Remote Meter Reading System based on Micro-power Wireless Ad-Hoc Network

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Abstract

Aiming at many problems of low voltage power line carrier meter reading, the wireless micro-power meter reading using frequency band 470-477 MHz is an effective meter reading mode for electric information collection. With its low cost, low power consumption, simple wiring , automatic relay node, it effectively implements the automatic meter reading of the full coverage and full collection for power users. In this paper, we design low-power wireless meter reading collector and concentrator, which composes the wireless meter reading system with survallian terminals. The system is installed in two electrical transformer district of rural area in our country. The results show that the wireless micro-power self-organizing network technology runs reliably in rural low-voltage centralized meter reading, and the data is correctly uploaded. This eliminates the huge workload of manual meter reading at the end of month.

Keywords

Wireless Ad-Hoc Network; Meter reading System; Network model.

1. Introduction

At present, a comprehensive power users of electricity information collection system is builted by the State Grid Corporation of Chin in order to achieve full coverage and full collection of power users automatic meter reading. The modes of resident users of electricity meter reading are mainly RS485 bus meter reading, low-voltage power line carrier meter reading and wireless meter reading and so on. RS485 meter reading is complex wiring, and the construction is of heavy load, so its promotion among the whole power grid is poor [1-2].

The low-voltage power line carrier technology occupies the mainstream in the current meter reading, but it has the following shortcomings [3-5]. First, the interference clutter in the power grid has great influence on the stability of the carrier communication. Secondly, the carrier communication is difficult to adapt to the change of the load . The third is the narrow-band of the low-voltage power line carrier has a low communication rate, and poor effectiveness, cannot meet with the high demand of information collection system for remote control and remote real-time power sales. Micro-power wireless meter reading technology for its low-cost, low power, easy wiring simple, automatic relay node can overcome the shortcomings of 485 bus and low-voltage power line carrier meter reading described the above. Wireless meter reading module has very low power consumption, the main module under the conditions of self-organizing network communication the active power is only 0.9W. Ad hoc network communication need no separate wiring, it re-establish communication by automatic relay routing, and ensure data are uploaded. Micro-power wireless meter reading also exists complex debugging and installation, wireless communication effects by the scene obstruction and many other factors [6].

In this paper, a remote meter reading system using micro-power RF communication and processing chip is presented, which includes wireless meter reading collector, concentrator in order to to get rid of disadvantages of PLC and RS485 bus communication. The collector through the wireless data transmission will be active power transmission to the wireless meter reading area concentrator, the concentrator and then through the GPRS uplink channel to the background master station to achieve wireless meter reading, while the master station can also need the information and the corresponding command Issued to the concentrator, wireless remote transmission through the collector to achieve remote power sales, remote control fees, ladder pricing and other management functions. In this paper, the thesis studies the problems of wireless mesh networks, automatic networking, multi-hop routing, automatic relaying and dynamic frequency hopping, etc., And has strong structural stability, environmental adaptability, interference avoidance, high real-time performance. A new generation of highly intelligent AMI system would overcome the last mile problem.

2. Overall Design

The system focuses on an integrated services distribution automation terminal that is 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.

Remote meter reading system mainly consists of computer information management host station system, integrated services terminal, energy collector and energy meters, which include three phase multi-functional meter for low voltage distribution transformer and single phase meter for the resident, in addition, portable collecting device is also used as needed. The architecture of the customized distribution automation system is shown in Figure 1. For the communication channels, 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, or uses power line carrier or RS485 bus in accordance with the requirements of the actual system.
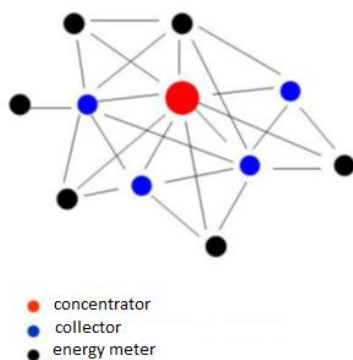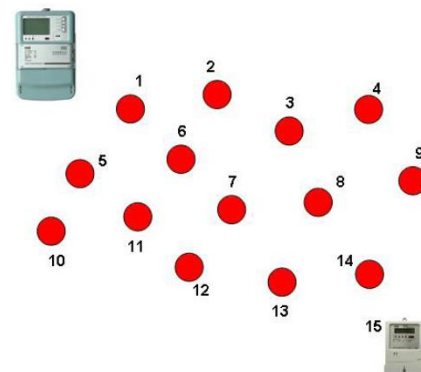

Fig. 1 Simplified network model   Fig. 2 Nodes of the network model

3. Network Design

Wireless Ad Hoc Network is a kind of intelligent wireless network in the field of wireless sensor network (WSN). It has the characteristics of automatic networking, maintenance-free, high reliability, real-time fast, low power consumption, small volume and longevity. Large-scale and complex environment of low-voltage electricity consumption information collection [7].

In order to achieve timely, complete and accurate collection of electricity information, low voltage acquisition system is the basic system of user power information collection. In order to meet the basic data and value-added service requirements of power management departments, combined with the characteristics of wireless communication technology, through the following three network programs to adapt to the complexity and variability of reality: (1) concentrator plus network watthour meter; (2)

concentrator , wireless collector and electric energy meter; (3) concentrator, wireless collector, electric energy meter and network watthour meter [8].

Fig.1 and Fig.2 illustrate the simplified network model of meter reading system. Each red circle presents one collector or watt-hour meter and is called a node.

4. Design of Routing Protocol

According to the characteristics of wireless meter reading network design of a wireless ad hoc network routing protocol. The routing protocol adopts "source routing". The packet header of each packet to be sent contains the complete route from the source node to the destination node, and the intermediate node forwards the packet according to the routing information in the packet. The routing protocol includes the route discovery process and the route maintenance process, and adopts the load balancing mechanism to avoid overloading nodes on the established routes. After power-on, the meter starts the route discovery process and establishes a route to the concentrator. The meter stores the created route into the route cache. Because the network structure is stable, the route established in the routing cache is valid for a long time.

4.1 Route Discovery

Similar to the DSR and AODC routing algorithms, route discovery is carried out in the form of flooding. A node that needs to establish a route broadcasts a route request packet to the whole network. The path is forwarded, which is initialized to the source node address, see Fig. 3.

4.2 Determine The Primary Path

Fig.4 show the example of the primary path. In the process of network, the system automatically determine the concentrator to a certain node path which is called as the main path. For example, these yellow dots: 2, 6, 7, 13, 15.
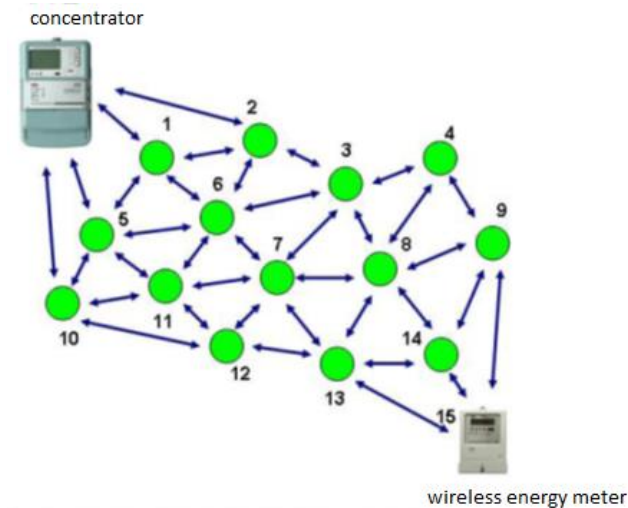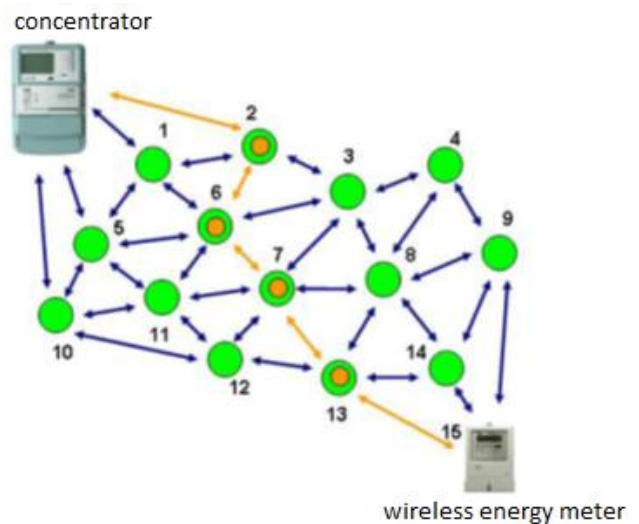

Fig.3 Route discovery   Fig.4 The primary path

4.3 Route Maintenance and Self-Repair

Although the meter reading network topology is stable, but still need to remove the network failure due to meter failure, resulting in the path of its failure, therefore, routing maintenance is also necessary, see in Fig.5 and Fig.6. During the route maintenance phase, the route maintenance process learned in the process of packet sending needs to return the route error packet according to the source path when a node in the path discovers that the link to its next level node is disconnected. The node passing through the route judges whether the stored routing information includes the link and removes the routing information including the link from the route cache. After the source node receives the route, it will

select other routes to the destination node. If there is no routing information, the route discovery process is restarted.
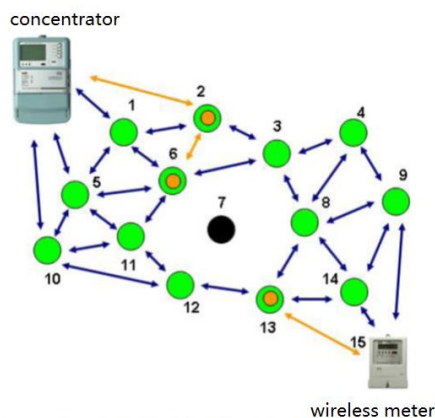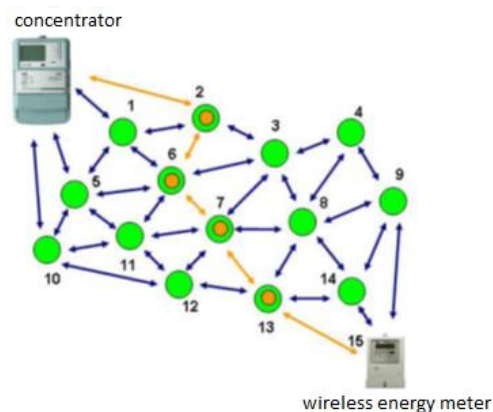

Fig.5 Node failure   Fig.6 Self-repair

5. Conclusion

This paper studies and designs an automatic meter reading system based on micro-power wireless ad hoc network. The research background and significance of the automatic meter reading system in our country are studied. The existing meter reading system and technical characteristics are introduced, and the main automatic meter reading schemes are analyzed and compared. The overall design of the micro-power wireless meter-reading system is given. The micro-power wireless communication technology of intelligent routing is a highly developed meter reading communication technology. It becomes a reliable channel for the construction of the electricity consumption information collection system. It is the technical base of building a good AMI system.

Acknowledgements

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