

A Survey on ZigBee Technology and ZigBee Network

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Abstract:

with the continuous optimization of ZigBee protocol, wireless sensor networks based on ZigBee technology are widely used in wireless industry, precision agriculture, home and building automation, military, consumer appliances and medical services. Compared with other wireless communication technologies, ZigBee technology has the advantages of low cost, low complexity, low power consumption, high reliability and self-organization. It is mainly suitable for remote monitoring, home automatic control, intelligent building system, intelligent transportation and environmental monitoring. In this paper, the characteristic, research status, existing problems and future research directions of ZigBee technology and ZigBee network are described.

Keywords —ZigBee Technology,ZigBee network,Wireless communication technology,research status

1 INTRODUCTION

In the 21st century, mankind has ushered in the era of digitization and informatization, and wireless communication technology has played an increasingly important role in people's lives. The research on Wireless Sensor Networks (WSN) in wireless communication technology has become one of the hot topics in today's society [1]. Wireless sensor network technology integrates sensor technology, wireless communication technology, embedded technology, micro electro mechanical technology and distributed computing technology, so that the wireless sensor node can complete many functions such as information collection, data storage and processing, and wireless communication in its tiny volume. After the information is processed by distributed computing technology, it is transmitted through wireless multi-hop network to the end user. At present, wireless sensor network has attracted the attention of science and technology and industry in many countries in the world, and some countries have listed it as an important national scientific research project [2]. Wireless sensor network has a very wide range of application prospects, and can play an important role in the fields of national defense and military, environmental monitoring, industrial control, health care and home automation [3].

The latest research results show that ZigBee will lead

the wireless mesh network sensor market, and will maintain this advantage. The ZigBee network based on 802.15.4 has become the main connection mode of the Internet of things, and the chip shipment using ZigBee alliance standard is expected to account for 85% in the next five years. ZigBee technology based on IEEE802.15.4 standard has become one of the most widely used technologies in wireless sensor networks. Compared with other wireless communication technologies, ZigBee technology has the advantages of low cost, low complexity, low power consumption, high reliability and self-organization [4]. This technology is mainly suitable for remote monitoring and operation, home automatic control, building intelligent system, intelligent transportation and environmental monitoring.

2 ZIGBEE TECHNOLOGY AND CHARACTERISTICS

Wireless communication technology has been developing in the direction of increasing data rate and transmission distance. ZigBee technology, which has been widely studied, is committed to providing a low-cost low-speed wireless communication technology with low complexity, low cost and power consumption for fixed, portable or mobile devices. This ZigBee wireless communication technology has the following characteristics:

(1) Low power consumption: in the working mode, the transmission rate of ZigBee technology is low, and the amount of data transmitted is small, so the signal receiving and transmitting time is very short. Secondly, in the non-working mode, ZigBee node is in sleep mode. Generally, the device search delay is 30ms, the sleep activation delay is 15ms, and the active device channel access delay is 15ms. Due to the short working time, low power consumption of sending and receiving information and the sleep mode, the ZigBee node is very power-saving, and the working time of the ZigBee node battery can be as long as 6 months to 2 years.

(2) Reliable data transmission: the media access control layer (MAC) of ZigBee adopts talk-when-ready collision avoidance mechanism. In this fully confirmed data transmission mechanism, when there is a demand for data transmission, it will be transmitted immediately. Every data packet sent must wait for the confirmation information from the receiver and reply with the confirmation information. If there is no reply with the confirmation information, it means that there is a collision and it will be transmitted again. This method can improve the reliability of system information transmission. At the same time, a special time slot is reserved for the communication services that need fixed bandwidth to avoid the competition and conflict when sending data. At the same time, ZigBee optimizes the delay sensitive applications, and the communication delay and sleep state activation delay are very short.

(3) Large network capacity: ZigBee is very suitable for supporting simple devices because of its low rate, low power consumption and short distance transmission. ZigBee defines two devices: full function device and simplified function device. For the full function device, it is required to support all 49 basic parameters. For the simplified functional device, only 38 basic parameters are required in the minimum configuration. A full-function device can communicate with simplified function devices and other full-function devices, and can work in three ways: personal area network coordinator, coordinator or device. The simplified function device can only communicate with the full function device, only for very simple applications. A Zigbee network consists of 255 ZigBee network nodes at most, one of which is a master device, and the other is a slave device. If the network coordinator (Network Coordinator) is used, the whole network can support more than 64000 ZigBee network nodes at most, and each network coordinator can be connected with each other, the number of nodes in the whole ZigBee network will be considerable.

(4) Compatibility: ZigBee technology is seamlessly integrated with existing control network standards. The network is automatically established by the coordinator,

and the channel access is carried out by CSMA-CA. For reliable transmission, full handshake protocol is also provided.

(5) Security: ZigBee provides data integrity check and authentication function, and provides three-level security in data transmission. The first level is actually no security mode. For a certain application, if the security is not important or the upper layer has provided enough security protection, the device can choose this mode to transfer data. For the second level of security, devices can use access control list (ACL) to prevent illegal devices from obtaining data, and no encryption measures are taken at this level. In the third level, the symmetric cipher belonging to Advanced Encryption Standard (AES) is used in data transfer. AES can be used to protect data payload and prevent attackers from impersonating legitimate devices.

ZigBee technology has the above advantages, which make ZigBee have great competitiveness in the field of wireless communication.

3 DEVELOPMENT TREND OF ZIGBEE TECHNOLOGY AND ZIGBEE NETWORK

ZigBee technology is a kind of wireless communication technology applied to electronic devices with low data transmission rate in short distance. As one of the key technologies of wireless sensor networks, ZigBee technology, which is based on IEEE 802.15.4 protocol [5], has the characteristics of low power, low rate, low cost and ad hoc network. It mainly works in the frequency of 2.4 GHz ISM, and has been widely used in many fields, such as power grid, agriculture, medical monitoring, fire, industry and so on. At present, the development direction of wireless sensor network is from wireless multimedia sensor network to ubiquitous sensor network, sensor network with sensing function to wireless sensor network with ultra-wideband technology, and finally to wireless sensor network based on cooperative communication ability [6]. So far, the research focus mainly includes two aspects: (1) ZigBee chip research and development. (2) Application Research of Technology: for example, environmental monitoring, street lamp control, production line data collection and other aspects.

With the continuous improvement of ZigBee technology standards and the drive of Internet of things, researchers pay more and more attention to how to improve the performance of ZigBee network system. ZigBee technology and ZigBee network has the following development trends:

(1) Low power consumption

Compared with Bluetooth, WiFi and other technologies, ZigBee has more advantages in low power consumption. Two batteries of No. 5 can make ZigBee nodes work for 6-24 months. As the development of science and technology

has solved the problem of hardware power consumption, low power consumption of ZigBee system is an inevitable trend [7]. Therefore, the low power consumption of ZigBee devices will also be valued.

(2) High networking capability

The current ZigBee technology has not yet solved the problem of isolated nodes caused by the lack of address allocation algorithm in ZigBee network. With the continuous development of ZigBee technology, the high networking capability of ZigBee system is an inevitable trend.

(3) Networking of the system

In the future, ZigBee will cater to the development trend of the Internet of things, and the remote processing and control of the system need ZigBee system to develop to network [8]. Therefore, the development of ZigBee system to network can meet the requirements of modern commercial market for big data acquisition and real-time communication.

(4) Massive data processing requirements

At present, most of the ZigBee systems used by transportation and commercial companies do not have the ability to process a large number of data. When they need to process more sensor data, ZigBee systems are difficult to deal with. Therefore, the future ZigBee system will be able to deal with large data sets.

4 PROBLEMS IN BUILDING ZIGBEE NETWORK

Although ZigBee technology and ZigBee network have been widely used, it brings great challenges to the network construction due to the diversity of network node types, self-organization of each network node and address allocation mechanism in the network.

(1) The security of data transmission

The data information transmission of each node in wireless network is easily interfered by devices outside the network. When transmitting signals between nodes, because the transmitted messages and packets are exposed in the physical space, they are easy to be captured and destroyed.

(2) Network parameter preset problem

Under natural conditions, the location of the network coordinator may deviate from the preset location of the network, resulting in other nodes can not find the preset network coordinator in the communication, which greatly reduces the transmission efficiency and performance of the wireless network.

(3) Data fusion

The coverage of sensor network is very large, and several sensor nodes may be in the adjacent position, resulting in redundancy and repetition of data acquisition, increasing the difficulty of data processing and consuming the energy of network nodes. Therefore, it is necessary to

improve the data fusion problem of sensor nodes.

(4) Network topology problem

In the field conditions, each node in the network may be offset, some weather factors may cause the actual effect of sensor nodes, and the artificial placement of sensor nodes in the network will cause the transformation of network topology, so the adaptive requirements for the whole wireless network are put forward.

(5) Address allocation mechanism

As the parent node in the wireless network, the network coordinator initiates networking information and assigns addresses to the surrounding nodes. Only the node assigned to the address can continue to assign addresses to the external network as the parent node. Because the whole process is randomly assigned, the address space of the parent node is inconsistent with the number of the child nodes, which makes some nodes unable to assign addresses, so they cannot join the network.

5 FUTURE RESEARCH DIRECTION OF ZIGBEE TECHNOLOGY AND ZIGBEE NETWORK

ZigBee technology is a kind of short-range wireless communication technology with unified technical standards. It is widely used in industrial control, environmental monitoring, business monitoring, automotive electronics, home digital control network and so on, so it has been developed rapidly. However, there are still many problems to be solved in the process of its application and development, including: (1) Because the energy of ZigBee node is limited, how to reduce its energy consumption. (2) how to solve the problem of address allocation mechanism in ZigBee network. (3) In large-scale wireless sensor networks, how to solve the problem of network transmission delay. (4) In the process of information transmission, how to maintain the security and integrity of information. (5) How to solve the problem that ZigBee nodes are affected by their limited hardware resources.

REFERENCES

- [1] Hu S C, Lin C K, Tseng Y C, et al. Distributed Address Assignment with Address Borrowing for ZigBee Networks[C]. IEEE International Conference on Communications Workshops. IEEE, 2014.
- [2] Pu Hongquan, Jia Junying, Zhang Xiaojiao. Overview of ZigBee network technology [J]. Computer system application, 2013,22 (10): 6-11.
- [3] ZigBee Alliance, ZigBee Specification Document 053474r17[S]. 2008.
- [4] Mu J, Song W, Wang W, et al. Self-healing hierarchical architecture for ZigBee network in smart grid application[J]. International Journal of Sensor Networks, 2015, 17(2):130.

- [5] Zhiyu, pan Lihu, Yang Xiaomei, et al. Research on Algorithm of isolated point access based on ZigBee technology [J]. Computer Application Research, 2016, 33 (1): 189-193.
- [6] Qing Xiaoxia, Wang Wenwen, Wang Bo. Outlier reduction algorithm for ZigBee networks based on node transfer [J]. Chinese Journal of Scientific Instrument, 2010 (7): 1650-1656.
- [7] Pan M S, Tseng Y C. ZigBee-based long-thin wireless sensor networks: address assignment and routing schemes[J]. International Journal of Ad Hoc and Ubiquitous Computing, 2013, 12(3): 147-156.
- [8] Chiahung Tsai, Yuchee Tseng. A Path-Connected-Cluster Wireless Sensor Network and Its Formation, Addressing, and Routing Protocols[J]. IEEE Sensors Journal, 2012, 12(6): 2135-2144.
- [9] Yuan-Yao Shih, Yukai Huang, Aichun Pang, Pangfeng Liu, Weini Chu. NAT-ZigBee: NAT-based Address Assignment for Scalable ZigBee Networks[C]. 7th International Conference on Heterogeneous Networking for Quality, Reliability, Security and Robustness, Houston USA, 2010, 74: 307-315.
- [10] Yao Y, Pengxiang L I, Ren Z, et al. Borrowed address assignment algorithm for ZigBee network[J]. Journal of Computer Applications, 2011, 31(8):2044-2043.
- [11] Tao D, Yang G, Chen H, et al. Efficient Image Transmission Schemes over Zigbee-Based Image Sensor Networks[J]. Chinese Journal of Electronics, 2016, 25(2): 284-289.
- [12] Hu S C, Lin C K, Tseng Y C. Automatic parameter selection for the ZigBee distributed address assignment mechanism[C].IEEE, International Symposium on Personal, Indoor, and Mobile Radio Communications. IEEE, 2013:2062-2066.
- [13] Wu Chia-Ming, Chang Ruay-Shiung, Lee Pu-I, et al. An Innovative Scheme for Increasing Connectivity and Life of ZigBee Networks[J]. Journal of Supercomputing, 2013, 65(1): 136-153.