Wireless Communication Chip Designs: analysis of the Wireless Integrated Network Sensors

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Abstract. With the development of wireless technology, wireless integrated network sensor is a new form of sensor network. It enables highly efficient data acquisition and transmission by connecting the sensor nodes wirelessly. The purpose of this study is to investigate the basic principles and techniques of wireless integrated network sensors, analyze their application fields, and conduct experimental studies to verify their performance. This study first introduces the basic principles of wireless integrated network sensors, including wireless communication, sensor nodes, and network topology. Then, related technologies, including energy management, routing protocols and network security, are studied to improve the performance and stability of wireless integrated network sensors. Wireless integrated network sensors have wide application prospects in environmental monitoring, intelligent transportation and agriculture. Meanwhile, the energy utilization efficiency and network stability of the sensor network can be improved by adopting the new energy management mechanism and routing protocol. This study reveals the potential and value in practical applications through the exploration and research of wireless integrated network sensors. In future studies, the energy management and routing mechanisms of sensor networks can be further optimized to improve their performance and reliability. In addition, more application scenarios suitable for wireless integrated network sensors can be explored to provide solutions for practical problems.

Keywords: Wireless sensor network, integrated network, sensor network, wireless communication, network sensor.

1. Introduction

With the development of telecommunication, an equipment with multifunction to achieve real-time monitoring of resources, security, traffic and situations of battleground is needed urgently [1]. Wireless integrated network sensor can solve this problem well. Its enormous commercial and military value attract a lot of countries' attention. Intel, Microsoft and other IT giants have started researching on wireless integrated network sensors. Japan, Germany, Britain, Italy and other countries with developed technology also perform huge interest in wireless integrated network sensor, and do researches on it one after another. Although the research work of wireless network was originally for military purposes, with the continuous extensive and in-depth research, civilian systems have occupied the vast majority, and tentative application research has been carried out in aspects including animal and plant monitoring, natural environment observation and forecasting, health care and so on.

In 2012, David et al. provided a description proposed wireless interconnect for the hybrid iWISE NoC architecture that improves network performance and power [2]. In 2014, Shuai Wang and Tao Jin described the design of WiNoCs from topology, routing algorithm, flow control, on-chip antenna and reliability [3]. Gregory have described some of the cooperative network behaviors that can be enabled by this technology to make the whole much more than the sum of its individual parts. They also pursued research into classification algorithms that can be used in individual nodes and data fusion techniques to take advantage of the variety of sensors and the spatially separated sensing elements [4]. With the development and deepening of the application of wireless network sensor, the research of ultra-micro embedded. WINS opportunities depend on development of a scalable, low-cost, sensor-network architecture. Such applications require delivery of sensor information to the user at a low bit rate through low-power transceivers [4]. Thus, for all of these applications, local processing of distributed measurement data is required for a low cost, scalable technology.

Distributed signal processing and decision making enable events to be identified at the remote sensor. Thus, information in the form of decisions is conveyed in short message packets.

Future applications of distributed embedded processors and sensors will require massive numbers of devices. Conventional methods for sensor networking would present impractical demands on cable installation and network bandwidth. By eliminating the requirements for transmission of all measured data, the burden on communication system components, networks, and human resources are drastically reduced [5]. This paper will further tell the system architecture and low power circuits for WINS. The content of this paper could be used in monitoring resources like water and air, or provide a manufacturing information service for cost and quality control.

2. Principle Analysis of System Architecture of WINS

Wireless integrated network sensor is mainly composed by sensor, spectrum analyzer and wireless network interface. Wireless sensor network (WSN) refers to the wireless network composed of a large number of low-cost, low-power consumption and self-organized sensor nodes. These sensor nodes are distributed in the monitored area, which can sense and collect various parameters in the environment, and transmit these data to the data processing center or other nodes through wireless communication. Wireless sensor network has a wide range of applications, and has been widely used in environmental monitoring, Internet of things, agriculture, intelligent transportation and other fields [6]. Wireless sensor networks are characterized by self-organization, distributed processing, adaptive capability, and large-scale scalability. Sensor nodes self-organize into a network to complete data acquisition and transmission through wireless communication and collaboration. Sensor nodes cooperate with each other and share information, thus improving the coverage of the network and the monitoring accuracy. At the same time, the wireless sensor network can adjust its working state according to the change of the environment, thus extending the life of the network. Moreover, the wireless sensor network can easily expand the network scale and add or delete the sensor nodes at any time as needed to meet the needs of different application scenarios [7].

In wireless sensor network, sensor node mainly consists of sensor, processor, wireless communication module and energy supply module. The sensor is responsible for the sensing and collection of environmental parameters, which can be various types of light, temperature, humidity and pressure; the processor is responsible for the processing and analysis of sensor data and the execution of algorithms; the wireless communication module is responsible for the communication between nodes to transmit the collected data to other nodes or base stations; the energy supply module provides the power needed for the nodes, usually through the battery or energy collection technology. Sensor nodes have a specific topological structure in the network, which can be star structure, network structure or layered structure, and are selected according to different application scenarios and requirements. Data exchange and collaboration between sensor nodes through wireless communication, and distributed data processing is transmitted to other nodes or base stations for comprehensive analysis. In order to ensure the reliability and security of data, the wireless sensor network adopts multi-path transmission, multi-hop communication and data encryption. In conclusion, wireless sensor networks, as an emerging wireless communication technology, play an important role in the Internet of Things and intelligent systems. Through self-organization, distributed processing and large-scale expansion, the comprehensive and real-time monitoring of environmental parameters, providing convenient and efficient data collection and transmission mode. In the future, with the continuous development and progress of wireless communication technology, the wireless sensor network will be applied in more fields, and make contributions to the development and progress of the society.

In the wireless integrated network sensor, the integrated network principle is the core to realize the information exchange and work together. By integrating the network, each sensor node distributed in the space can communicate with each other, share information, and coordinate to complete specific tasks. The principle of the integrated network is introduced from three aspects: network topology, communication protocol and routing algorithm. First, the topology of the network is the foundation for building an integrated network. Common topologies include star, reticulation and tree structure, etc. In the star topology, all nodes are directly connected to the central node, which is responsible for transmitting and forwarding the data. In the network topology, the nodes are connected to each other to form a complex network structure. In the tree topology, the nodes are connected according to the hierarchy, and the upper nodes are responsible for summarizing and forwarding the data from the lower nodes. The choice of a suitable topology depends on the specific application scenario and requirements. Secondly, the communication protocol is a necessary condition to ensure the effective communication between the nodes. There are many communication protocols commonly used in wireless sensor networks, such as ZigBee, Bluetooth, and WiFi. These protocols have low power consumption, high reliability and low cost, which can meet the needs of sensor network communication. When selecting communication protocol, transmission distance, network topology and power consumption are considered to ensure reliable transmission of data and effective control of energy consumption [8]. Finally, the routing algorithm is the key to realize the data transmission. In an integrated network, the sensor node needs to select appropriate routes to transfer data from the source node to the target node. The commonly used routing algorithms include the shortest path algorithm, flood algorithm and greedy algorithm. The shortest path algorithm aims to find the path with the shortest distance, while the flood algorithm broadcasts the data to all nodes, while the greedy algorithm selects the optimal neighbor node for data transmission. Different routing algorithms are suitable for different network environments and application requirements, and need to be selected and optimized according to specific situations.

In conclusion, the principle of integrated network is the basis for realizing the collaborative work of wireless integrated network sensors. With suitable network topology, communication protocols, and routing algorithms, sensor nodes can communicate with each other, share information, and coordinate with various tasks. In practical application, it is necessary to choose suitable principles according to specific requirements to optimize the function and performance of wireless integrated network sensors.

In the wireless integrated network sensors, the working mechanism of the sensor plays a crucial role. The sensor realizes the environment monitoring and data acquisition by sensing various parameters in the environment and converting these parameters into digital signals available for wireless transmission. This section describes the working mechanism of wireless integrated network sensors. A sketch is shown in Fig. 1. First, wireless integrated network sensors perceive different parameters of the environment by using various sensors, such as temperature sensors, humidity sensors, pressure sensors, etc. These sensors are able to collect data in the environment in real time and convert it into electrical signals. These electrical signals are processed by an analog-to-digital converter and converted into digital signals in preparation for subsequent transmission. Secondly, the collected digital signal is transmitted through a built-in wireless communication module. The communication module in the wireless integrated network sensor aims to realize low power consumption, long distance data transmission. Common communication technologies include radio frequency transmission, infrared transmission, Bluetooth transmission and so on. These communication technologies can ensure the accurate transmission of data, and maintain low power consumption in the transmission, to extend the standby time of the sensor [9].

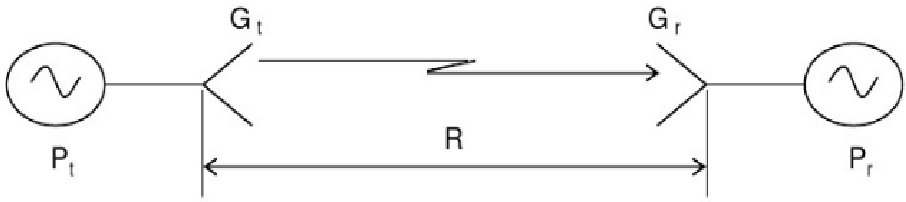

Figure 1. Working mechanism of wireless integrated network sensors

In the progress of transmitting, to decrease the path loss, one needs the Friese transport equation, in this function, Pr is the power of receiving, Pt is the power of transmit antenna, Gt is the gain of transmit antenna, Gr is the gain of receive antenna, R is the distance between two antennas:

$$\mathrm{Pr} = \mathrm{Pt}\frac{\mathrm{GtGr}\lambda^2}{(4\pi \mathrm{R})^2} \tag{1}$$

Next, wireless communication between sensor nodes to realize data convergence and sharing. The advantage of using wireless integrated network is that there is no complex wired connection between sensor nodes, but data exchange through wireless communication. This distributed communication mode allows the sensor nodes to be deployed in a wider range of areas to monitor a large range of environments. Finally, data transmission through the sensor node is sent to the destination specified by the user. Normally, the data is sent to the data center or to the cloud platform for further storage and analysis. In this way, the wireless integrated network sensor can realize the real-time monitoring and data collection of the environment, and provide valuable information to the user.

To sum up, the working mechanism of the wireless integrated network sensor mainly includes the sensor perception, the transformation and transmission of the data, and the wireless communication between the nodes. This working mechanism enables sensors to be deployed in a wide range of areas, and enables real-time monitoring of the environment and data collection, providing valuable information to users. Continuous improvement and innovation in the working mechanism of wireless integrated network sensors will further drive the field.

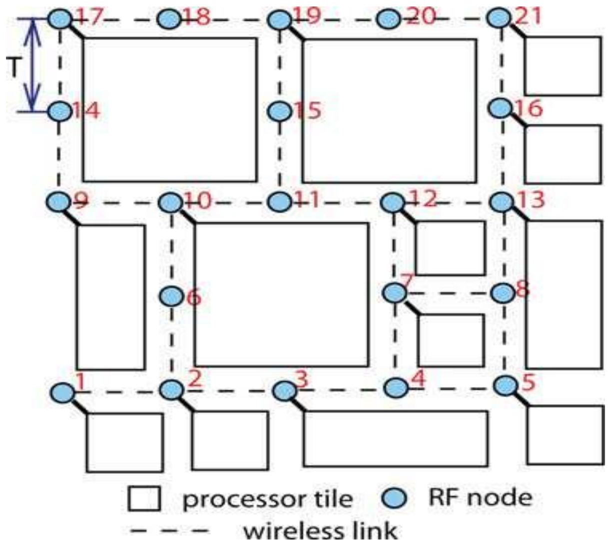

Figure 2. Topology of an irregular mesh WiNoC.

3. Implementation Approach and Discussion

This section details the design process of the wireless integrated network sensor experiment. In the experimental design, this paper will focus on key elements such as the layout of the sensor nodes, data acquisition scheme and transmission protocol. First, in terms of the sensor node layout, this paper needs to rationally arrange the location of the sensor nodes to ensure the uniformity of the coverage and the mutual communication ability between the sensor nodes (seen from Fig. 2). Based on previous studies, this paper chose a layout algorithm based on network topology to determine the optimal layout scheme by calculating the distance between nodes and the signal decay factor. In this way, the communication distance between the sensor nodes can be minimized and improve the efficiency of data collection [10]. Secondly, in terms of the data acquisition scheme, this paper needs to determine the appropriate data acquisition parameters and the sensor sampling frequency. For different application scenarios, this paper chose the data acquisition parameters adapted to this scenario. For example, in terms of environmental monitoring, this paper focused on the trends in parameters such as temperature and humidity, so this paper set the sampling frequency at 10-minute intervals to ensure sufficient data points for analysis [10]. Third, in terms of the transmission protocol, this paper chose an efficient transmission protocol to realize the communication between the sensor nodes. According to the previous studies, this paper adopted a wireless communication scheme based on the ZigBee protocol. This protocol features low power, low cost and high reliability for the deployment of large-scale sensor networks. As shown in Fig. 3, the structure of Zigbee protocol can be seen. Finally, in the experimental design, this paper also considered some other factors, such as energy management, network security, and data quality control. Through reasonable experimental design, the stability, reliability and rehabilitee of the experiment can be ensured, and lay the foundation for subsequent experimental data collection and result analysis.

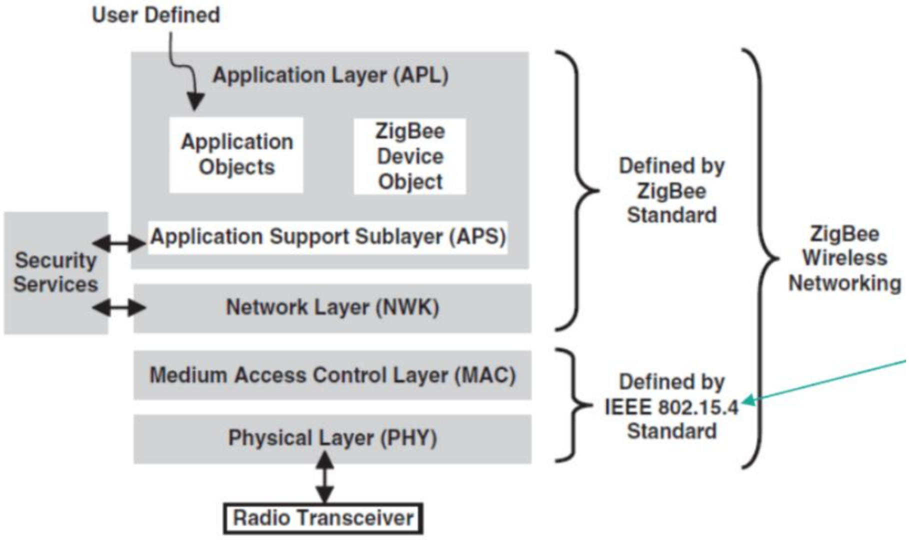

Figure 3. Zigbee protocol

In summary, this section presents the design process of the sensor experiment for wireless integrated networks. Through rational layout, data acquisition scheme and transmission protocol selection, this paper can improve the communication efficiency between sensor nodes and obtain reliable experimental data. In the next section, this paper will focus on the process of experimental data collection and detailed interpretation of experimental results. The collection of experimental data is an important part of the study, and the analysis of the data can further verify our hypothesis and draw conclusions. This paper designed a complete set of data collection system, including the deployment of sensor nodes, the configuration of data acquisition equipment, and data transmission and storage. This paper selected representative experimental scenarios and arranged the sensor nodes in appropriate locations. Each node is equipped with various kinds of sensors, such as temperature, humidity, light, etc., to collect multi-dimensional experimental data. First, one uses a variety of data communication modes between sensor nodes, including wireless transmission and wired transmission. Nodes using wireless transmission exchange the data through a specific wireless communication protocol, while wired transmission transfers the data to the storage device through a connecting line. Such a design aims to simulate the wireless network transmission in a real application environment and to further evaluate its performance. Second, this paper carefully selected a series of experimental data of different indicators for collection. These indicators include the data transmission delay between the sensor nodes, the data transmission success rate, the energy consumption, etc. Through the collection of experimental data, a comprehensive analysis and evaluation of the performance of the wireless integrated network sensors under different conditions can be conducted. Thirdly, the analysis of experimental data involves the processing and statistics of a large number of raw data. Appropriate data processing algorithms and statistical methods are used to pre-process and clean the collected data to ensure the accuracy and reliability of the data. Then, this paper performed a statistical analysis of the cleaned data, such as calculating the mean, variance and correlation coefficient, to draw conclusions about the performance of the data. During the experimental data collection phase, this paper also focused specifically on the consistency and controllability of the experimental environment. During each experiment, this paper tried to maintain the consistency of the experimental conditions, such as the same working time, the same transmission distance, etc., to eliminate the interference of uncertainty factors on the data collection. In conclusion, this paper has successfully collected a large amount of data in wireless integrated network sensor experiments, and through careful processing and analysis, this paper draws a series of important conclusions about the performance of wireless integrated network sensors. These data and conclusions will provide important references for further research and provide useful guidance for the application of wireless integrated network sensors.

Besides, his paper will discuss the performance of wireless integrated network sensors under different workloads. First, by monitoring the energy consumption of the sensor nodes, it is founded that the energy consumption has increased significantly in the case of high load, which may be due to the need of more computing and communication resources for the sensor nodes to process a large amount of data. Secondly, this paper analyzes the communication delays between the sensor nodes and find that the delays show a clear increasing trend under high load conditions. This may be due to increased traffic between sensor nodes, causing channel resources to be competed, thus triggering an increase in delay. Next, this paper will focus on the reliability of the wireless integrated network sensors. Thirdly, through the analysis of experimental data, it is founded that the packet loss rate of sensor nodes increased significantly under high load. This means that under high load conditions, the data transmission between the sensor nodes may be lost, thus affecting the normal operation of the whole network. Fourth, this paper also analyzed the failure rate of the sensor nodes, and found that the failure rate increased significantly in the high load situation. This suggests that under high load, the sensor nodes may face more risk of failure, thus affecting the reliability and stability of the network. Furthermore, this paper present experimental studies on performance optimization strategies for wireless integrated network sensors. This paper first tried a dynamic load scheduling algorithm to realize the equalization of energy consumption and the optimization of communication delay by dynamically adjusting the workload of the sensor nodes. The experimental results show that the proposed algorithm can effectively improve the performance index of wireless integrated network sensors. Fifth, this paper also tries an adaptive channel allocation algorithm, which optimizes the communication quality by dynamically allocating channel resources to different sensor nodes according to the real-time communication load situation. Experimental results show that the proposed algorithm can significantly reduce the communication delay between sensor nodes and improve the reliability of the network. In conclusion, through the detailed analysis and interpretation of the experimental data, this paper has deeply explored the performance and reliability of the wireless integrated network sensors under different workloads. This paper also proposes some performance optimization strategies and verify them experimentally. These findings have important implications for the further development and application of wireless integrated network sensors. In future studies, this paper will continue to explore more optimization strategies to further improve the performance and reliability of the wireless integrated network sensors.

4. Limitations and Prospects

A series of important achievements have been made in the field of wireless integrated network sensors. However, some issues still need to be addressed in future studies. Here are some thoughts on the prospect of future research. First, further exploration of wireless integrated network sensors in complex environments is needed. Most current studies have focused on scenarios under laboratory conditions and have not fully considered the complex situations in the real world. Therefore, future research should focus more on the application of wireless integrated network sensors in real environments, such as cities, factories, farmland, etc. In this way, one can better understand its performance and feasibility in practical application. Secondly, attention needs to be paid to the energy management of wireless integrated network sensors. Since the energy supply of wireless sensors is usually limited, how to manage the energy effectively becomes an important topic. Future research could consider using energy-saving technologies, energy collection technologies, and algorithms to optimize energy consumption to extend the service life of sensors and reduce energy consumption.

In addition, further research on the security and privacy protection of wireless integrated network sensors is also needed. With the development of the Internet of Things, the information collected by the sensors has become more and more important and sensitive, and how to ensure the security of the sensor network has become an urgent problem. Future studies could consider the design of more secure communication protocols, encryption algorithms, and permission management mechanisms to ensure the security and user privacy of sensor networks. Finally, the integration of wireless integrated network sensors with other technologies can also be explored. For example, combining artificial intelligence, big data analysis and other technologies can further improve the intelligence degree and data processing capability of the sensor network. This can not only improve the performance of the sensor network, but also bring more possibilities for its application scenarios. To sum up, the wireless integrated network sensors still have a broad space for development in the future research. Through in-depth studies of its applications, energy management, security, and technology integration in complex environments, it is confident to further promote the development of wireless integrated network sensors that can better serve the needs of all sectors of society.

5. Conclusion

To sum up, this study deeply explores the design, performance analysis, and application scenarios of wireless integrated network sensors. Through the research of relevant theories and technologies, scholars have achieved some important achievements, which has certain guiding significance for the development and application of wireless integrated network sensors.

Firstly, in the design of wireless integrated network sensor, this paper adopts a sensor node design scheme based on Xbee communication module. By optimizing the hardware and software, the nodes have low power consumption, high reliability and flexible deployment. In the networking of node network, this paper adopts a topology based on networking protocol to realize effective communication and data transmission between nodes.

Second, this paper provides a detailed analysis of the performance of the wireless integrated network sensors. By building a sensor network in an experimental environment, this paper tests and evaluates the network delay, energy consumption and transmission reliability. The experimental results show that the designed sensor network shows good performance and can meet the practical application requirements. Finally, this paper studies and explores the application scenarios of wireless integrated network sensors. Through cooperation with experts in related fields, specific application schemes are put forward in agriculture, environmental monitoring, smart home and other fields. In the field of agriculture, this paper designs a farmland irrigation monitoring system to realize the real-time monitoring and control of farmland moisture and temperature indicators. In the field of smart home, one proposes a smart home system based on the sensor network, which provides functions such as intelligent security, intelligent lighting and smart home appliance control.

In conclusion, this study systematically investigated the design, performance analysis and application scenarios of wireless integrated network sensors. The results of this paper are important for the development and application of wireless integrated network sensors. However, there are still some problems and challenges in the current research, such as the further reduction of node energy consumption, the improvement of network security, and the wide promotion of application scenarios. Therefore, future studies will continue to explore and solve these problems, further improve the theory and technology of wireless integrated network sensors, and provide more reliable and efficient solutions for applications.

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