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Design of RTSJ-based intelligent home system gateway

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ABSTRACT

The core of this system with AMD Geode NX1500 processor constructs intelligent home hardware platform, provides the system structure and hardware diagram, through the house gateway to realize the family appliance equipment remote monitoring. The gateway uses hierarchical model "Internet/3G + Fieldbus" method to realize the wired/wireless data interaction, and in real-time Linux operating system, it uses RTSJ standards for the reference of real-time Java to realize home gateway protocol conversion and applies Socket technology to realize communication software design of between two layers of network.

KEYWORDS

Geode NX1500 processo; Fieldbus; RTSJ; Socket technology.

INTRODUCTION

Along with the computer network technology and communication technology development, home networking is being closely watched by people, the emergence of the integration of the three kinds of networks and the needs of the new features make the design of the intelligent home gateway is becoming more and more complicated, and the traditional development methods (C/C++) programming complexity, low development efficiency, error prone and disadvantages such as lack of security has been the block of development of the embedded intelligent household system.

Fortunately, the characteristics of Java technology to make up for these shortcomings, and real-time Java platform expert group needs analysis based on real-time extension of the Java extension specification developed in terms of real-time, that the company and partner Sun Java Real-Time Specification published (RTSJ, JSR-001)[1], to make up for deficiencies in the Java language in real-time applications, real-time Java language itself not only inherited the characteristics and increased real-time threads, memory management, high-resolution time and other new features, can support a variety of unique real-time requirements of embedded systems. This system will use the RTSJ as the reference of designing the Real-time Java home intelligent system software, the implementation of the RTSJ requires from the underlying operating system and the JRE (Java runtime environment) components support. This paper chooses fully compatible with the RTSJ standards released by IBM WebSphere Real Time development platform[2]. WebSphere Real Time is a cross platform J9 IBM RT-Linux operating system, the platform provides real-time service to support RTSJ standard behavior, while the introduction of the new advance (Ahead of Time, AOT) compilation technology and deterministic garbage collector Metronome GC, is not suitable for hard real-time performance using the JIT compiler system, ensure the high real-time home gateway. System uses AMD Geode NX1500 processor supports the J9 virtual machine as intelligent Home Furnishing system gateway hardware platform, which has the control and communication ability of excellent, very suitable for application in communication network equipment.

In this paper, according to the International Telecommunication Union (ITU) is the new standard G.hn standard, smart home is proposed to design a hardware platform based on Geode NX1500 processor, using the "Ethernet/3G +Fieldbus[3]" approach to achieve a gateway design communication protocol conversion and data transfer, using the reference to a standard real-time RTSJ Java technology home gateway software.

INTELLIGENT HOME SYSTEM ARCHITECTURE

Intelligent home system is controlled via the fieldbus and family information platform electrical equipment, lighting detection systems, detection systems and other security subsystems together into a unified whole, connected to Internet/3G network of remote monitoring appliances. Due to the current intelligent home system, the underlying device communication interface is not uniform, the system uses RS-485 bus[4] as a fieldbus. The bus has a transmission speed, simple structure, strong anti-jamming capability and real-time, and many other advantages, is ideally suited for smart home system. This paper will be divided into three layers of intelligent home systems[5]:

Device Layer: Hardware platform and each subsystem module. The microprocessor and the various sensing devices and monitoring equipment connected to achieve, the state detection function, the data conversion and transmission, providing a standard interface. In order to achieve the exchange of information between multiple microprocessor units, including household appliances, lights off equipment, gas detection and alarm system, each unit via RS-485 communication bus and the middle layer, which centralized management and monitoring.

Middle Layer: Intelligent home system control platform. This system will WebSphere Real-time embedded control platform components using Java technology to achieve real-time Web services, protocol conversion and data management gateway functions to complete home communications,

networking and management tasks. Users can use browser access controller via Ethernet or 3G network to remote real-time monitoring of home.

Application Layer: Remote communication control device. It is via Ethernet/3G networks and intelligent home system control platform connectivity, remote control of computers and uses the Internet or mobile phone short message remote monitoring appliances via Web services. Intelligent home system based on embedded system architecture shown in Figure 1.

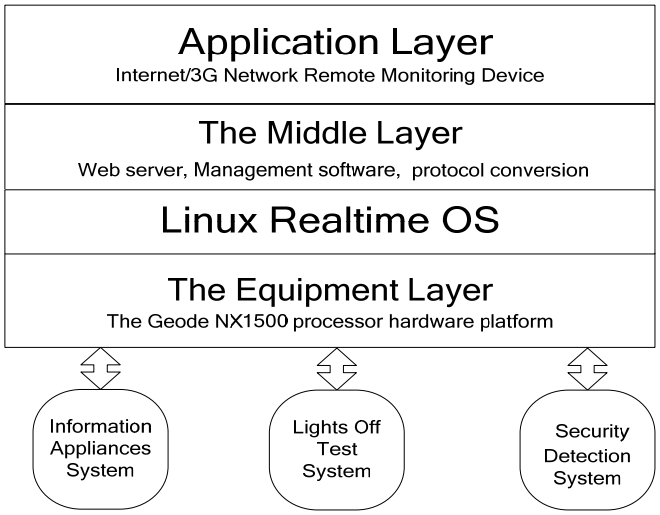

Figure 1 : Intelligent home system structure

When the system is running, the control platform periodically to detect a variety of indoor appliances and a variety of sensors, and the data stored in the local database. Users can access a local database reads Internet/3G network access and transmit data via Ethernet controllers, and operate instructions CDMA2000 module, remote monitoring and communications. When an abnormality is detected happens, the terminal control information will be sent via CDMA2000 module prompts the user happens danger and take appropriate precautions.

CONTROL PLATFORM HARDWARE DESIGN

Construction and implementation of embedded intelligent home system controller is based on building an intelligent home system embedded hardware platforms. The main part of gateway hardware platform by the master chip Geode NX1500 processor, memory modules and communication modules (Ethernet / 3G controller, RS-485 bus interface) and so on.

System hardware basic components

The system uses AMD's production of high-performance, low-power Geode NX1500 processor as the main chip. The Geode NX1500 processor is an X86 -based architecture, the use of advanced embedded processor with Direct Connect Architecture and Hyper Transport bus and other advanced technologies, has a rich peripheral interfaces. Through external expansion memory, USB interface, JTAG debug interface and a network interface like hardware platform. Flash memory is used to store system smart home system BIOS and kernel, Web servers, data resources and services needed to support a variety of file systems; DDR SDRAM memory interface using the extended support up to 1GB. The system uses an LCD touch screen as the input and output man-machine interface, touch screen input control using Burr-Brown has introduced a 4-wire control chip ADS7846 achieved. LCD screen display control by SEIKO EPSON 's LCD controller SED1335 realize that the controller has I/O buffers

powerful, rich control instructions, data can be transmitted in parallel to achieve four characteristics. Control terminal hardware platform consisting shown in Figure 2.

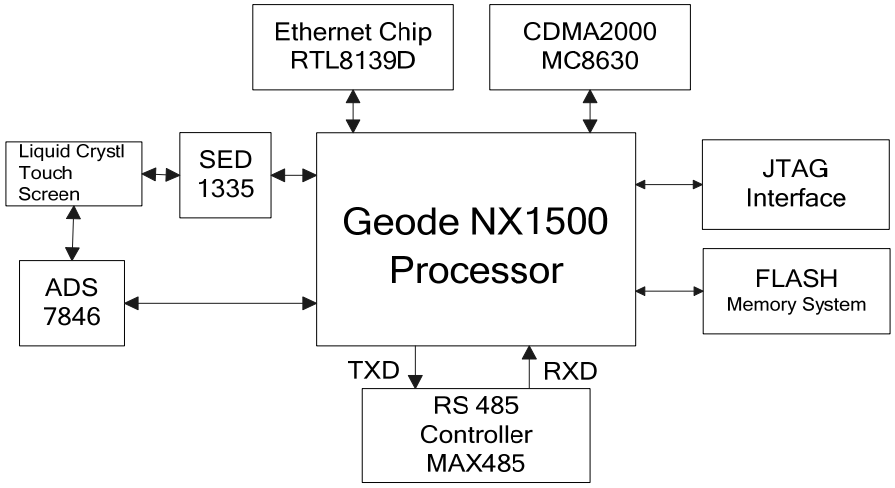

Figure 2 : Embedded-based system of intelligent home hardware platform structure

System network interface design

1. Internet/3G communication module

Internet communication module uses RTL8139D control chip that produced by Realtek Semiconductor, which is compatible with IEEE802.3, low-power, low-cost Internet control module. The module is connected via the PCI bus and processor, use the Linux operating system embedded TCP/IP protocol to communicate with the Internet, reducing the difficulty of the design, greatly improving the ability to process data gateway. The system uses CDMA2000 3G wireless communication module, CDMA2000 module uses ZTE's MC8630 module, MC8630 and Geode NX1500 connection is very simple, both 2.0 interface to connect via standard USB. MC8630 is a based on CDMA2000 1X/EVDORev. A version of 3G communication module, supports embedded TCP/IP protocol, with text messaging and high-speed data services and other functions, can be widely applied in the field of intelligent home appliances speed data transmission equipment.

2. RS-485 bus communication module

Intelligent home network using hierarchical control, the underlying device subsystems access RS-485 bus via bus coupler (BCU), the data collected is sent to the control platform via RS-485 interface, and achieve TCP/IP and RS-485 protocol conversion between. This selection of MAXIM's MAX485 chip communications processor control and RS-485 bus. MAX 485 comprising an inner drive and a receiver, an RO and a TTL data received from the client data DI, and two RS-485 differential signal terminals A and B. Since Geode NX1500 contains three universal asynchronous serial interfaces, MAX485 chip just RO/DI and TXD/RXD two signal lines connecting the two data communication can be realized. In order to reduce the interference of various noise required between RS185 bus terminals A and B plus a 100Ω resistor is.

INTELLIGENT HOME SYSTEM GATEWAY SOFTWARE DESIGN

The gateway software system designed by protocol analysis and embedded Web server, whose main functions: 1)In the database to achieve a data collection/ transmission, and the collected data is stored; 2)Users can directly access the gateway through a Web browser, for real-time remote control. Embedded gateway design structure shown in Figure 3, Real time library module is an important part of

WebSphere Real Time operating environment, which provides real-time between applications and the underlying Java Interface.

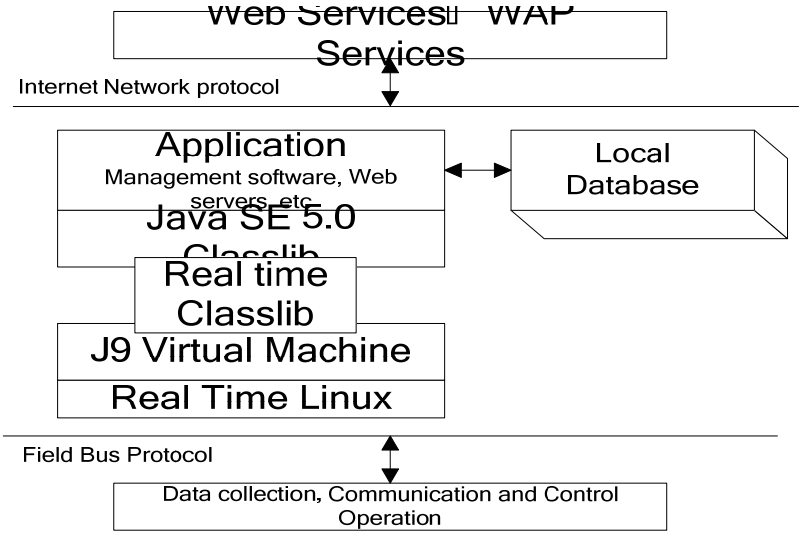

Figure 3 : The structure diagram of intelligent home gateway

RS-485 bus communication design

In this paper, the home gateway in the OSI reference model layer performs two different data transmission protocol conversion. Real-time Java technology inherits the advantages of Java network programming language, and the reference standard RTSJ extends the real-time, RTSJ provides a constructor for the real-time threads, memory management parameters constructor solve garbage collection for real-time, thus ensuring the home gateway real-time design. RS-485 bus to reach each thread is responsible for sending appliances user operation, receiving thread is to receive data from the underlying fieldbus networks (smart devices underlying real-time data acquisition control network) and press the TCP/IP protocol format packaged data to achieve RS-485 bus protocol conversion to TCP/IP protocol, the latest data will be saved to a local database, real-time refresh the home gateway database content[6]. RS-485 bus real-time thread to create a thread object calls RS_TX() by RealtimeThread classes and RS_RX() function to achieve the RS-485 bus interface transfer operation. In order to complete the format conversion TCP/IP and RS-485 data between data, real-time thread calls RS_TCP() and TCP_RS() function to achieve both conversion data protocol uses TCP/IP protocol communication by RS-485 data bus protocol after the format package saved, sent out by the RS-485 interface.

RS-485 bus communication design

Internet/3G communication gateway implemented through Linux embedded TCP/IP protocol stack and the user to communicate with users through the browser to C/S (client/server) mode to access domestic services platform and realize household appliance remote control. This paper uses real-time Java and c/s Socket technologies support platform, implementing multithreaded server services[7]. Server-side calls the constructor of the ServerSocket class; initialize a port variable specifies which server-side service port monitor. Programs using a ServerSocket object call accept on the server side() method receives a client connection request, it returns a Socket object representing Terminal established communications with the user interface. Client user by making a call to the server request, obtain server IP addresses, depending on the server's client IP address and port number to establish a socket object that implements flow method with server-side data transmission. When the traffic after the operation is finished, both sides call close() function releases the Socket resources.

This paper uses the Executors sub interface ExecutorService service creates a thread pool, which says the family gateway can use multiple threads at the same time providing multiple services. Each thread uses the TaskHandler class to call Run() method to perform operation, real-time thread class of real-time Java technique using thread creation process, the class to provide Executors services. A real-time thread class RealtimeThreadFactory to achieve the common thread class ThreadFactory. Pass an instance of it to the Executors. newFixedThreadPool server(), will cause the real-time thread to become the highest priority is for the use of the FIFO scheduling mechanism, ensure the task execution time predictability and avoid priority inversion caused by blocking I/O. Real time Java provides variable source area of memory, release parameters and scheduling priority and other tools to intercept the JVM and application, work interference with control of the garbage collector and a lower priority task of the current thread. C/S service platform code:

```
import java.util.concurrent.*;
import java.net.*;
import javax.realtime.*;
class Server {
private int port = XXX;// port number
private ServerSocket serversocket;
private ExecutorService threadPool;// create a thread pool Server(int numThreads) {ThreadFactory
theFactory = new ThreadFactory(); this.threadPool = Executors.newFixedThreadPool(numThreads,
theFactory);//capacity threads
}
serverSocket = new ServerSocket(port); public void start() {while (true) {Socket socket = null; socket =
severSocket.accept(); //creating a time- predictable performance processor instance to finish the task of
processing the transaction cycle TaskHandler task = new TaskHandler(socket);
this.threadPool.execute(task);//the task of communicating with customers to thread pool
}
this.threadPool.shutdown();
}
public static void main(String[] args) {int serverThreads = Integer.parseInt(args[0]); new
Server(serverThreads).start();
}
}
class RealtimeThreadFactory implements ThreadFactory {
      public Thread newThread(Runnable r) {
            //create a real-time thread RealtimeThread rtThread = new RealtimeThread(null, null, null,
null, null, r); // adjust the requirement of parameters PriorityParameters pp = (PriorityParameters)
rtThread.getSchedulingParameters(); PriorityScheduler scheduler = PriorityScheduler.instance();
pp.setPriority(scheduler.getMaxPriority());
      return rtThread;
      }
}
```

In this paper, the quality of real-time thread through experiments with common threads of service were compared, it can be seen from Figure 4, the real-time thread volatility significantly improved operating time, have a good stability, a large number of operations (throughput/month) are completed in 16-17 milliseconds. Worst-case operating time and the average operation time is very similar. The results represent the entire Smart Home Gateway is fully in line with the quality of the millisecond accuracy of real-time systems and applications herein desired service requirements.

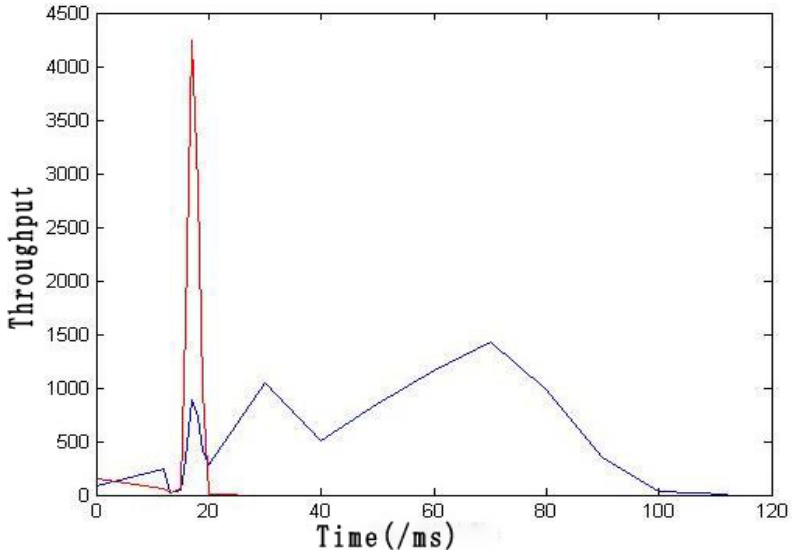

Figure 4 : Service quality comparison of real-time thread and common thread (Red：The real-time thread, Blue：The common thread)

CONCLUSION

In this paper, X86 architecture intelligent home gateway hardware design Geode NX1500 processor and fieldbus technology through real-time Java, Socket technology for wired/wireless gateway and protocol conversion between the two layers of network communication software design, complete with the underlying device reliable connection and a home gateway for remote monitoring network terminal.

New features real-time Java threads and real-time JVM, such as real-time to ensure the real-time design home gateway appliances to achieve a state to obtain accurate information and perform real-time network users through Internet/3G operating instructions. Introducing real-time Java provides the necessary tools for the application designer to solve the variability of JVM and application, to meet the family gateway service quality. Meanwhile, it has the advantage of greatly improving the design of embedded devices difficulty desktop software, developers can easily create a web interface for embedded devices directly connected to the Internet/3G network to transmit data. Provides a real-time Java for real-time programmer productivity and design, modern mainstream language, believe that the introduction of real-time Java technology will have a tremendous impact in the field in real time.

REFERENCES

[1] Tian Gang; The Research of The Embedded Real-Time Java Technology [D], Beijing University of Posts and Telecommunications, **(2006)**.

[2] I.B.M.; real-time Java[EB/OL]. http://www.ibm.com/developrworks/cn/java/j-rtj1/, **(2010)**.

[3] Li Jian, Wang Xiaoming, Han Lihong; The Application of Embedded Real-Time Gateway Based on ARM [J], Journal of Chongqing Institute of Technology, **23(2)**, 143-145 **(2009)**.

[4] Zhong Jianguo; The Design and Implementation of Intelligent Home Furnishing Control Terminal Based On The Internet [J], The Modern Electronic Technology, **16,** 109-111 **(2008)**.

[5] Cao Jiangang, Wang Ming; The Realization of Intelligent Home Furnishing Networks Based on Embedded System [J], Journal of Anhui University of Technology and Science, **21(4)**, 43-47 **(2006)**.

[6] Yan Liping, Zeng Hui, Song Kai, Gan Lan; The Research and Design of Embedded Intelligent Home Gateway [J], Micro Computer Information, **21(12-2)**, 14-16 **(2005)**.

[7] Yao Xiaofeng, Zhang Chunguang; Socket Programming Technology in The Application of Embedded Gateway Development and JAVA Implementation[J], The Industrial Control Computer, **19(2)**, 21-22 **(2006)**.