Research on a New Generation of Wireless Internet of Things and Gateway

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Abstract

The paper put forward a networking scheme for short-range and low-power wireless application network base on 6LoWPAN protocol, use 32bit ARM Cortex M3 MPU and 86FR212 to form a network system, design a new generation wireless gateway, the gateway is low cost embedded with multi-protocol wireless gateway.

Keywords: Internet of Things; Wireless gateway; IPv6; 802.15.4; ARM cortex M3; 86FR212; Route Under MAC

1 Introduction

The Internet of Things(IoT) refers to put anything in the world through wired or wireless way connected to each other, exchange of information, communication and sharing, so as to realize intelligent identification, location, tracking, monitoring and management, its goal is to build a wisdom interconnection that can connected anything in the world anywhere and anytime. In industrial control, smart homes, intelligent electric grid, environmental monitoring, telemedicine, logistics tracking or other fields, the Internet of Things technology has a broad application prospects.

How to connect the terminal device with network is one of the key technologies of IoT at present. Along with the rapid development of integrated circuit technology and radio frequency technology, low cost, low power consumption wireless access technology for Internet provides a convenient way of accessing, for the popularization of the Internet of things application has established good foundation [1].

In this paper, we will study a kind of the Internet of things application network system which consists of IEEE 802.15.4 Mac and 6LoWPAN network protocol stack , Using the United States ATMEL company's latest 86fr212 FR chip, using the TI/ATMEL 32-bit ARM CORTEX M3 microcontroller and IAR as an embedded system development platform, we will develop the corresponding application gateway base on this network system and realize to real-time control the remote terminal at anywhere through Internet.

2 Overall design

The Network Protocol Layer uses the 6LoWPAN international standard; ATMEL Company developed the corresponding protocol stack.

The wireless gateway is the focus of this study and it is the key equipment of the network of the Internet of Things applications [2].

In this study, use IEEEE 802.15.4 as the MAC Layer, and it achieve by the RF chip 86FR212. The RF chip 86FR212 integrates the complete baseband circuit of the 802.15.4 Physical Layer and MAC Layer and RF transceiver front-end circuit. Work under 1GHz,the 86FR212 transceiver according to the application area of different configuration in 780MHZ, 868MHZ or 915MHz band, and it has strong penetrability and wide adaptability. 86FR212 provided to a tall 120DB the link budget, to provide protection for the terminal equipment reliable connection.

The Network Protocol Layer uses the 6LoWPAN international standard; ATMEL Company developed the corresponding protocol stack.

The wireless gateway in this study use TI company's latest 32-bit ARM single chip microcomputer LM3s9b96[3]. LM3s9b96 is very powerful, it integrated Ethernet interface, UART, I2C interface, and the SPI interface abundant resources, it is an ideal choice for the development of wireless gateway. Use the IAR Work Bench 5.4 as software development environment, and use the world's most popular embedded real-time operating system FREERTOS. FREERTOS is one of the international most popular embedded real-time multi-task operating system in recent years which only have three core document.

Through the Company utasker's TCP/IP protocol stack, (The protocol stack integrated the ARP, RARP, ICMP, IP, UDP, DHCP, DNS, TFTP, TCP, dynamic HTTP, HTTP POST, FTP, SMTP, POP3, TELNET, NetBIOS and VLAN and other networking protocols.)the gateway has a broad application base.

3 System Architecture

The main support technology of the system include Embedded technology, Wireless LAN networking technology, Multi-Protocol processing, Human–Machine Interface, the implementation of multi-tasking and so On[4].

3.1 NETWORK ARCHITECTURE

Figure 1 shows the network structure of the system. It is a prototype of the future development of Internet of Things. We can see from figure 1 that each wireless terminal comprises the wireless application system. The wireless gateway is the bridge of the core parts of the network system, to provide bridging of external internet. And realize interconversion between protocols.

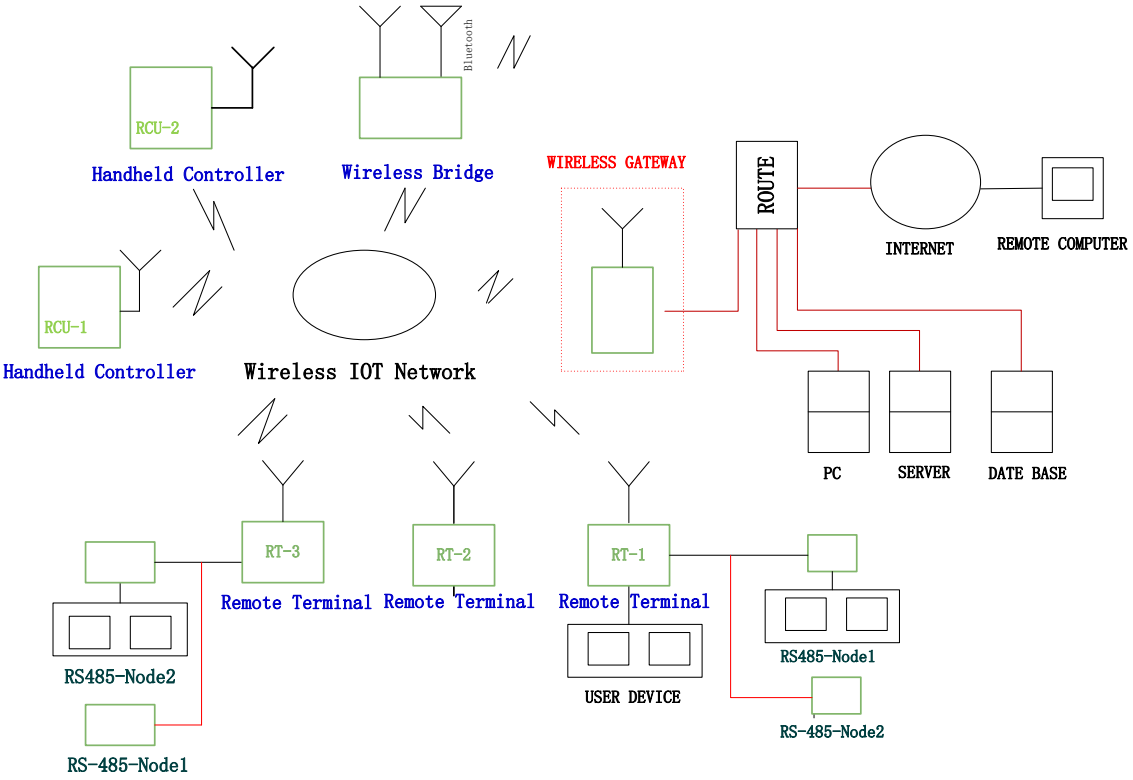

Figure 1 Network architecture

Due to the use of the IPv6 technology, each node terminal assigned IP addresses. Unlike the 32-bit address used in the IPv4, IPv6 use 128-bit address. IPv6 provides a virtually unlimited number of addresses, so that the earth has a unique IP address of any article on earth becomes possible.

3.2 EMBEDDED HARDWARE AND SOFTWARE DEVELOPMENT

IAR Embedded Workbench is the development for the software which written with C language, utilize JTAG interface, make use of IAR C-SPY debugger hardware emulation. Debug system hardware departmental module, realize unitary function.

The software system consists of RTOS, network protocol stack and application software.

Figure 2 shows the software architecture.

The protocol stack is a key part of the software development, and compared with other protocols, 6LoWPAN has the advantage of small code space.

Protocol stack and application modules can operate relatively independent. The ATMEL RUM (Route Under MAC) technology is transplant, cutting from the ATMEL RUM (Route Under MAC) technology. Atmel specific RUM technology at the MAC layer transparent routing method, the method allows any node on the packet received is not his own automatically forwarding the packet relay function.

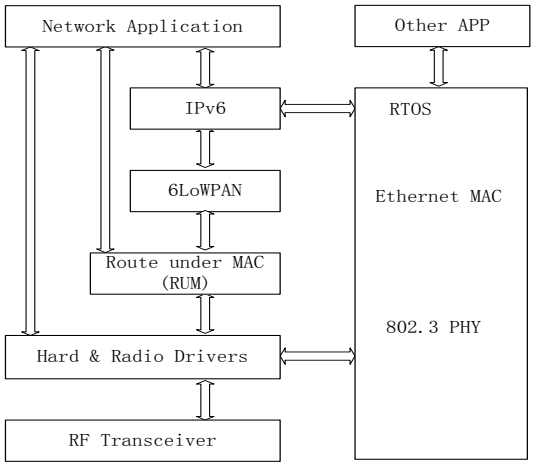

Figure 2 Software architecture

Due to use real-time operating system (FREETOS), it is the real-time multitasking operating system of preemptive, through the establishment of multi-tasking and queue mechanism to simplify program design and debugging.

Hardware modules uses the 32-bit ARM Cortex M3 microcontroller LM3S9B96[4] as its core and integrate RF212 transceiver and the corresponding periphery application interfaces.

RF part of the pre-formed relatively independent modules, and an integrated PCB antenna, can be reused in different applications, which greatly simplifies the development and debugging of hardware. RF modules are connected through the SPI interface and microcontroller.

Embedded system development process generally "host / target board" development model, namely the use of the host (PC) on the hardware and software resources and good development environment and debugging tools to develop software on the target board, and then cross-compiler environment to generate object code and executable files downloaded to the target board via serial / USB / Ethernet, etc., the use of cross-debugger running in the monitoring program, real-time analysis, and finally cured to download the program on the target machine to complete throughout the development process. Software design, embedded system design is a combination of the the ARM hardware environment and the IAR software development environment to develop a flow chart. The whole development process consists of the following steps:

(1) Source coding: the preparation of source C and assembler
(2) Compile the program: cross compiler in IAR compiler
(3) The software simulation debugging: Observe the operation of simulation software in the SDK
(4) Download: downloaded to the target board through JTAG, USB, UART way
(5) Hardware and software testing, debugging: Joint debugger through JTAG, etc
(6) Download curing: if the program is correct, download it to the product and produce it[4].

4. Key technologies

Several key technologies during the design and implementtation process of the project are as follows:

(1) The wireless gateway needs 802.15.4 and 6LoWPAN to realize the function of the data communication, thus studying on the Communication mechanism of the platform and the gateway module, and the design of the related protocol is a key problem.
(2) The important contents in the research include the following aspects, such as how to integrate the protocol stack and manage them effectively, and how to communicate reliably between the applications. Therefore, it needs to study deeply on the bonding mechanism of the network protocol stack of FREERTOS.
(3) In this project, how to develop and optimize the applications in the FREERTOS as well as establish efficient communication mechanism, they are having far-reaching significance to promote the application of this study.
(4) RF technology is always the difficult point of embedded systems, especially anti-jamming problem that requires repeated and detailed optimization process.
(5) Energy saving and reliable are the two key points cared by the wireless network, research on energy-saving and reliable routing protocol of the Internet of Things network is a key problem of the project[4].
(6) Passive fault detection method for wireless sensor networks. The project to take a combination of wireless sensor networks sink-based passive reception and BP neural network fault diagnosis method.

5 Application prospects

The new generation of wireless networking gateway using low-power wireless networking, supporting the IPv6 protocol, is the key necessary equipment for the networking of the Things networking.

IPv6 is the industry recognized "good medicine" to solve the problem of IP address depletion, there is a widely circulated sentence to describe IPv6: "for each piece of sand on Earth are assigned an IP address ". The most basic requirement of Internet of Things is that we must assign an IP address for each object, only by this way can we realize to communicate two object. In IPv4 era , global IP addresses is limited. The IP address' consumption is very large in the era of the Internet of things, IPv6 can meet the gap.

This wireless gateway compatible IPv6 technology so that support a variety of network application protocol, convenient networking , low cost, transmission distance, and strong anti-interference, can be widely used in smart home, smart grid, industrial control, environmental monitoring, logistics tracking, and so on.

6 Conclusions

In this paper, put forward a new generation wireless Internet of Things gateway based on the TI/ATMEL 32-bit ARM CORTEX M3 microcontroller and 6LoWPLAN network protocol stack.

6LoWPAN is the key to achieve wireless embedded Internet. 6LoWPAN protocol stack code capacity is low, easy integration into resource-limited embedded micro controller system. 6LoWPAN technology destroys obstacles exist in the low-bandwidth wireless networks, the use of IPv6 in the low-power embedded devices with limited processing power [5].

The gateway realizes to connect the local application network to Internet network connected. Achieve the ubiquitous ever-present network.

Build sub-GHz band wireless networking system with low power consumption, transmission distance, high reliability, simple networking, and low cost which has broad application prospects [6].

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