

## The Application of Internet of Things for Intelligent Electrical Meter Reading System

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**Abstract:** Combining Internet of Things with general packet radio service is a new development of the existing global system of mobile communication digital mobile communication system data bearer services, following the voice transmission services. The remote data transmission system has a self-evident importance. This paper focuses on the general packet radio service terminal of things technology and design. The terminal system is designed to achieve a complete transmission control protocol/internet protocol, with a strong versatility, only by simply extending the general packet radio service system which can be a different composition for being applied to various fields. Through applied data acquisition interface, plus related data processing steps on the basis of the existing microcontroller programming terminal can be applied to various types of monitoring on-site and the data acquisition system. *Copyright © 2013 IFSA.*

**Keywords:** Internet of things, Electrical meter, General packet radio service system, Machine to machine, Wireless sensor network.

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### 1. Introduction

Currently, a variety of products are used for residential electricity meter reading, IC card table and power line carrier set copied application accounted for a large proportion, but for the energy-saving and loss reduction, they are not widely used in electric power industry for economic benefit in terms of actual effect. Prepaid IC card electric meter, the scheme only solve a single settlement electricity recovery problem, but it is difficult to maintenance to monitor the electricity function, so it is prone to decrypt the electricity theft or other evasion of electricity [1-3].

Low carrier concentration of meter reading, the technical scheme has many advantages, it makes use of the existing low voltage power line as communication carriers to implement computer automatic meter reading, not only can save the laying

line and maintenance line amount of work and cost, at the same time line safety is guaranteed, also, the communication cost is low. It can not only replace the original meter but additionally arranged on a small sensor to complete the conversion and transmission of data, which can save a lot of money. But it has the disadvantages of power grid line, periodic, continuous signal interference and interference of random sudden and variability which affect the data transmission stability. Although, it can be used to avoid interference by relay technology to improve the success rate of some reading, but product technology solutions (telephone line carrier communication) from go up at all are unable to adapt to the various domestic power network structure, and collecting data is very low, it is difficult to stably guaranteed every day to collect complete station data. Because the low communication rate phone line and can not always maintain connection state with a lot of

communication costs, it is unable to realize the on-line monitoring and automatic alarm function, so the limitation affects the popularization and application of products.

GPRS (General Packet Radio Service), namely the general packet radio service, the wireless service is available in the GSM network which opens a new packet data transmission business. It is the use of "packet switching" (Packet-Switched) concept which has developed a set of wireless transmission mode. Through the GPRS network system, the industrial and civilian meter acquisition of power system can be real-time data transmitted to the ground, city, and provincial centralized monitoring center, to achieve the power monitoring equipment of unified control and distributed management and to provide a simple and efficient means of communication transmission. GPRS system can provide wide area wireless IP connection, in the business platform and the construction of intelligent power meter reading system of electric data, the wireless data transmission which can make full use of the existing network, shorten the construction period, with lower construction cost, and the installation is convenient, simple maintenance.

GPRS electric power remote meter reading system is in power station by the distribution center and is located in the residential area of meter data collection points which makes use of existing GPRS/GSM network for meter data via GPRS/GSM network transmission. The residents of the community a meter is first connected to the electric meter concentrator, residents of electricity data from multi-rate meter through the RS485 bus to the meter concentrator, and via the RS232 interface to GPRS DTU transparent data transmission terminal is connected, meter data after protocol encapsulation and is sent to the GPRS data network, through GPRS data network to transmit data to a distribution data center, realizing the meter data and data center system real-time on-line connection. GPRS uses packet switching technology, and it can allow multiple users to share a certain fixed channel resource. GPRS is especially suitable for intermittent, abrupt or frequent, small amounts of data transmission, but also suitable for the large volume of data transmission. GPRS relative wired telephone also has a communication channel which is safe and reliable, high speed, real time online with low communication cost, wide spreading, convenient installation and other advantages.

The research is the application of Internet of things for intelligent electrical meter reading system. It is able to provide automatic data collecting, data analysis, measurement query, print statements and other functions, to achieve a remote, centralized, automatic meter reading, make metric data collection, statistics, analysis in a very short time to reduce the labor intensity, and to improve work efficiency, avoiding man-made reading error and some other uncertain factors; and the system has increased base data management functions, including reading

abnormal information maintenance, meter box maintenance, reading class information maintenance, maintenance, supply the information area information maintenance and meter reading information maintenance and other functions [4, 5]. These functions will bring huge economic benefits, to improve the meter reading system economic value and vitality. In the data processing system, it also breaks the previous data limitations, to expand the network function.

According to the main contents of the paper, the subsequent chapters are as follows: in section two, the overall system is designed, and working principle, working process, the system function module thought of software and database design are analyzed in detail. In section three, the GPRS wireless communication technology and GPS satellite positioning technology are used to undertake specific implementation, and the chapters on the basic principle of the technology are discussed in detail. The GPRS communication module of the software and hardware design are described and analyzed, and the GPS technology principle, measurement mode of operation and measurement implementation methods are analyzed and compared, the conclusion. Section four is conclusion and expectation.

## 2. The Structure of System Function

The overall design of the system includes software overall structure design, interface design, software design, data design and reliability design. Intelligent power meter reading system uses GPS technology, the GPRS wireless communication technology, combined with intelligent embedded operating system and embedded database. The use of GPS global positioning system showed in Fig. 1 can access to location information of each table box.



Fig. 1. GPS Locator.

A meter box contains the electrical energy table information for binding; when the meter reader uses GPS navigation meter to read, it will automatically calculate and to copy watch box between the distances. It will also automatically pop-up interface for meter reading meter reading. Using GPRS wireless communication technology, the meter

reading data with the master station management system can be for remote synchronization and exchange, implementation of meter reading meter reading position real-time tracking, realizing the requirements on power meter in place with the work of supervision and inspection. Intelligent embedded operating system and embedded database is to realize the intelligent electricity consumption analysis, anomaly report, data statistics and calculation functions.

Currently, household instrument networking operation is the key technology of terminal access and service platform. The terminal is a direct contact with the user using interface, while the platform is the core system of bearer services. Terminal access and platform service is to protect household instrument networking application end-to-end quality of service, and operational management household instrument networking relates to the network level two key technologies.

Terminal access technology: household instrument networking terminal includes household instrument networking gateway, household meter communication module and a large number of the industry terminal, especially to the industry the most abundant types of terminal. From the terminal access point of view, household instrument networking gateway, household meter communication module and households with instrumentation intelligent terminal are currently the focus of attention.

Household instrument networking gateway: it is connected to sensor network and communication network of key equipment. The main functions are data gathering, data transmission, the protocol adaptation, node management. Internet gateway is standard network element equipment; it has gathered a variety of different techniques of heterogeneous sensor network through remote transmission; on the other hand, Internet gateway and the remote operation docking platform provide users with management, security services.

Household instrument networking communication module: it is mounted on the terminal within the independent components, which are used for information transmission over a long distance, which is the terminal data communication independent function block. A communication module is a networking application terminal based. Internet industry terminal variety, volume, processing ability, external interfaces each are not identical, and communication module will become the networking intelligent service channel, from all walks of life to provide networking intelligent channel service.

Household instrument networking intelligent terminal: it satisfies the interconnection of various types of intelligent application demand, which has certain data processing capability of the terminal nodes, except for data acquisition, also has certain operations, processing and implementation capacity. Intelligent terminal and application requirements are closely related, such as in the heat field of application of intelligent monitor terminal, with the exception of

heat meter data acquisition function, but also has real-time analysis and early warning function. The intelligent monitoring terminal in the network operation process on the heating and heat meter status real-time analysis, in the heating and heat meter fault occurred before the alarm information is sent to a remote administrator hand, which plays the role of a remote intelligent management.

Household instrument networking platform service technology: an ideal networking application architecture, there should be a common platform, common for all walks of life to provide universal service capability, such as data management, communication management, basic ability to call (such as positioning), business process customization, equipment maintenance services.

Embedded computer residential household instrument management system communication box (M2M equipment) [6]: it is available on the functions of the terminal management and monitoring, and for the industry application system industry application data forwarding functions of intermediate platform. Platform includes achieve terminal access control, terminal control, terminal private protocol adaptation, industry application system access, industry application private protocol adaptation, trade application data forwarding, application environment, the application runtime environment, business management and other functions. M2M device used for household devices on the INTERNET server to provide intelligent pipeline operation platform, can control the terminal to use the network reasonably, monitoring terminal flow and distribution of early warning, providing assisted rapid fault location, with convenient terminal remote operation and maintenance tools.

Household instrument networking and cloud services platform showed in Fig. 2: cloud computing technology as the foundation, which sets up internet cloud services platform, for a variety of different Internet application providing unified service delivery platform, to provide the massive computing and storage resources, also to provide a unified format of data storage and data analysis means, greatly to simplify the application delivery process and reduce the cost of delivery. Cloud computing and networking of the fusion, will make the Internet showing a variety of data acquisition terminal, ubiquitous network, intelligent background processing characteristics.

Electric operators should focus on the Internet of things technology, first should be the network layer itself, whether satisfy itself business needs; followed by the sensing layer and the application layer in what way, what technology and network layer are tightly connected, so as to ensure the flow of information (e.g., access gateway and management platform) for information collection, information gathering, as well as the analysis method; finally is to focus on how to use the cyber source of the acquired information, and to provide networking closely integrated information service.

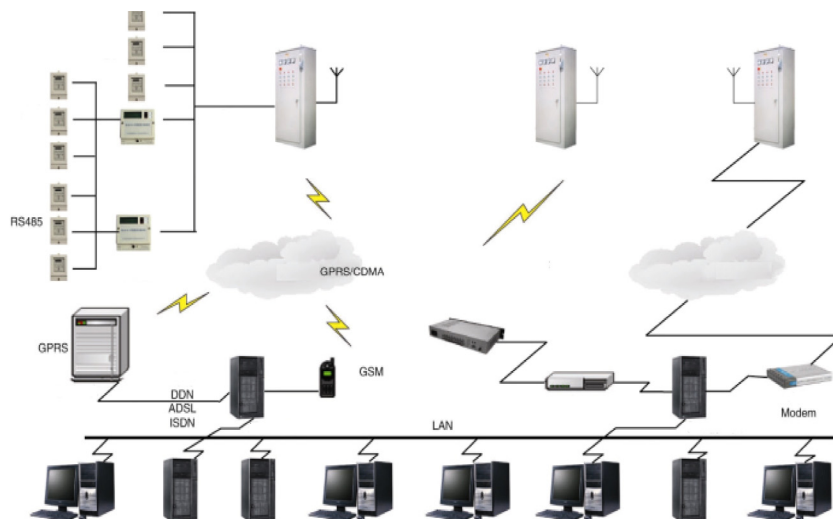


Fig. 2. Remote Communication Network diagram.

### 3. The Key Technology

The system is possible through the integration of different Internet of Things identification equipment of Things sensing equipment [14, 15], and gateway device can be reliable to different manufacturers compatible communication protocols, including Internet of Things platform technology using TOA (facing the Internet of Things Architecture, Things Oriented Architecture) technology, and integrated application of technology-based middleware TOC (oriented communication of Things, Things Oriented Communication) technology, for the different communication protocols for different enterprises and different applications of the Internet of Things applications common platform.

TOA is an object-oriented networking system design philosophy and architecture technology, which abstracts the interactions between the various types of sensors (water, electricity, heat, gas metering meter) object to a uniform level, focusing on independent each of Things networking object system functions through a simple, unified interface to interact with information and communication, and the using of loose coupling between the characteristics of Things networked objects is to ensure the openness and the size scalability of the system platform.

Due to the networked objects of Things has a wide range of characteristics, the TOA core concept is flexible to design methods and to break the traditional application system fragmentation design concept, also to overcome the shortcomings of the past, that different classes, different manufacturers are incompatible between. TOA pay more attention to independent Internet of Things of various networked objects, through various objects interact with one another and mutual service of ideology. The organic link independent system of networked object of Things makes rapid systemic function and operation [7, 8].

TOC is based on the TOA system architecture to achieve "people-object", "objects-objects" effective interaction between middleware, and each of Things networked object maintains an interactive list CTL (Concerning Things List), conducting of Things networking between objects interaction. By simply selecting the list of Things object, the collaboration and communication between objects can be achieved [9, 10]. CTL which adds and removes support for the Internet of Things object interaction supports Push-based menu-driven collaboration, simplifies interaction and interactive interface design on the one hand, and the other hand Push process to be completed by the Internet of Things object itself self-explanatory services, not familiar object or services can also be easy to complete the communication of information. TOC middleware system is composed of three parts by the Server, Client, Agent using P2P overall design technology which using extended XMPP protocol the (Extend Extensible Messaging and Presence Protocol, x-XMPP) format for message exchange between the Server and Client.

System product solutions are all based on the TOA and TOC technology, the hierarchy of all products is shown as: Network layer devices with system integration to achieve the company's products are mainly located in the sensing layer and application layer which are compatible with the sensor terminal products of different manufacturers. It can be directly through the user interface of the application layer to interact with all types of users and applications to show (i.e. Users can be computers, mobile terminals, mobile phones, and specialized equipment and system for data exchange). The data obtained by the user interface is a standard data after processing through data exchange platform, and a comprehensive analysis, statistics, and applications can be facilitated.

Middleware advanced HAL (Hardware Abstraction Layer) is hardware abstraction layer abstraction of the hardware platform, the basic

components (such as the clock, interrupt the processor, memory management unit the MMU, external devices, network interfaces, etc.) is used for the logic components hidden processor specific form and peripherals, external uniform definition interface logic parts packaged as a hardware-independent virtual machines (hardware abstraction layer), also is used for system memory management, process management, task scheduling, I/O device management and network interface management.

### 3.1. Intelligent GPRS Communication Module

GPRS network is an increase in the existing GSM network in the GGSN and the SGSN, it enables user to send or receive data in an end-to-end mode. The GPRS packet from the base station sends GPRS serving support node SGSN to communicate with the gateway support node GGSN. GGSN is used to send the packet data corresponding to the destination network, such as PDN or Internet. Forwarded to datagram packet from the Internet to identify the IP address of the mobile station, it is received by the GGSN, and then SGSN sends to the remote data center [11].

Intelligent GPRS communication module GPRS network which achieves full-duplex data communication with the host computer for data center, must be attached to the GPRS network by landing on the PC or on the Internet and its connection to establish a data link and data transmission [12, 13]. Completion of this process

must achieve the GPRS attachment and packet data protocol PDP context activation. Through the GPRS attachment of the registered user information, the activation process can activate the IP protocol to ensure that data which can be transmitted in the form of the IP datagram.

The optional GPRS wireless transceiver is Siemens MC55. This wireless transceiver modules support 900/1800/1900 MHz three band tri-band module and advanced wireless module with GSM/GPRS full set of voice and data capabilities. Embedded TCP/IP protocol stack supports TCP, UDP, FTP, SMTP, POP3 protocol, eliminating the need for system TCP/IP protocol processing time. 3.3 V-4.8 V voltage supply, the AT commands mode is used to achieve data transmission, each transmission will show result status return which does not require the user to switch the state. The MC55 provides two full-duplex serial port, two TCP channel transmission, GPRS and SMS or voice state automatically switch.

Intelligent GPRS communication module micro controller selects the Atmel Corporation AT89C51RC, which contains 32 KB of Flash program memory, 512 bytes of on-chip RAM, 32-line programmable I/O ports, three programmable timers, hardware janitor dog timer WDT. Two programmable UART serial communication ports, power supply 4.0-5.5 V, the maximum operating frequency of 33 MHz, MC55 hardware the microcontroller AT89C51RC GPRS wireless transceiver is connected to the principle shown in Fig. 3.

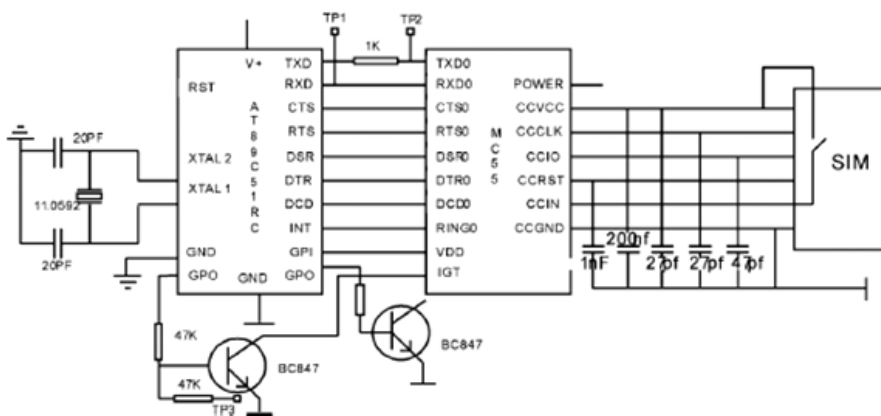


Fig. 3. Microcontrollers with GPRS wireless transceiver hardware connection scheme.

Communication the MC55 and AT89C51RC data mainly through the ports TXD0 to complete the data transfer between of TXD, RXD0 with RXD the GPRS wireless transceiver chip MC55 TXD0 port for receiving data coming from microcontroller AT89C51RC, while the microcontroller TXD port is used to send data to the microcontroller. The microcontroller RXD port is used for receiving from the data transmission to the GPRS wireless transceiver chip and pin IGT GPRS wireless

transceiver chip MC55 is used for ignition reset, and its role is to do GPRS wireless transceiver of a reset of the chip conversion the GPRS wireless transceiver chip MC55 base band processor with an integrated SIM interface. It is directly wired to the host interface for connection to an external SIM card holder. SIM card has 6 pin CCVCC CCCLK CCIO CCRST, CCIN and CCGND: respectively corresponding to 6 pin connected to the MC55.

The distance between the pins of the wireless transceiver chip connector and SIM card holder should not exceed 20 cm SIM bracket laying a layer of copper isolated network, in order to achieve the best results, the layer of copper and SIM card CCGND pin are connected.

For the realization of the power-down data protection features, the introduction of non-volatile memory can store system user name, account number, meter number, real-time power, history of electricity and related set parameters. By comparing varieties of non-volatile memory read and write speed for convenience of programming, the FM3130 is selected as storage devices. At the same time, it can provide real-time clock function. The size of FM3130 in FRAM is 64 KB, which provides effective unlimited number of writes, write operations without any delay, like RAM random fast read and write, and the power-down after the data is not lost, so the data can be stored for decades.

AT89C51RC microcontroller has two full-duplex UART serial port, a GPRS wireless transceiver MC55 communication, another data transmission terminal equipment is connected to the external. In order to enhance the versatility connected with the external terminal device it also provides two serial RS-485 or RS-232 communication interface mode. AT89C51RC serial port is TTL level, and TTL level signals need to be converted to RS-485 or RS-232 bus level signal. RS-232 serial interface can be directly connected to a PC, so that can be released through the serial port on a PC AT command of the MC55 module.

The working power of Intelligent GPRS communication module microcontroller AT89C51RC is 4.0 V-5.5 V and the GPRS wireless transceiver needs MC55 3.3-4.8 V power to be supplied. The power module frequency alternates current after treatment, in order to provide appropriate power the microcontroller AT89C51RC MC55 GPRS wireless transceiver. In order to improve the reliability of the work at the same time, it can also be installed lithium battery, to realize the power supply from uninterruptible power supply.

### 3.2. Design of Intelligent GPRS Communication Module Software

Completed the GPRS wireless transceiver chip the MC55 with microcontroller AT89C51RC between communication software designs, it is need to define a unified communications protocol between the provisions of the format of the data transmission. Data of GPRS is transferred via AT commands. The microcontroller AT89C51RC which uses AT commands to complete with the GPRS wireless transceiver chip MC55 between data transmission steps are as follows:

```
AT ^ SICS = 0, CONTYPE, GPRS0 / * Select the connection type GPRS0 * /
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AT ^ SICS = 0, DNS1, "*. *. *. *" / * Set the DNS server address * /
AT ^ SICS = 0, PASSWD, T - D1 / * Set access GPRS network password * /
AT ^ SICS = 1, APN, "INTERNET.T-D1.DE" / * Set the access node APN * /
AT ^ SISS = 1, SRVTYPE, SOCKET / * Set the interface type of service * /
AT ^ SISS = 1, CONID, 0 / * Set the connection specification 0 * /
AT ^ SISS = 1, ADDRESS, "SOCKTCP :/ *. *. *. *. *****" / * Client specification contains the distant master IP address and TCP port number * /
AT ^ SISO = 1 / * Open a TCP connection * /
OK / * Feedback: open successful * /
AT ^ SISW = 1,20 / * Write data channel 1 sends 20 bytes of data * /
SISW: 1,20 / * Feedback: 20 bytes of data can be sent * /
***** / * Input to send 20 bytes of data * /
AT ^ SISR = 1,100 / * Read data sent to received data length of 100 bytes * /
SISR: 1,90 / *Feedback information, the data length of 90 bytes can be transmitted * /
AT ^ SISC = 1, / * Close the connection * /
OK / * Feedback: Close successful * /
```

To facilitate debugging maintenance and transplantation, intelligent GPRS communication module software design should follow a modular design idea, which using the C programming language. Intelligent GPRS communication module software design is divided into the system which is initialized, establishing a connection, data transmission and disconnect.

The program firstly initializes the system hardware and software. Microcontroller initialization part AT89C51RC serial port is set for the work, that is, 8 data bits and 1 stop bit timer optional timer work 8 automatically reload timer, setting the baud rate 9600 bps. Then the software buffers and various flags should be initialized. Communication between the GPRS wireless communication module and the master are initialized by using AT commands of the wireless transceiver MC55 chip and to establish a TCP connection, then the TCP connection is established, data can be sent directly by MC55 data transfer mode. On one hand, MC55 accepts the command sent by the master server or data sent through the serial port to the microcontroller AT89C51RC. The microcontroller AT89C51RC is according to the command of the master to process them accordingly. On the other hand, the microcontroller AT89C51RC is via RS-232 or RS-485 data to accept external terminal and by another serial port to the MC55. Data is forwarded to the appropriate IP address of the PC serial port by MC55, MC55 chip in the access network. The set MC55 chip data communication cycle, controlled by the microcontroller is used to send heartbeat information to the master station to keep the GPRS network

connection. The master receives heartbeat information should response to the response signal disconnected after the end of the data transfer.

#### 4. Conclusions

The research is the application of Internet of Things for intelligent electrical meter reading system. It is able to provide automatic data collecting, data analysis, measurement query, print statements and other functions, to achieve a remote, centralized, automatic meter reading, make metric data collection, statistics, and analysis in a very short time to reduce the labor intensity, and to improve work efficiency, avoiding man-made reading error and some other uncertain factors. The system has increased base data management functions, including reading abnormal information maintenance, meter box maintenance, reading class information maintenance, maintenance, supply the information area information maintenance and meter reading information maintenance. These functions will bring huge economic benefits, like to improve the meter reading system economic value and vitality. In the data processing system, it also breaks the previous data limitations, to expand the network function.

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