AN INVESTIGATE USING IOT GATEWAY FOR THE REAL-TIME JAVA PROTOCOL

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Abstract

Given that people now employ antiquated development methods to implement Internet gateway software, the Internet of Things (IOT) gateway is crucial in bridging the gap between traditional information networks and network awareness. A plan utilising real-time Java technology was developed. The AMD Operation 1100 processor's ARM cortex-A57 architecture serves as the foundation for this paper's hardware platform for an IOT gateway system, which enables remote monitoring of the underlying device. In order to achieve wired and wireless data exchange, the IOT gateway uses "Internet + Sensor Network / Field Bus Technology" network schemes. The two-layer network communication software is designed to ensure IOT gateway security in real-time communication, and the Internet gateway protocol conversion is accomplished using the Web Sphere Real Time development platform's fully compatible Real-Time Specification for Java (RTSJ). This article concludes by outlining the gateway's application and implementation method.

Keywords - *IOT Gateway; Sensor Network Technology; Field Bus; Real-time Communication*

1. INTRODUCTION

As wireless communication, embedded systems, and sensors have advanced. People are now very concerned about how to combine computers, communications, and electrical gadgets. Sensors, global positioning systems, and other data are used in Internet of Things (IOT) sensing devices [1]. According to the agreement, it can connect anything on the planet to the Internet, allowing people and things to communicate and share information without any barriers. It can then achieve intelligent identification, tracking, positioning, monitoring, and management, among other things, similar to these functional networks. Public safety, smart grid, intelligent transportation systems, and warehouses have all made extensive use of the Internet of Things.

Structures as well as other domains are an essential component of the Internet of Things is the IOT gateway. It is an essential piece of equipment for integrating various Internet of things components. The quality and safety of business networking are ensured by its ability to perform forwarding and control, exchange signaling, encoding and decoding functions, terminal management, authentication, and other tasks in addition to meeting access needs in local area short distance communication, implementation, and public network connections [2].

Because of the need for new development languages and tools to support the advancement and use of Internet of Things technology, the design of networking gateways has become increasingly complex due to the emergence of new things and new function demands. Traditional development methods (C/C++) programming are too complex, have low development efficiency, are prone to errors, and lack security [3].

Thankfully, Java technology makes up for the aforementioned shortcomings. Sun Microsystems Company and IBM collaborated to develop the Java language in real-time extension of the standard based on the real-time specification for Java (RTSJ,JSR-001) [4] and an analysis of the demand for real-time extension platforms. In order to meet a variety of specific networking system real-time requirements, real-time Java not only inherits the characteristics of the Java language after correcting its flaws in real-time applications, but it also offers a more dependable and predictable

scheduling strategy, a variety of memory models, a better predictably threaded and synchronised model, asynchronous processing, and a high resolution (high-resolution) time mechanism.
The underlying operating system, JRE, and Java Library (Java Class Library, or JCL) must support the RTSJ standard [5]. This document includes several new technologies designed to enhance the Web Sphere Real Time IBM development platform's real-time system, and it is completely compliant with the RTSJ standard. The foundation of Web Sphere Real Time is IBM's cross-platform J9 technology, which includes the deterministic garbage collector metronome GC and the new advance ahead of time (AOT) compilation technology. It guarantees the high real-time performance of the Internet gateway and offers hard real-time performance for the system that is unsuitable for the usage of JIT compilers [6]. In order to enable RTSJ behavior, the Linux real-time operating system offers low latency and hard real-time applications with POSIX real-time specifications of real-time services. The hardware basis for the Internet of Things gateway in this article is the AMD Option 1100 CPU, which supports J9 technology. It is very appropriate for use in Internet of Things gateway equipment because to its powerful data processing and control capabilities.

1.1 The System Architecture of the IOT Gateway

The Internet of Things is an integrated network with cognitive processing capabilities, dependable transmission, and general sensing. Through the use of sensor network technologies and field buses, several sensor data collecting nodes are integrated into a single entity [7].As seen in Figure 1, the data will be gathered for additional processing and connected to an Internet or 3G network to enable remote networking equipment monitoring. The system uses wireless sensor networks, field buses, and other multiple access technologies to connect to the core network; it will also realise remote transmission and data protocol conversion due to the disparity between the various components in the device's bottom region and the communication protocol. The hierarchical communication system architecture is used in this work to discuss the Internet of Things

In order to achieve the access of multiple communication protocols, the perception layer matches diverse sensing network technologies, completes network control, and provides physical access to the sensing extension device [8]. Each module communicates with the network layer using wireless sensor networks and field bus technology to perform centralised data collection and control in order to meet the diversification of the Internet of Things' underlying equipment, including smart homes, smart communities, intelligent transportation, and other industries [9].

The network layer serves as a platform for Internet of Things system management [10]. This article is based on the notion of modularization by leveraging Web Sphere Real time to the development platform because of the many applications of the underlying network and the various technological standards. In order to accomplish the many management activities of the Internet of Things gateway, including Web services, network protocol conversion, information aggregation, security applications, and other gateway operations, it also makes use of real-time Java technology. Long-distance data transmission is another essential network layer technology in addition to the management function. The layer of applications: Application layer: the use of business management software and Internet of Things architecture to deliver services straight to end users' application processes [11].

Through an Ethernet or 3G network, the user connects to the internet of things management system platform via a browser or client software. The remote controlling computer and mobile terminal networking enable remote real-time monitoring of the Internet of things' bottom end with Web services by using the perceptual data of analytical processing.

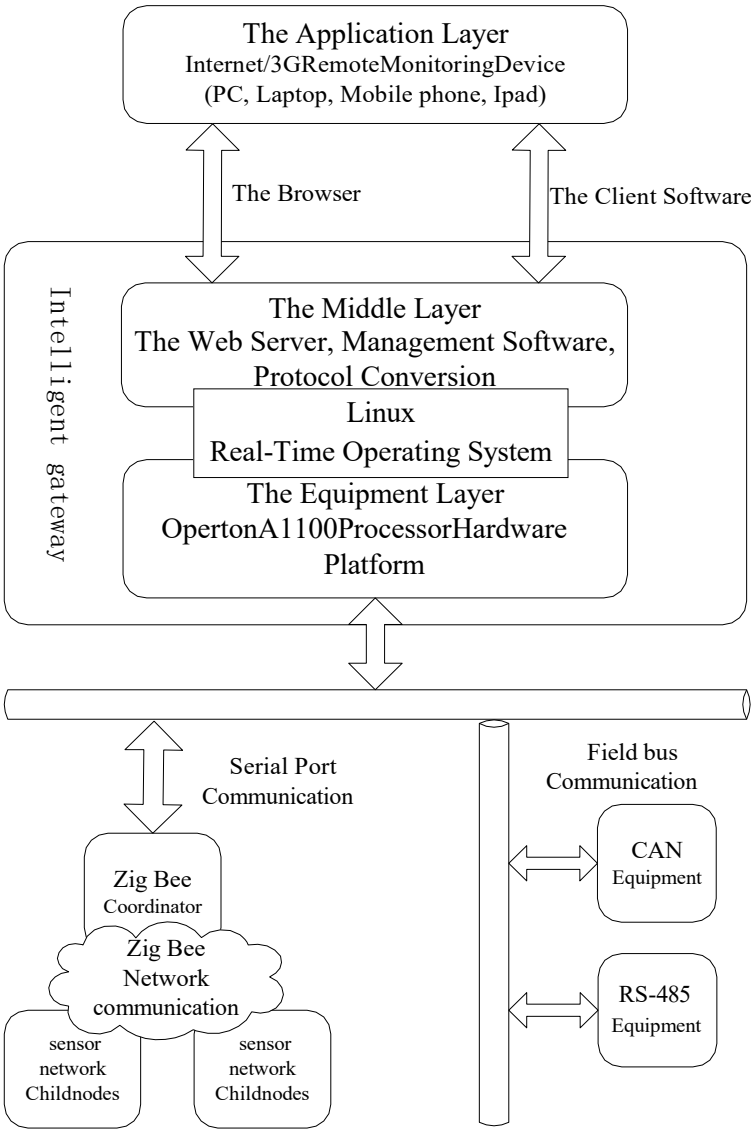

Fig.1.IOTSystemOverallStructure

2. DESIGN

2.1 The IOT Gateway System Hardware Platform Design

The Internet of Things gateway is designed in this study using the modular concept. The design accomplishes a gateway with low power consumption and strong performance in the face of various sensing networks and basic networks. According to the modular concept, the gateway system is separated into the processing/storage, Internet connectivity, sensor network communication and power modules.

2.2 The System Processor/Storage Module Design

First, a minimum system of the IOT gateway system hardware platform must be built in order to realise the basic functions of the networking gateway. The upper formation function is based on the running of an embedded operating system, after which the hardware communication module corresponding to the communicating protocol should be extended in order to realise data exchange between the gateway and the Internet and sensor network [12].

The AMD Opteron A1100, manufactured by the AMD Company, is the primary control chip used in this system to realise data processing in a variety of areas, including protocol conversion, management, and security. It offers great performance, low power consumption, and support for J9 technology. The ARM Cortex-A57 64-bit architecture, SoC single chip design, and huge memory/storage capacity are the foundations of the A110 Opteron server CPU. Additionally, it contains transceiver chips and extensive peripheral interfaces that can extend data by accessing many protocols. After that, it regulates how various signals are sent.
The system memory Flash is used to store the Internet of things system, the operating system, the data resources of Web server and the file system needed to support all sorts of services. The RDIMM DDR3 channel expands memory, with a maximum capacity of 128GB. The hardware platform used in this article consists of a network interface, USB3.0 interface, ZigBee/FielBus communication module, and external expansion memory. Figure 1.3 depicts the Internet of Things system's hardware platform.

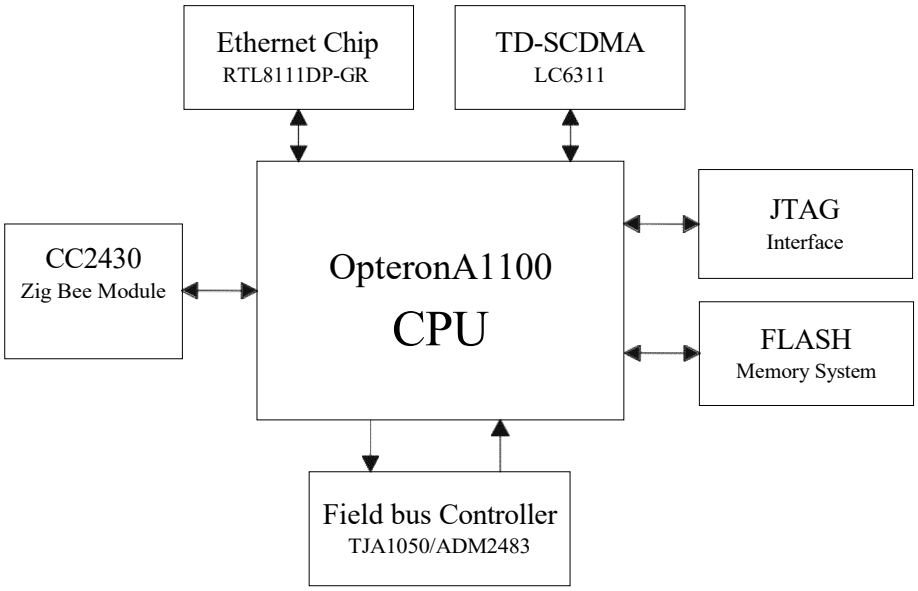

Fig.1.3 IOT Gateway Hardware Structure Diagram of the System Platform

2.3 The System Network Interface Design

2.3.1 Internet communication module

Internet communication module makes the gateway connect to the wide area network, and this paper uses wired and wireless. The wired communication module uses RTL8111DP-GR control chip from the Realtek Semiconductor Corporate, which has the network real-time management function and completely conforms to the DASH long-distance network management technology standard. The module is connected with the processor through the PCI-E interface and gets communication with Internet by using TCP/IP embedded by Linux operating system, which reduces the difficulty of the design, and greatly improves the ability of the gateway processing data [13].
The TD-SCDMA module is used by this system to enable 3G wireless communications connectivity. The Core Technology Company's LC6311 chip powers the TD-SCDMA module. Connecting LC6311 with A1100 Opteron is pretty easy. Through the same USB interface, they establish a link. The TD-SCDMA&GSM (GPRS) dual mode wireless module LC6311 has an integrated TCP/IP protocol integration capability [14]. The module may be widely utilised in high-speed data transmission of the Internet of things and offers SMS and high-speed data services, among other features.

2.3.2 Sensor network communication module

The physical gateway system for the network switches to modular control. Field bus and wireless sensor network technology are used in this system to facilitate data transfers between each subsystem and control platform. Additionally, it converts protocols between TCP/IP and several bottom network kinds. The TJA1050 transceiver chip from Philips and the ADI transceiver chip from ADM2483 Company are used in the design process to enable communication between the CPU and the Can/RS-485 field via the bus coupler (BCU). By simply connecting the two signal lines, the Field Bus controller may achieve data connection between the RO/DI and UART0 of the universal asynchronous serial interface TXD/RXD. To create a wireless sensor network, the sensor node simultaneously adopts a ZigBee module. The CC2430 chip of the 2.4 System, the first to be produced in line with Chipcon Company's ZigBee technology, is selected by the Zig Bee module. By connecting to the CPU via the UART1 interface, the chip completes the task of short-distance data transmission and reception [15].

2.4 The IOT Gateway System Software Design

Gateway software still has to implement data protocol parsing and storage, remote sensing and security access control, etc., in addition to coordinating hardware to realise data collection and transmit function. To better implement these functions, the system will be split into two sections: the protocol analysis program and the embedded Web server gateway. The primary function is to extract unified application data in accordance with the TLV (Type, Length, Value) method of organising and encapsulating packets, data acquisition/transmission, and data storage in the database; 2) users can access gateway Web browser/client software directly, allowing for real-time remote monitoring. Figure 3 displays the software design structure diagram for the IOT gateway.

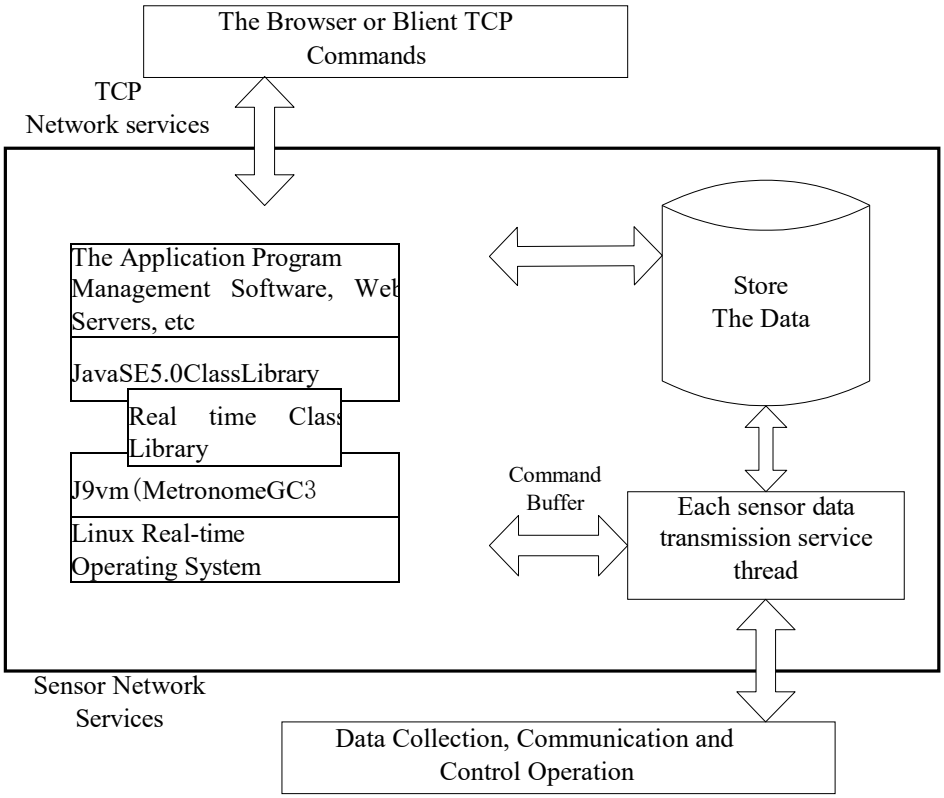

Fig.2.4.1 IOT Gateway Software Hierarchy Structure

2.5 The Sensor Network Communication Module Design

Sensor network module is to achieve the communication function between the gateway and the underlying perception extended network the sensor network data gathered here. Described in this article the Internet gateway uses the OSI reference model to complete two different protocol conversions at the transport layer, and through Java multi-threading technology in real time to realize data transmission function at the same time, a thread is responsible for a transport protocol. Real-time Java technology provides real-time thread constructor, the constructor parameters of memory management to solve the impact of garbage collection in real-time, so as to ensure the real-time performance of IOT gateway design. The Web server or specially written client program can be accessed through TCP protocol and the underlying communication equipment data acquisition module, communication port to port 8088. Sensor network module is responsible for the operation of user by sending thread to each device, The receiving threads are receiving data from the sensing network and according to TCP/IP protocol format data packages, realization of the underlying device node protocol to TCP/IP protocol conversion, the latest data is stored in the local database, real-time refresh networking gateway database content, for other programs to deal with.

Real-Time thread of FieldBus devices through real-time threads class to create a thread object call FB_TX() and FB_RX() function to realize the field bus interface transmission operation. In order to complete conversion between the TCP/IP data and field data format real-time thread calls FB_TCP() and TCP_FB() function to realize data protocol conversion, the TCP/IP protocol communication data according to the field bus protocol format saved after encapsulation, sending it out by the field bus interface; ZigBee node set between the gateway and the AT instruction set complete ZigBee network communication agreement. In this paper, according to the modular thought, in the underlying equipment data acquisition module and IOT gateway inter- face control commands and data acquisition module only between interactive instruc- tion, do not focus on specific network protocol, achieve network protocol independ- ence. Because the gateway connected to a variety of different underlying devices,then the content of the data mapping relationship management is very important gateway. Hang the bottom of the equipment under this gateway for all possible input and output data format were analyzed, and then defines the underlying equipment respectively corresponding communication interface configuration. FieldBus thread part of the code is as follows

```
import javax. realtime.*; public class FB Gateway {
scheduling =                    // Scheduling priority parameters of the object new Priority parameters(PriorityShceduler.MIN_PRIORITY+20);
memory =                        // Copy of a valid memory parameters structure thread new Memory Parameters(MemoryParametters.NO_MAX,0);
area = Heap Memory. Instance ();        //Thread object memory area, control of garbage collection
ProcessingGroupParametersgroup=null;//Processingparameterscontrol of periodic set of activities Run able logic = new My Thread();//Reference implementation Run able interface instance
Real time Thread FB_rt=new Real time Thread (scheduling, memory,area, group, logic);
};
```

2.5 The Internet Communication Module Design

Internet module by operating system internal TCP/IP protocol stack to communicate with each other between the gateway and the application layer, the user through the browser or client software access Internet service platform to realize remote monitoring of the underlying devices. In this paper, real-time Java and Socket technology is adopted to establish the software support platform, and to implement multithreaded server service, it can execute concurrently multiple commands [16]. In the server-side call Web Socket class constructors, initialize the server-side service program specified port. Server-side programs using Web Socket object call accept() method receives the client connection requests and returns a Socket class object, representative and client to create a channel of communication. In order to create a client terminal communication interface configuration object and implement the command buffer pool method with the server for data transfer, the client to the server "connected" requests the server's IP address. Based on the IP address, the client initializes the port number. The two parties invoke the close () procedure to relinquish the socket resources when the communication is complete.

This article uses the Executor Service to create thread pool which contains multiple threads, and a thread is for a sensor network module. This article uses real-time Java technology to create a real-time thread class that provides the Executors service. Real-time Thread Factory promises real-time capability of common thread Thread Factory. Each thread uses the Task Handler class to invoke the Run () method to perform the relevant operation. Utilising the Web Sphere Real Time development platform in accordance with the Metronome GC implementation's time schedule inside the JVM garbage collection behaviour of certainty, minimal pause times, to guarantee the garbage collector's high Real Time capabilities [17][18]. The next section of the code leverages the server platform's real-time Java method to change a common thread into a real-time thread

```
import java. util. concurrent.*; import java.net.*;
import javax. realtime.*;
class Realtime Thread Factory implements Thread Factory{ public Thread new Thread (Runnable r) {
Realtime Thread RT Thread=new Realtime Thread(r);//Createreal-
Time thread
Priority Parameters PP=(Priority Parameters)
RT Thread. Get Scheduling
Parameters(); //Parameter adjust-
Mentneed
```

```
Priority Scheduler Scheduler=Priority Scheduler. instance(); PP.set Priority(Scheduler. Get Max Priority());
Return RT Thread;
}
};
```

3. The IOT Gateway System Application and Test

The background of soot emission monitoring is used in the essay to test the Internet of Things. The system will automatically check the data server for photos, time, and darkness values each time it identifies a target. As seen in figure 4, the entire interface is separated into areas for monitoring image display, monitoring target list, and monitoring analysis drawing, among other things. The system will automatically shoot a preset to the monitoring target, corresponding to the preset will target image displayed in the optics of the monitoring window. For example, to query the target state, enter the name that needs to be found in the box (supporting fuzzy queries) and double-click the monitoring target list to control monitoring. Digital monitor that corresponds to it target list that includes all of the monitoring targets, a preset, the name of the target, the monitor, and the most recent time and blackness values. Red indicated that it surpasses bid badly, while yellow indicated that it is normally very alarming. Regulators can access the monitoring target's real-time pollution data when the monitoring value above the bid (more than the alert threshold).

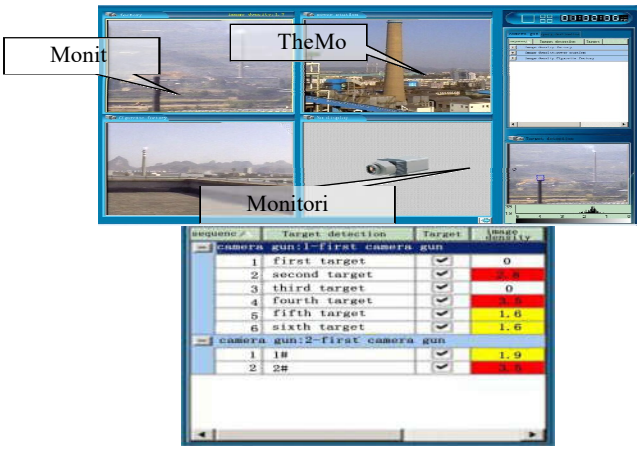

Fig. 3.1 Carbon Monitoring System Test Pattern

In the process of Internet of things software implementation, this article uses fully compatible with the RTSJ Web Sphere Real Time development platform to ensure realtime service gateway. As can be seen from the figure 5, real-time and the Metronome GC significantly improved the variability of operating time, each task has a good stability, a large number of operations are made within the time 11 ~ 20 milliseconds. Worst case of average operation time and operation time are very close, which full compliance with millisecond precision of real-time systems applications. For most developers, they provide a predictable performance and won't appear unpredictable GC delays Java server that is very attractive.

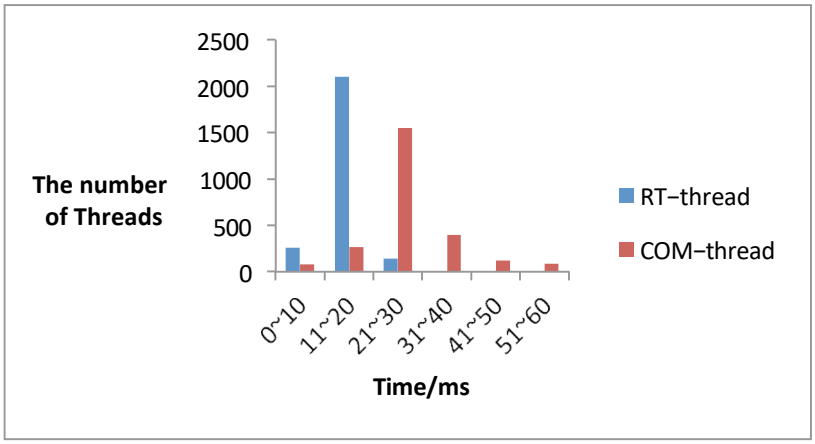

Fig.5. Real-time Compared with Common Threads of Service Quality

4. Conclusion

In this paper uses AMDO pteron 1100 processor architected by the Cortex-A57 ARM and sensor network technology / field bus intelligent gateway hardware to de- sign plan. And it develops a platform by fully compatible with Web Sphere Real Time RTSJ to achieve the software design of wired / wireless gateway protocol conversion and networking three layers network communication. It can achieve the TCP protocol reliable communication with the Internet which is known transmission layer network upside. Downside, it completes the reliable connection of the bottom equipment and the home gateway and the remote monitoring and controlling of the network terminal. It ensures there altime design of the Internet gateway that realtime thread and JVM of low pause time garbage collection and some other new features provided by Java real time specification. And it has achieved to obtain the action instructions of accurate information on the bottom of the underlying device and the implementation of user through the Internet. It provides application designers with necessary tools to solve the uncertainty of traditional Java language that the leading of real time Java, and then it meets the quality of the home gateway service. For developers, there will be very big advantages leading the advantages of introducing Java language into the creation of the RT system. At the same time, the advantages it has greatly improved the designing difficulty of desktop software of embedded equipment. Developers can easily setup the web interface of embedded equipment and directly connect to the Internet/3G network transmission data. Real time Java provides a modern mainstream language designed for productivity to realtime programmer. It is believed that the Leading of realtime Java technology will bring garget impact on the realtime field.

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