can be designed to achieve change public variable resident energy information collection and monitoring, distribution transformer monitoring, metering monitoring, reactive power compensation. Taiwan District line has data collection and analysis and many other features to meet the development trend of modern power management, effectively to improve the management level of the distribution network, save the investment, promote the distribution network management standardization. System has a high technical content and promotion of values.

Acknowledgments

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