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Computer Hardware and Communication Network Technology in Internet of Things

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Abstract: With the rapid development and improvement of optical fibres, mobile communications, sensors and other technologies, the "Internet of Things" has been proposed. With the rapid advances in communication technologies and integrated circuits, the "Internet of Things" has also evolved rapidly over the past decade. With the advancement of IoT devices and communication network technologies, the design of IoT gateway platforms and sensor networks is becoming increasingly important. Although much research on IoT technologies in computing and communication networks exists, detailed system induction is lacking. This paper addresses the current development of sensor networks and IoT, IoT architecture, the relationship between sensor networks and IoT, and the implementation of sensor networks in IoT. In line with the IoT architecture and the role of home gateways, a market study and demand analysis of home gateways has been conducted to establish the deployment environment for home gateways and the deployment environment for sensor network nodes. In this paper, we propose the addition of a gateway data aggregation module to perform real-time data aggregation processing for sensor network data packet data processing. Aggregation processing can increase the payload in information transmission, reduce the number of times the sensor nodes send data in the home gateway, and effectively improve the network transmission efficiency and network throughput. Based on the software and hardware platforms of the built-in IoT home gateway and the software and hardware platforms of the sensor network, this paper gives a demand analysis of the home gateway sensor network access module, and proposes that the serial network is used to access the sensor network convergence node to implement the home gateway Development plan of sensor network access module. According to the needs analysis, design the flow chart of the access module and determine the communication interface between the access module and other modules, and complete the outline design of the access module. By simulating the data aggregation module of the home gateway and simulating the aggregation queue length threshold in the aggregation algorithm, the optimal aggregation queue length is obtained. The results show that the aggregation module reduces the number of calls of the home gateway data sending module by 40% and improves the home gateway network transmission efficiency.

1. Introduction

The IoT home gateway is a transmission gateway, which is a control device that connects the sensor network to the IoT. It is used to connect internal home networks, including Wi-Fi, sensor networks and mobile networks, to the IoT and to transfer and transmit a wide range of data. Sensor networking is a key technology for IoT. The sensor network research presented in this paper contributes to IoT research and development. However, the research and implementations presented in this paper are necessary to complete the development of the IoT inner corridor, and it is the focus of development in the IoT home gateway project. The research in this article is helpful for the development of the IoT home gateway and promotes the industrialization of the IoT.

Due to the importance of research on sensor networks based on the Internet of Things, many research teams have begun to research wireless sensor networks and have achieved good results. For example, Sandeep Pirbhulal started research on sensor networks earlier, which emphasized the acquisition of battlefield intelligence. Capabilities, comprehensive information capabilities, and information utilization capabilities, taking sensor networks as an important research area, and setting up a series of military sensor network research projects [1]. Karthikeyan approved implementation during the fiscal year. The basic idea is to deploy a large number of sensors on the battlefield, which collect and transmit data, filter out the relevant raw data, and then send this relevant data to various data fusion centres, which combine the large amount of data into a panoramic image. Participants receive this information as needed, greatly enhancing their ability to understand the battlefield situation [2]. Eleftherakis has proposed a "National Intelligent Transport System Project Plan" to be fully operational by 2025. The plan aims to integrate and effectively apply state-of-the-art information, data transmission, sensing, surveillance and information technologies for the overall management of land transport and to create an integrated, large-scale system for efficient, real-time traffic management[3]. Paul Nicolae Borza has developed a wireless sensor network research plan. Established a sensor network research center at the University of California, Los Angeles, and collaborated with surrounding UC Berkeley and the University of Southern California to launch research projects on "embedded smart sensors" in order to use sensor networks to achieve a full range of our physical world Testing and control, supporting the research of related basic theories [4].

In the research of computer hardware and communication network technology in the Internet of Things, using wireless sensor networks to implement is a good method. Yaw-Wen Kuo proposed a feasible Internet of Things implementation scheme. VPDNs are required to automatically connect personal terminals and data centers across different industries. It is a uniform standard IoT based on wireless private data network and high-speed packet data network [5]. At this stage, when common data collection systems implement information and communication tools, they typically use methods for IoT business centers and VPDN platforms, and are added to support security technologies to ensure the security of VPDN as well. As a result, unauthorized users will not be able to access the Internet.

This article first summarizes the research background of sensor networks and the Internet of Things, including the current state of sensor network research, as well as the current state of the Internet of Things and the architecture of the Internet of Things, and analyzes the relationship between the sensor network and the Internet of Things. Then it introduces the physical devices where this article is located- Home gateway, its basic software and hardware development platform and architecture, introduces sensor nodes, proposes a method for sensor network access in home gateways, and then discusses the background of sensor network data aggregation in IoT home gateways. Research on data aggregation. After researching emerging sensor network data aggregation and frame aggregation technologies in 802.11n networks, a data aggregation scheme in this home gateway is proposed, and the aggregation scheme is simulated to demonstrate the aggregation scheme The effectiveness of improving the transmission efficiency of the network and improving the throughput of the network, and the selection of the aggregation queue length threshold in the aggregation algorithm is simulated, and the optimal aggregation queue length is obtained. The experimental results show that the optimal aggregation queue obtained in this paper reduces the number of calls of the home gateway data sending module by 40% and improves the network transmission efficiency.

2. Proposed Method

2.1. Sensor Networks and the Internet of Things

The basis and core of the Internet of Things is observation. Observations include signal generation with sensors to achieve the goals of joint processes, management and control of intelligent networks and information services. Among them is a sensor network, a sensor network, which is the connection between parts and parts; A mobile network is a data transmission network, which is the interconnection between people; the Internet is a network that connects virtual information sharing, and the Internet of Things is connected to the physical world Network [6]. In this respect, the Internet of Things is the product of the efficient integration of sensor networks, the Internet, and mobile communication networks, and the "three networks". It is the product of the efficient fusion of information systems and physical systems (also known as information physical fusion systems)[7].

The observation layer is the basis for the development and implementation of the Internet of Things. RFID technology, identification and monitoring technology, and short-term wireless communication technology are key technologies in the identification layer [8]. The sensor layer contains the sensor nodes that enter the gate. The smart node recognizes the data (temperature, humidity, photos, etc.) and transmits the network to a higher gateway base station. The portal sends the emotional processing data collected to the background through the web layer. When the background data processing is completed, the executable command is sent to the corresponding executable office to complete the correction of the control variables of the monitored / measured object or to send the signal type immediately to achieve the command. From its distance[9].

(1) Home gateway architecture

In this project, the IoT home gateway is used to interconnect the internal network of the home, including WiFi network, sensor network, and mobile communication network, in the entire IoT network, to realize the conversion and forwarding of various data. For sensor networks, it is a control device that connects sensor networks to the Internet of Things [10].

Inside the home gateway, the sensor node collects the data in the sensing area, sends it to the convergence node after simple processing; the sensor network access module in the home gateway reads the data from the sensor network under the home gateway and converts it through communication with the convergence node. Into the information that users can know, such as temperature, humidity, light intensity, etc. in the deployment area of the sensor node; and then carry out long-distance transmission, including Ethernet, wireless communication network, etc., and finally reach the remote IoT area server [11]. At the same time, the home gateway can also encapsulate sensor network messages such as control commands and send them to the sensor nodes of each sensor network to implement collection and management of sensor network data.

The development of a home gateway first determines the hardware and software environment of the home gateway according to the specific functional requirements of the home gateway. After the previous market research and the analysis of the requirements for the specific functions of the home gateway, the development of the final project chose the ARM11 architecture HHARM6410 development board as the main control board of the home gateway, and embedded Linux as the system platform for multi-access home gateway

1)HHARM6410 Development Board

HHARM6410 is developed by Huaheng Technology for the development of high-end handheld devices and miniature intelligent control devices. The processor S3C6410 / S3C6410 using the ARM11 core of Samsung Korea. The size of the core board of this development board is only equivalent to the size of a 48mm * 67mm square.

The HHARM6410 kit consists of a core board and a backplane (peripheral board or basic board). The core board integrates the Samsung S3C6410 processor, 128MB of DDR memory, and 1GB of NANDFLASH. At the same time, 256KNORFLASH is reserved. Provides ample space for application research and development [12]. The development board is shown in Figure 1:

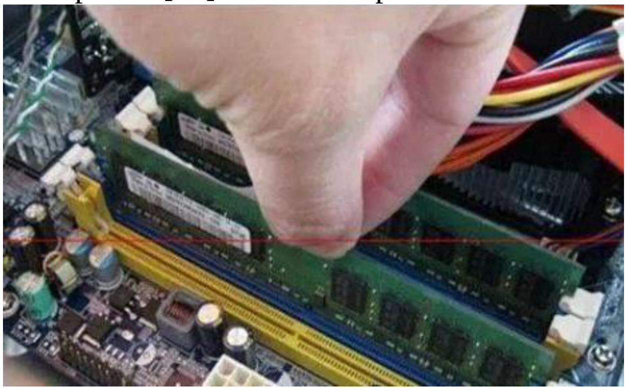

Figure 1. HHARM6410 development board

As shown in Figure 1. The following peripheral interfaces are provided on the development board backplane:

Two four-wire RS-232 serial ports (COM0, COM1)
One USB HOST interface (USB device interface is on the core board)
One 10M / 100M adaptive Ethernet interface, one TFT LCD interface, one touch screen interface
A wm8987 sound interface
One 4x4 button interface
One video input (analog saa7113 or digital ov9650, optional)
One video output TVOUT
An RTC and watchdog
One SDIO interface WiFi module
One SD card interface

The combination of the master table and the backplane creates at least one complete software system. The system is small, low power consumption and high performance, and can load and use the included Linux operating system. Users can create separate applications on this platform [13].

The characteristics of the S3C6410 microprocessor are as follows:

ARM11 embedded processor core, clocked up to 667MHz
Expansion bus maximum frequency 133MHz
32-bit data bus and 32-bit external address bus
Completely static design (0-667M)
Memory controller (eight banks)
Contains SROM, SRAM controller, NAND controller
Boot chip selection on reset (8-bit, 16-bit storage or NAND to choose from)
Five thirty-two timers
Interrupt controller with up to 64 interrupt sources
Four UARTs, Supports IrDA 1.0
Four DMA controllers with 8 channels per DMA controller
IIS audio interface
Two USB host ports, one USB device
IIC-Bus interface (6410 only one, 6410 supports two)
Two serial peripheral interface circuits (SPI)

Three SD card interfaces (support 1/4/8 bit mode, rate up to 50MHz)

MFC (multi-format video codec) interface, supporting H263, H264, MPEG4 and VC-1 2) hardware codec

The IoT home gateway is used to interconnect the internal network of the home, including WiFi network, sensor network, and mobile communication network, to achieve the conversion and forwarding of various data. From the perspective of the IoT architecture in this article, the home gateway is connected to the home's internal sensing access layer and the entire IoT access layer. According to the requirements of the home gateway function, the home gateway mainly completes the function of protocol adaptation and protocol conversion [14-15].Its software architecture is shown in Figure 2 below:

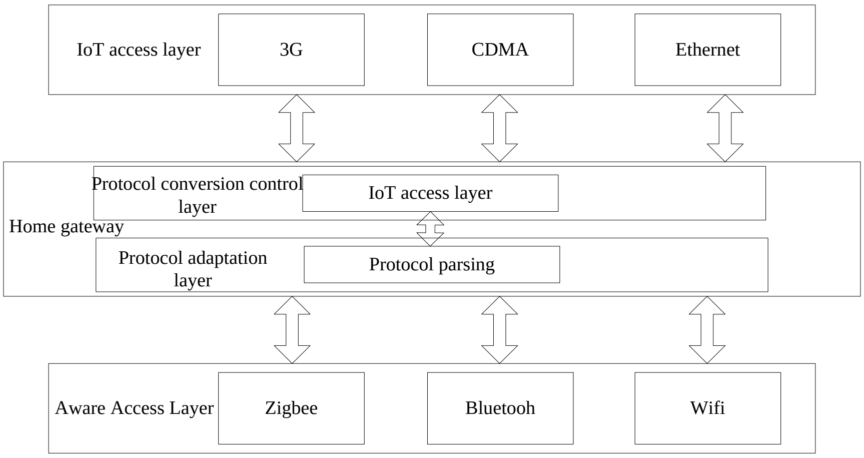

Figure 2. Residential Gateway software architecture

For sensor networks, the sensory data received from the sensor network needs to be parsed and processed into a general data packet through a protocol, and then the general data packet is sent to the remote area server [16]. At the same time, the protocol analysis module can receive the universal data packets from the remote machine, convert them into sensor network data packets, and send them to the sensor network.

The wireless sensor network has gone through three stages: smart sensor, wireless smart sensor, and wireless sensor network. Smart sensors combine computer power with sensors, so sensor nodes not only have the ability to receive data, but also the ability to filter and process data. Wireless intelligent sensors have enhanced wireless communication capabilities based on intelligent sensors and greatly expanded the sensor antenna. Sensor design costs are reduced; Wireless sensor networks have introduced wireless intelligent sensor network technology, so sensors are no longer a single sensor unit, but an organic combination that can exchange information and facilitate management. Due to the low cost and complexity of a wireless sensor network, it is particularly suitable for home network installations[17-18].

Wireless network sensor base station MIB520 development board, MIB520 development board provides USB interface for Mote for communication and online programming. As long as the base station application program is programmed on the Mote node, the Mote node combined with the MIB520 development board can be used as a base station [19]. MIB520 provides two independent ports: one for online Mote programming and the other for USB data transfer.

2.2. LoRa and LoRaWAN

(1) LoRaWAN Standard

LoRaWAN defines network protocols and network architecture.

LoRaWANs are typically set up in a star geography where the message forwarding port between the terminal and the central server goes backwards. Communication between terminals and ports is spread over different networks and data rates. Use the adapter baud rate system to increase battery life.

The LoRaWAN network envisions three types of terminal equipment [5]: Class A, Class B, and Class C, each of which is associated with a different working mode. As shown in Figure 3 below.

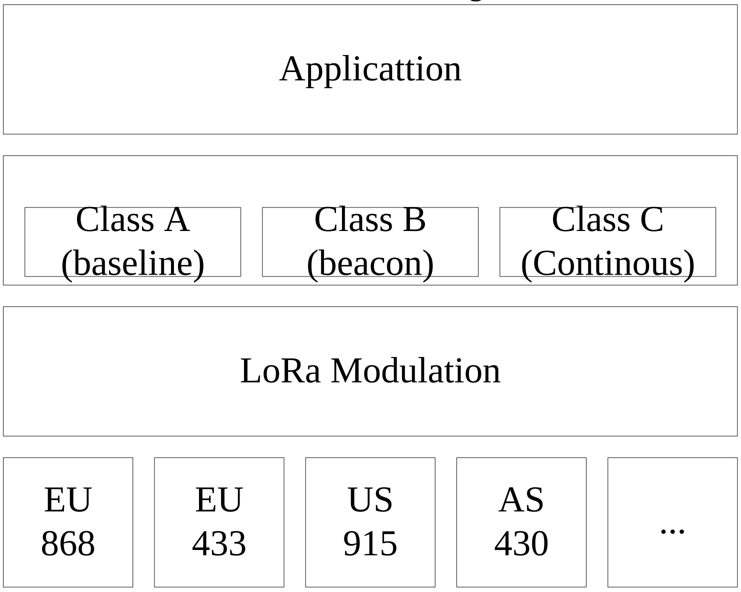

Figure 3. LoRaWAN protocol model

As shown in Figure 3 above, the LoRaWAN network includes three types of terminal equipment: Class A, B, and C, each of which is associated with a different working mode

Dual terminal with transmitter (Type B): In addition to the Type A random receiver window, Type B device opens an additional receiver window for a predetermined period of time. In order for the terminal to open the receiver window at a predetermined time, it receives a time-synchronizing light from the port. It lets the server know when the terminal is listening[21-22].

Two-way terminal device with maximum receiving slot (Type C): A Type C terminal device opens the receiving window almost continuously and only closes when sending.

1) Physical layer information format

LoRaWAN has three types of terminal equipment. All LoRaWAN end devices must implement Class A functionality.

LoRa physical messages distinguish between uplink and downlink messages.

2) LoRaWAN communication security standard

The LoRaWAN protocol provides signatures and encryption for LoRaWAN package components. This is done using a symmetric key that recognizes the known node and the network server (and possibly the software server behind the network server) and divides it into one of two paths depending on how the node is connected. Network [24].

The first way to allow nodes to join LoRaWAN is through OTAA. Each node here uses a unique 128-bit application key (AppKey) that is used when an application sends a request to join. Messages are not encrypted and are signed using this AppKey. The node sends an integrated request containing each AppEUI and DevEUI value, such as DevNonce, which must be arbitrary two bits. AppEUI must be unique to the device owner. DevEUI must be the only universal identification tool for your device.

ABP (enabled by customization) Unlike OTAA, in that node there is a DevAddr and two batch keys (NwkSKey and AppSKey) and the node must be unique. Since the node contains all the necessary information and keys, they can communicate with the web server without having to join the message [25].

When a node connects to a LoRa network via OTAA or ABP, all incoming messages are encrypted and signed using a combination of NwkSKey and AppSKey. Because only certain web servers and nodes are aware of these keys, nodes or other brokers should not be able to download data without text. The K-encryption key used depends on the value of FPport:

3) Duty cycle restrictions

There are some limitations to using the 868 MHz band in public networks. In Europe, the main limit is a 1% duty cycle (in most cases). This means that if you measure the average length of time a gateway transmits over time, you cannot exceed 1%. Therefore, how much the gateway transmits is very limited. In the United States, the FCC has no such restriction on ISM band regulations. In a 915 MHz Symphony Link system, the gateway is transmitting approximately 15% of the time.

2.3. Research and Development of the Home Gateway Sensor Network Access Module

(1) Research on the home gateway sensor network access module

The construction of the sensor network access module in the home gateway is guided by practicability, openness, functional scalability, and advanced technology. Through the analysis of the sensor network data transmission process, the sensor network access module in the home gateway The overall achievement goals are as follows:

1) The design of the sensor network access module in the home gateway should be modularized and can be executed in parallel with other module programs;

2) The design of the sensor network access module in the home gateway must have good scalability, leaving an interface for the subsequent development of sensor network management functions;

3) The sensor network access module in the home gateway must implement the collection, conversion, and control command forwarding of sensor network node information.

Because the home gateway is a multi-access system, the use of existing technology solutions can speed up the development cycle of the home gateway and enhance the applicability of the gateway.

Known from the hardware platform of the home gateway in the previous chapter, the home gateway uses HHARM6410 embedded development platform based on Huaheng Technology. On this platform, the development of 802.11n can be quickly carried out to realize the access of WiFi devices. Using the platform's Mini PCI-E interface, 3G modules can be developed and extended to achieve integration with mobile communication networks.

The sensor network used in the construction is the industry's largest wireless sensor network product supplier Crossbow company's high-performance low-cost new product IRIS node. IRIS nodes have low power consumption, support sensor board to collect data, Zigbee compatible, support Tinyos operating system platform and so on. It is suitable for temperature, humidity, light intensity and other sensor nodes in home network networking.

The sink node is the center of the sensor network, and it is responsible for collecting the sensor data information of the network. The communication between the convergence node and the embedded home gateway completes the access of the sensor network in the IoT home gateway. As the USB hardware serial port of this home gateway is reserved for extended development, we can directly use the USB serial port to access the aggregation node and complete the data reading, conversion, and forwarding in the home gateway. The access of the sensor network in the home gateway is realized through the communication between the gateway and the aggregation node, and the module of the sensor network access in the home gateway can be realized through the module in which the home gateway communicates with the aggregation node.

Using serial port to access the sensor network convergence node to quickly realize the development of the home gateway sensor network access module, not only expands the management function of the sensor network, but also reduces the product development cycle. The collection, conversion, and control commands of sensor network node information can be realized by reading and writing sensor network messages to the sensor network convergence node through the serial port of the home gateway.

(2) Development of home gateway sensor network access module

After understanding the data frame format of the sink node and the data format and data flow diagram transmitted in the serial port, you can use the serial port programming to read the sink node data and then perform related processing operations.

The access of the sensor network in the home gateway means that the home gateway uses serial communication to read and write the data of the aggregation node. According to the data flow diagram of the home gateway sensor network access module, the functions of the home gateway sensor network access module are mainly divided into the following three aspects: the initialization of the serial port; reading the message data sent from the serial port and verifying the processing. Send to the IoT area server; Encapsulate the TinyOS message received from the IoT area server as a serial port message and write it to the serial port.

Due to the difference between the serial data format and the TinyOS message format, when the home gateway receives the serial byte stream sent by the sensor network convergence node through the serial port, it first restores the serial byte stream to the original serial data packet, and then converts the serial data The packet reverts to a TinyOS message packet that the sink node will send to the IoT area server.

After the system is initialized, the system waits for events in the file descriptor set to occur. When the serial port already has data or the Mote module sends data to the main control board through the serial port, the system calls the select function to monitor the occurrence of a serial port event corresponding to the serial port descriptor and calls the Serial_Read module to read the serial port data.

The Serial_Read module first stores the serial port character stream into the opened buffer buffer at one time, and then sorts the serial port character stream into serial data packets without errors by reading and judging each byte of the buffer.

The Serial_Read module performs preliminary processing on the serial data packet. If the serial data packet needs confirmation, it immediately sends a confirmation data packet to the serial port.

For each serial data packet, the Serial_Read module creates a linked list of data packets of the same type. The error-free parsing data packet is stored in the data packet linked list. After reading the serial port character stream, the data packet stored in the data packet linked list is popped up and returned to the main function to call the socket module to send to the IoT area server. Similarly, when the IoT area server sends a message to the sensor network convergence node through the home gateway, such as sending control commands to the sensor network node, the home gateway needs to encapsulate the TinyOS message packet sent by the area server into a serial data packet, and then send it through the serial port. Send to the sink node.

3. Experiments

3.1. Experimental Background

This paper uses MATLAB simulation software to study the performance of the proposed data aggregation algorithm. This chapter analyzes the effect of the aggregation algorithm on the data sent by the home gateway, and analyzes the effect of the length of the aggregation queue on the algorithm to obtain the optimal length of the aggregation queue. The simulation is performed in an environment of 30 sensor network nodes, and the node numbers are in the order of 1-30. Among 30 sensor network nodes, nodes 1 to 5 are sensitive information nodes, nodes 6 to 10 are single-node multi-packet aggregation type nodes, and nodes 11 to 20 are multi-node multi-packet aggregation type nodes. The home gateway processes the data packets randomly sent to the home gateway by 30 nodes.

After the aggregation algorithm processes each data packet according to the node information aggregation type, it calls the sending module interface to send data, and calling the sending module interface once is equivalent to sending the data packet processed by the data aggregation module once.

3.2. Experimental Methods

For this research, I used the LoRa development kit Waspmote. Waspmote is an IoT development hardware platform from Libelium. It is a sensor device specifically for developers. It can use different protocols (Zigbee, LoRa, Bluetooth) and frequencies (2.4GHz, 868MHz, 900MHz) up to 22k. Its sleep mode is 0.06uA, which allows to save battery when not transmitting. There are already more than 50 sensors and a complete open source IDE (API library + compiler) to easily start working with the platform. This is the hardware information used in the experiment:

Microcontroller: ATmega1281
Frequency: 14.7456MHz
SRAM: 8KB
EEPROM: 4KB
FLASH: 128KB
SD Card: 2GB
Weight: 20gr
Dimensions: 73.5 x 51 x 13mm
Clock: RTC (32KHz

Experiments can use different modules (Zigbee, Sigfox, LoRa). I use the LoRa module to do my job.

Wapsmote's LoRa module is a module based on the Semtech SX1272 chip. It enables us to send and receive messages via LoRa modulation.

When analyzing the effect of the aggregation algorithm on the data sent by the home gateway, we first randomly generate variable k packets, indicating that the access module received k sensor network data packets, and k increased from 1 to 300. After processing by this data aggregation algorithm, the sending module is called to send. Calling the sending module interface once is equivalent to sending the data packet once after data aggregation processing. The k packets received for processing are compared with the number of times the aggregation module calls the sending module after receiving k packets. Is the spectrum of a signal with different propagation effects. These signals are captured by the HackRF One SDR and analyzed by the Gqrx SDR. From the picture we can find that the diffusion factor can affect the packet transmission rate. When we choose a large spreading factor, it takes more time to send the packet. That is, when the spreading factor becomes larger, the modulation signal transmission rate decreases.

3.3. Experimental Collection

In this experiment, I used four Wapsmote terminal devices. Two of them are transmitters and the other two are receivers. We put two senders in the same room and the other two receivers in the other room. The distance between the receiver and the transmitter is 15m. The two receivers are connected to the wire for synchronization to ensure that they can send packets at the same time. Communication between the sender and receiver is based on LoRa modulation information. The distance between the sender and receiver is 10 meters. The receiver connects to the computer through a serial port and stores all the packets it receives. Both senders work with the same parameters, except for the propagation factor. The sender TX1 always uses the mode SF = 7, BW = 500 KHz and CR = 4/5; the sender TX2 works on the same BW and CR, but after sending 200 packets, the SF changes from 7 to 12.

4. Discussion

4.1. Experimental Analysis of the Impact of Transmission Bandwidth

All LoRa storage and messages that contain a PHY counter-charge (fast charge) start with a one-bit MAC header (MHDR) followed by a MAC load (MACPayload) and a 4-bit back integrity code (MIC). The MAC header specifies the message type (MType) and is based on the primary version of the LoRaWAN (Major) layer script script. As shown in Table 1 below.

Table 1. MAC information types

MType	Description
000	Join Request
001	Join Accept
010	Unconfirmed Date Up
011	Unconfirmed Date Down

As shown in Table 1 above, LoRaWAN network terminals allow only individual data rates. It is used to manage and increase the maximum data rate of a fixed terminal. This is called Adapter Data Rate (ADR) and when launched the network is optimized to use the fastest data rate.

Bandwidth (BW) is the frequency of the transmission area. Higher BW provides higher data rates (and therefore shorter transmission times) but lower sensitivity (due to additional noise). Smaller BW offers greater sensitivity but lower data rates. Low BW also requires more accurate crystallization (less than ppm). Data is transmitted at a screen speed corresponding to the bandwidth. Therefore, the bandwidth of 125 kHz corresponds to the chip speed of 125 kbps. The SX1272 has three programmable bandwidth settings: 500 kHz, 250 kHz and 125 kHz. The Semtech SX1272 can be programmed from 7.8 kHz to 500 kHz, although the bandwidth requires thermal compensation (TCXO) below 62.5 kHz. The test results are shown in Figure 4 below.

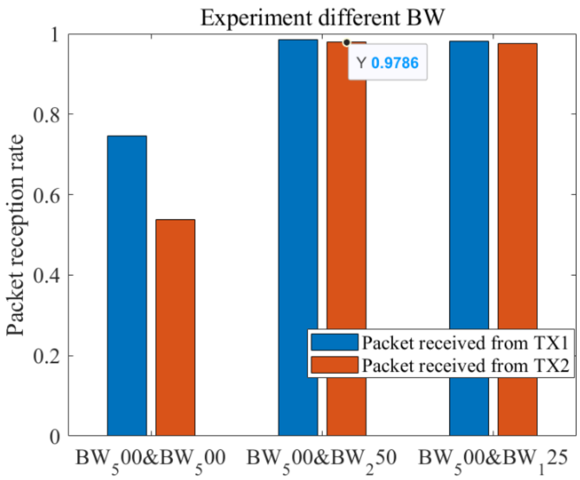

Figure 4. Packet acceptance rates for different bandwidths

As shown in Figure 4 above, SF = 12, CR = 4/5. The Y-axis represents the packet reception rate. The blue bar on the X axis represents TX1, which is always BW = 500KHz, and the orange bar on the X axis represents TX2 whose BW is from 500KHz to 125KHz.

We can see that when two senders work at the same bandwidth. The packet loss rate is high. When they work in different SFs, the packet loss rate is less than 2%. Sending packets with different bandwidths can reduce or avoid collisions.

4.2. Aggregation Algorithm Affects the Delay Caused by the Home Gateway When Processing Data Packets.

Experimental analysis. Data aggregation is at the expense of real-time network data packets. Adding an aggregation module to the processing will bring the module processing delay and Waiting delay in the aggregate queue. In order to simulate the delay data of the data packet after adding the aggregation module, in this simulation, the timing starts whenever a data packet is received, and the timing stops when the sending module is called to send the entire aggregated data packet, so that each time the sending module is called The maximum delay of the sensor network data packet in the home gateway before sending data. The average delay of k sensor network packets is obtained from the maximum delay of each time. When k increases from 0 to 300, the average delay of processing k sensor network packets is obtained as shown in Figure 5 below.

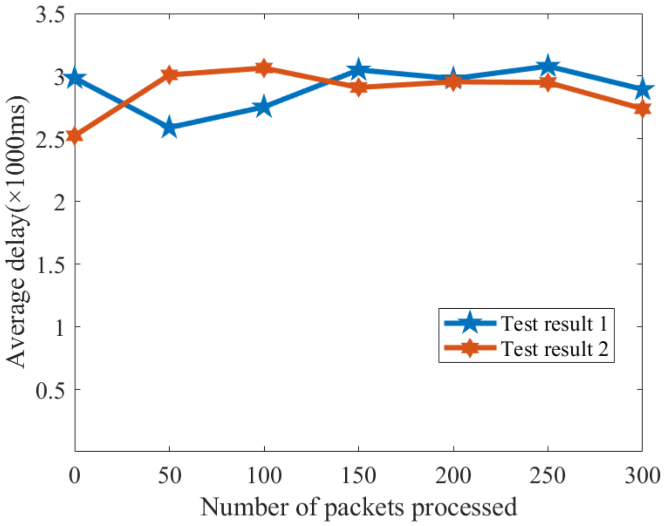

Figure 5. the average delay when processing k-packet

As shown in Figure 5 above, when the number of different sensor network data packets is received, the average delay in processing sensor network data packets approaches 2.6 μs, that is, the average delay in processing each sensor network data packet through this module. It is 2.6 μs. At this time, the aggregation module has little effect on the operating efficiency of the home gateway.

4.3. Impact of the Length of the Aggregation Queue on the Algorithm

In the aggregation threshold control parameter set, an important parameter is the length of the aggregation queue. The length of the aggregation queue is related to the number of aggregation packets and the length of each packet. Since the length of each sensor network packet in the home gateway is the same, the length of the aggregation queue is only related to the number of aggregated packets. Therefore, in the data aggregation algorithm, we set the aggregation queue length to the number of aggregatable packets.

Perform the following configuration in the interface view:

Table 2. QoS token configuration analysis

Operating	Command	Description
Enter system view	System-view	-
Enter interface view	Interface interface-type interface-number	-
Configure Qos token function	qos qmtoken token-number	Required By default, the Qos token function is not enabled.

As shown in Table 2 above, after completing the token configuration, use the shutdown / undo shutdown function to start the interface to implement the token sending function of QoS. When analyzing the aggregation queue length in this data aggregation algorithm, we simulated 300 randomly generated data packets under different aggregation queue lengths, that is, the number of different aggregation packets, and obtained 300 data packets under different aggregation queue lengths. The number of sending times and the average sending times are shown in Figure 6 below.

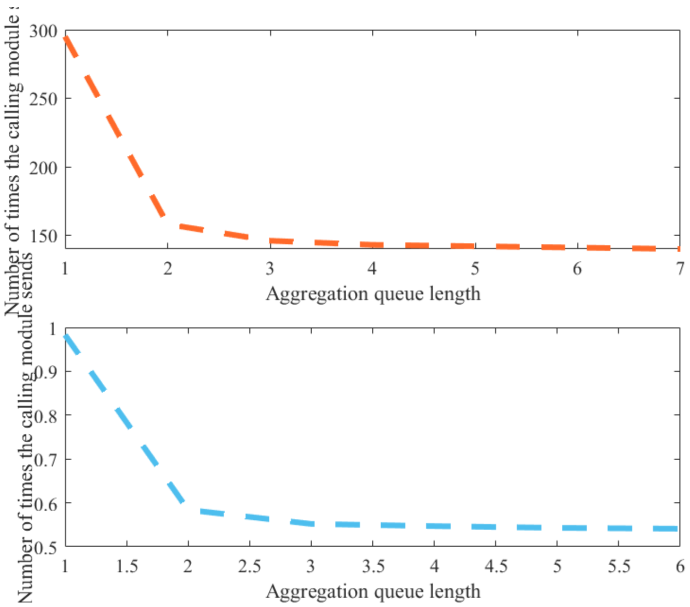

Figure 6. the mean number of sending when processing 300 packets on the condition of different aggregation queue length

As shown in Figure 6 above, when the aggregation queue length is 1 to 5, the aggregation queue length has a significant change in the number of transmissions after 300 packets are aggregated. When the aggregation queue length is 5, the extreme points of the simulation curve are obtained. When the aggregation queue length is 5 to 10, the effect of the change in the number of transmissions after the aggregation queue length is aggregated on 300 data packets is small. When the aggregation queue length is 10 to 30, the aggregation queue length is aggregated on 300 data packets. The effect of changes in the number of transmissions after processing is minimal. It can be considered that the aggregation queue length of 10 is the minimum value of the aggregation effect obtained by the aggregation queue length for 300 packets.

It can be seen from the curve that when the aggregate queue length is 10, as the number of node packets increases, the average number of processing times of each packet approaches a stable value. It is concluded from this that the aggregation queue length of 10 is the optimal value for the aggregation effect obtained by packet aggregation processing.

Because the length of the aggregation queue is related to the aggregation delay of the data packets, we obtain the results of different latency experiments for processing 300 packets at different aggregation queue lengths as shown in Figure 7 below.

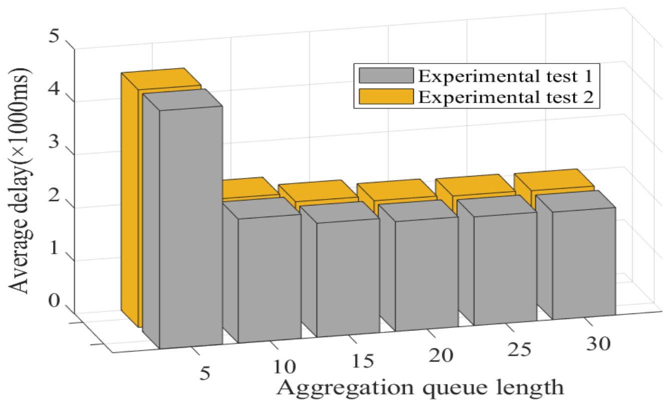

Figure 7. the average delay when processing 300 packets on the condition of different aggregation queue length

The analysis of the graph is similar to the relationship between the aggregate queue length and the sending of 300 data packets in the figure above. When the aggregate queue length is 1 to 5, the aggregate queue length has a significant change in the delay after the 300 packets are aggregated. When the aggregation queue length is 5, the extreme points of the simulation curve are obtained. When the aggregation queue length is 5 to 10, the effect of the delay change after the aggregation queue length is aggregated on 300 packets is small. When the aggregation queue length is 10 to 30, the aggregation queue length is aggregated on 300 packets. The effect of delay changes after treatment is minimal. It can be considered that the aggregate queue length of 10 is the minimum delay obtained by the aggregate queue length when 300 packets are aggregated.

It is concluded from the above simulation that the aggregation queue length of 10 is the optimal value of the aggregation effect obtained by performing packet aggregation processing, and the delay obtained by the aggregation processing of 300 packets is the smallest, so the aggregation queue length is 10 The optimal aggregation queue length of the aggregation module.

5. Conclusion

This article is at the stage of the definition of the Internet of Things and home gateway functions. First, according to the current research progress of the Internet of Things, the design of the Internet of Things system architecture in the project is completed to achieve the goal of Internet of Things and provide a platform for research and application of Internet of Things. The system architecture defines the functional role of the IoT home gateway. In the home gateway requirement analysis phase, based on the analysis of the function and role of the IoT home gateway in the previous stage, market research and home gateway requirement analysis were performed to build the home gateway development environment and sensor network node development environment.

This article considers that due to the inconsistency of the current Internet of Things standards, the entire Internet of Things function is divided into two stages: preliminary research for basic function development and later research for enhanced function development. In the development of basic functions, the multi-access function of the Internet of Things home gateway was determined. For the sensor network, the construction of the sensor network and the access of the sensor gateway in the Internet of Things home network must be completed. This article finally uses the serial port to access the sensor network aggregation node on the main control board platform of the established home gateway to achieve the sensor network access in the IoT home gateway.

This article is to improve the effectiveness of the communication between the IoT home gateway and the IoT area server in the development phase of the home gateway enhancement function. Based on the analysis of the requirements of the home gateway in the IoT architecture and the actual software and hardware platforms, this paper draws on the data aggregation technology in the sensor network and the IEEE 802.11n MAC layer frame aggregation technology. Aggregation processing of sensor network data messages. Aggregation processing can reduce the extra information carried in information transmission, improve network transmission efficiency and network throughput. After proposing the implementation of the aggregation of this module, use MATLAB simulation software to simulate this aggregation module. Through the simulation of the home gateway data aggregation module, the results show that the aggregation module reduces the number of calls of the home gateway data transmission module by 40%, and improves the home gateway network transmission efficiency. The simulation of the aggregation queue length threshold in the aggregation algorithm is carried out to obtain the optimal aggregation queue length.

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Data Availability

Data sharing is not applicable to this article as no new data were created or analysed in this study.

Conflict of Interest

The author states that this article has no conflict of interest.

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