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A Design of Wireless Environment Monitoring System based on Lora Spread Spectrum

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Abstract. With the expansion of the power grid scale, there are contradictory between the increasing speed of operation and maintenance personnel and the expansion of operation and maintenance scope. Once the operating environment changes, it is easy to bring on safety accidents. In order to solve those wire communication unreachable problem, this paper considers to develop a wireless environment monitoring system based on Lora spread spectrum technology, the system includes Lora terminal nodes, gateway nodes and the PC display system. In the system, the operating environment real-time measurement of the equipment is carried out to realize automatic alarm and improve power supply reliability of the power grid.

Introduction

With the expansion of the power grid, the security work becomes increasingly important. It is vital to monitor the running state of the cable line, to monitor the environment of the machine room, and to monitor the environment of shaft and cable. Due to the irreconcilable contradiction between the number of maintenance personnel and the workload, it is a problem to rely solely on human resources for all kinds of inspection. Therefore, it is a subject to monitor the operation status of all kinds of equipment through monitoring device.

To solve the situation of application effect is not ideal, e.g. wired communications under line, cable trench, shaft, and the harsh environment that does not require high speed of data transmission. This paper puts forward a idea of Lora technology which applied to environmental monitoring system.[1] The monitoring information is collected through the deployment sensor, and the data is sent to the gateway device for uploading the data. Through the design gateway, the combination of wireless communication and wired communication is realized.

System Contracture Designation

This system consists of the following parts: The first part is the terminal nodes, mainly measures cable surface temperature and the temperature data to upload, and accepts the effect of temperature measurements descending order at any time. The main implementation is realized through the deployment of various kinds of sensors. The second part is Lora gateway. The gateway compose the power supply module, MCU, Lora module, Ethernet controller and other circuit interfaces, implements the LoraWAN protocol and TCP/IP protocol, and the data conversion between achieve the unity of the signal transmission. The LoraWAN network architecture is a typical star topology, the gateway and the terminal are connected by the star network mode, which can realize multi-channel two-way parallel receiving and multi-channel signal processing.[2] The third part is the upper computer display part. Through the web page, it realizes the monitoring information display. At the same time, the acquisition information is analyzed to get the operation status of the equipment.

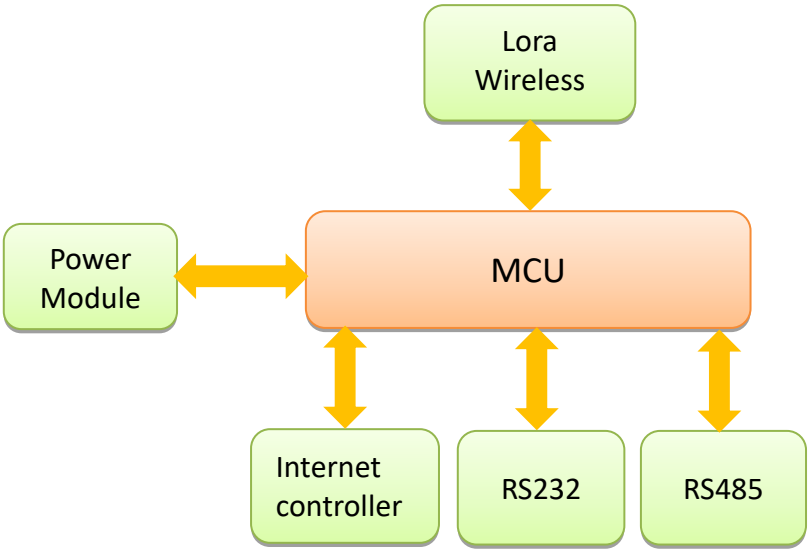

Fig.1 The functional structure of wireless Environment Monitoring gateway

Design of Lora Terminal Nodes

Lora terminal node includes batteries, sensors, MCU processing and Lora communication four parts. The power supply departments adopt efficient light load switch power supply to reduce switching power loss, with low power consumption MCU processor, using the mechanism of intermittent work to ensure the working life of equipment. Through the deployment of various types of sensors for data acquisition; data will be collected by Lora terminal to the gateway equipment.[3] Lora communication part includes the physical layer and MAC layer and application layer. [4]The communication process is divided into three steps: first is the activation of the terminal, second is to join the network, and the third is the data transmission. Terminal activation can be done in two ways: ABP and OTAA. The terminal joins the network by configuring the AppEUI and DevEUI parameters, and taking the RSSI random values of Lora chip, to get DevNonce. The three parameters are composed of JoinRequest data frame and sent to LoraWAN Sever. When LoraWAN Sever received the Join Request, the DevAddr was assigned, along with AppNonce and NetID, which was organized into JoinAccept data frame and responded to the terminal. The terminal joins the network after successfully accepts Join Accept, and finally carries on the data transmission.

Design of Gateway Nodes

A gateway is a transparent relay, which can realize data mutual transformation between in LoraWAN protocol and TCP/IP protocol, implements the terminal LoRa data communication and TCP/IP data communication with the server.

Transmission control protocol/Internet protocol (TCP/IP), also known as network communication protocol. TCP/IP is actually a protocol cluster that contains hundreds of protocols that can perform various functions. [5]The TCP/IP protocol model is divided into four layers: Network access layer, Internet layer, Transport layer and Application layer. In this design, the system architecture refers to the "TCP/IP reference model" of Microchip. The TCP/IP protocol stack adopts the modular design, follow the TCP/IP protocol, the protocol stack to support various application modules, application layer, support HTTP, FTP and DHCP (dynamic host configuration protocol) transport layer supports TCP and UDP protocol, the internet layer supports IPv4, ARP, and part of the ICMP protocol. Because TCP/IP protocol stack is relatively large, in the design of the gateway, only realize few functions and the function of the network access layer is provided by the hardware chip. The internet layer provides the IP protocol, the transport layer support the TCP transport layer, the application layer implements LoraWAN data with TCP/IP data conversion.

Gateway device acquires from Lora terminal nodes by receiving wireless data, and saves the data to receive the cache. By using a pointer, the data is copied to the TCP/IP to the cache, and transports

the data. When the data transports though the transport layer, network layer of TCP/IP protocol stack, it adds each layer a control information of the head and tail, the data is converted to TCP/IP protocol data. Then sends it out though wireless gateway.[6] Wireless data in the TCP/IP packet encapsulation is shown in the figure below. When the TCP/IP data needs to be converted to wireless data, remove the transport layer and the network layer in the TCP/IP protocol stack on the head and tail control information, copies of the original data to Lora data cache area, so it can be sent.

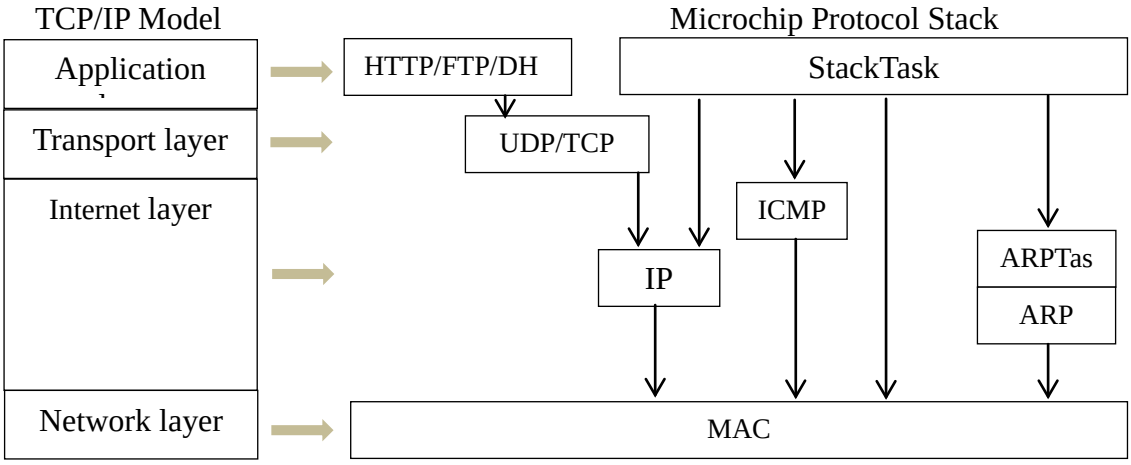

Fig.2 TCP/IP model correspond with Microchip protocol stack

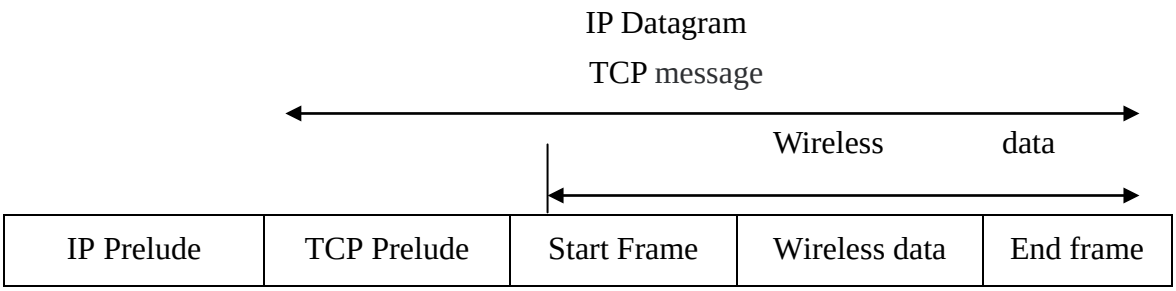

Fig.3 Transmission of IP data

Display of Upper PC

The data collected by Lora terminal is transferred to the server side through the gateway conversion to TCPIP protocol, and the storage management of data is carried out via MySQL database. Upper PC can use C/S and B/S architecture for data interaction with the server. The PC supports multi-level information visualization environment, data curve drawing, data-analysis and data-mining, abnormal data alarm, GIS map information system with quick-location of abnormal point identify, and other functions. Display screen installation executable application, as the client to establish a TCP connection to server. WEB browser installed free login management platform, to look through the collected data and information, remote configures the terminal working condition, for convenient management.

Conclusion

To ensure the reliable operation of electric power lines has an inestimable effect on improving Power-grid supplement reliability. Once malfunctions occur, it is extremely easy to cause a safety accident. This system is a solution to the unreachable communication of the electric power line cable, the cable trench, the well. It achieves an all-around seamless information integration from the scene environment monitor layer to the upper management layer, and establishes a intelligent management system satisfy complete set of variety of environmental information monitoring , which can effectively identify the hidden trouble especially fire accidents, such as cable-aging or overheating connector. This technology uses low cost measurement and control equipment for environment monitoring, could be an effective relief for problems between the shortage of

operations staff and the growing operational range.

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