Study of Smart Multi-antenna and Multi-channel for Smart Distribution Grid Based on Mesh Networks

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Abstract. Smart Distribution Grid is an important part of Smart Grid and its operating conditions directly affect the effectiveness of the industry. In order to achieve the goal of real-time and reliability of data transmission of Smart Distribution Grid, we design a smart multi-antenna distribution communication system of multi-channel based on Mesh Networks. Elaborated from the network structure and MAC layer protocols, and finally by the simulation in the design, the load transmission capacity compared to conventional technology has been significantly improved.

Introduction

Smart Distribution Grid (SDG) is a new technology that makes the various distributions of organic integration, anastomosing and make the performance of the system a revolutionary change, it plays a key role in the process of the Smart Grid construction which connects the power supply and user connects. To cover the entire grid information communication system is the foundation of the smart distribution network data transmission and use. The Smart Grid data acquisition, protection and control all need the support of such information and communication system, thus building a strong, flexible networking, strong interactivity and extensibility of distribution network automation communication networks is an important part of the smart distribution networks construction.

Smart Distribution Grid and Communication Needs

The Smart Distribution Grid. SDG through distributed smart equipment widely used and automatic control system, communication system, the distribution equipment running status real-time monitoring, collection, integration and analysis of data mining. In order to realize the target that power grid real-time communication between members of each department and the corresponding.

The Communication needs. In SDG, besides electricity conveying this basic task, it also need to have functions that data acquisition and monitoring, adaptive problem of processing, self-healing and user side electricity information collection transmission. In these functions it needs to have the power of communication technology support.

At present, the wireless communication technology has become a hot research topic in the Smart Grid. This new type of energy transmission network has several research objectives: aims to design an information and communication technology infrastructure, to meet the service quality of service (QOS) for Smart Grid. Specifically, 1) use wireless sensor network technology for online distribution network state detection, early warning; 2) smart meter user side requires us to use the grid wireless sensor network has a enough bandwidth to enable two-way communication platform for users and users of electricity .

To solve these problems, we use a wireless sensor network architecture based on Wireless Mesh Network (WMN) communication method to meet the needs of rapid and timely real-time transmission and two-way communication in SDG.

Network Deployment Strategy

The Principle and Characteristic of Mesh Technology. WMN is a multiple hops self-organizing network, suitable for cover and high-speed broadband wireless access and regional environment. The user equipment can be involved in the construction of WMN dynamically, at the same time they can undertake other equipment user terminals and routers, each WMN node can be connected to the terminal, also has the function of routing and forwarding information, has a very high degrees of freedom in networks.

The Network Architecture. Based on the above requirements, we adopt the client Mesh structure networks. The client Mesh structure is a wireless transceiver configured by the end user itself, forming a point to point network connection over a wireless channel. Terminal equipment can be run at any time without the other infrastructure conditions, support a higher rate, and rapidly form a broadband network.
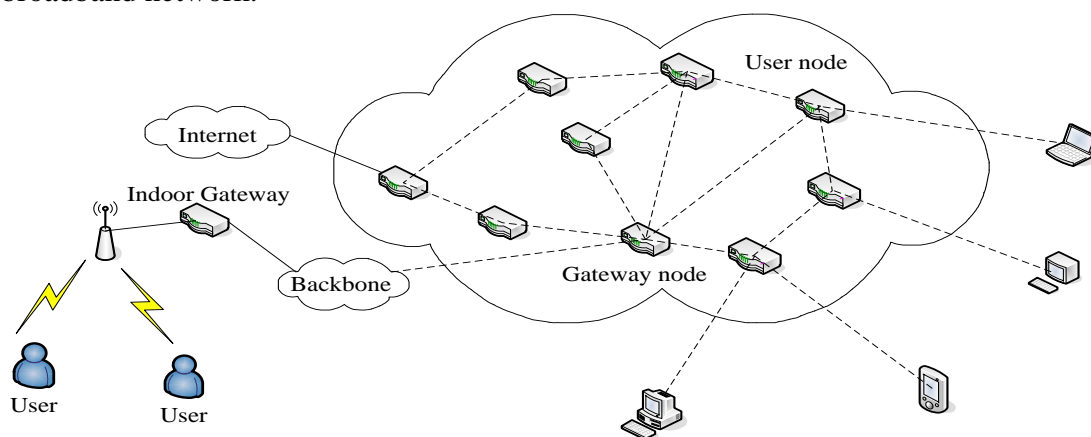

Fig.1. The experimental results

Smart Multi-antenna Diversity Transmission Method Based on Mesh Networks

Smart Multi-antenna Diversity Transmission. In WMN the data having been processed packed into a data packet and sent out by the antenna, if using a single-antenna, the transmission and reception of data just can be simultaneously so we unable to duplex communication. It will affect the timely delivery of early warning information. Different signals superimposed phase to produce weaken or cause noise interference to other signals, resulting in fading signals.

In wireless sensor networks simply increasing the power of transmitting antenna is not realistic. The principle of diversity technique is to receive multiple copies of the same information by receiving node, due to after reflection and scattering of multiple copies of a signal experiences fading loss is different, the receiving node uses multiple copies of signal contains information that can be relatively accurately recover the original transmitted signal. Here, we use the spatial diversity technique, the configuration of multi-antenna on one wireless network node. Due to the presence of multipath affect, spatial diversity techniques can reduce the correlation between each branch. For the spatial diversity, the diversity branches to count the better the greater the diversity, but the diversity branches greater than 3, diversity complexity is increased, increase the diversity gain increases with the number of diversity branches become slow. Therefore, this system uses 3 antenna systems.

MAC Layer Protocols. Depending on the realization of smart antenna technology can be divided into: Switched-Beam Systems and Adaptive Array Systems. In this system, we are using the Adaptive Array Systems and all the omni - directional mode under work and here we use omni directional RTS and RTS binding mechanism.

Under this mechanism, each node is pre stored with the neighbor node MAC address. Sending node has a packet to be sent at the time, will carry out a physical carrier sensing potential towards

the direction of the adjacent receiving end while checking their DNAV table, if it is free it sends an omni-directional ORTS, however DNAV is not free but the desired direction DNAV no obstruction, it is directed to send DRTS. After being DRTS destination node checks DNAV table, if not blocked in all directions sends OCTS, or not respond. Since the omnidirectional receiving transmitted neighbor ORTS sending node during transmission will remain retracted, does not interfere with control packet. Considering the WMN is a multi-hop network, such as: A and C node can not communicate directly, A B-node to node needs to go through with the C node for data transmission, when the then RTS / CTS transmission between A, C two nodes equally to go through the node B, the transmission through the multi-hop mode. So in this case, RTS when sending, the sender will first build a forward RTS, RTS is included in the forward message to the transmitting end and a receiving section, each node receives the RTS to the front of the front-to-RTS the destination address is included on the next node information table neighbor MAC addresses decision-making, while updating neighbor information table.

Simulation and Analysis

In OPNET simulation tool for the environment, DMAC, 802.11 and omni-directional RTS mechanism combines these three protocols were compared. The simulation settings are as follows:

Table.1. MAC simulation parameters

Parameter	The Numerical	Parameter	The Numerical
RTS	352bits	the number of antenna beam	2/4
CTS	304bits	antenna beam width	90^0/180^0
ACK	304bits	antenna gain	0dB
DATA	512/1024/1536/2048/3072bits	channel bandwidth	22MHz
RTS threshold	2bits	send the power	0.005W
Buffer Size	256000bits	Modulation	DPSK

Collective agreement throughput results along with the change of load increase
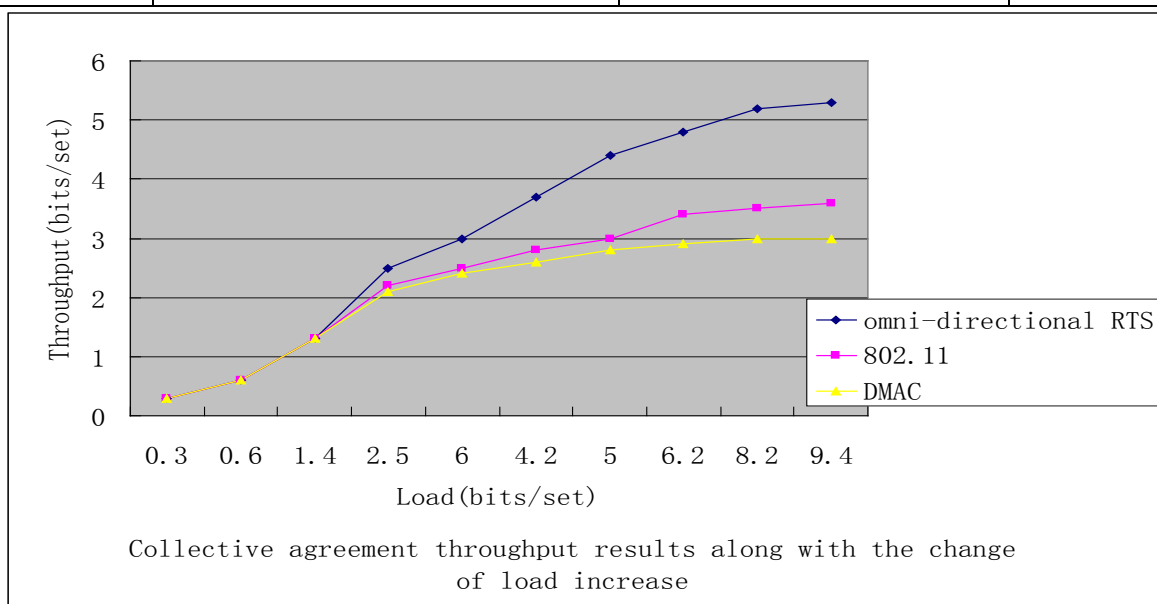
Fig.2. The experimental results

After seen from Fig.2, as the load increases, the throughput of the entire network is increased first stabilized, stabilized at a fixed value. Compared to the traditional 802.11 and DMAC protocol, smart multi-antenna and multi-channel technology has the advantage of spatial multiplexing, also exists in the network communication to make more, reside in the send queue data timely send out.

Summary

In order to realize the goal of smart power distribution network automation and less people, design the smart multi-antenna power distribution communication system based on WMN. This paper analyzes the special structure of distribution network, principles and advantages of multi-antenna diversity techniques, network structure and MAC layer protocols. The application of the protocol mechanism of multi-antenna diversity reception technology and omni-directional RTS bound to overcome the traditional weakness against multi-path wireless network poor. This method provides a new way for the realization of SDG automatic.

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