# RESEARCH OF THE ELECTRICAL ENERGY MEASUREMENT DATA ACQUISITION ENGINEERING BASED ON SCDMA

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## *ABSTRACT*

*The electrical energy measurement data is the basis of estimating electrical energy supply and sales related cost; also it is important information which analyzes the loss of electrical energy transmission and the efficiency of electrical energy consumption. The electrical energy measurement stations are not only distributed among buildings and the streets in the urban areas, but also have been disperses extensively in rural regions such as in the fields and along mountainous areas. Due to the features of dispersed measurement stations, it needs an efficient data-collecting network, which is with large capacity and coverage, to achieve the automatic collection of long-distance measurement data. SCDMA is a kind of wireless communication technique, where SCDMA stands for Synchronized Code Division Multiple Access. To construct specific data-collecting network for electrical energy measurement data by using SCDMA wireless communication technique, the problems associated with the establishment of wireless network should be solved; at the same time, the connection problem of SCDMA network bearing electrical energy measurement data collection service should be settled. This article, which is based on the view of engineering construction, utilizes the features of SCDMA's cellular network establishment technology and smart antenna technology to analyze and suggest the most appropriate electric wave transmission model for urban and rural areas respectively. It also mentions the accession and connection method to serve electrical energy measurement data collection and management, as well as facing-the-object data collecting pattern and device management model. These are applied in the engineering construction and have remarkably solved the base station selecting and signal coverage designs that are associated with SCDMA wireless network establishment, and they help to cope with the connection problems of electrical energy measurement data collection center, enhancing the real-time of electrical energy measurement data collection and building up excellent foundation for analyzing the loss of electrical energy transmission and the efficiency of electrical energy consumption.*

## INTRODUCTION

Due to the significance of the electrical energy measurement data in the electrical energy supply and sales chain, to realize the AMR (Automatic Meter Reading) is helpful to the exact management of energy consumption, and rapidly reflecting the market movement. Also AMR benefits constituting of the flexible electrical energy price policy, which can stimulate the rational consumption and energy saving. Monitoring to the status of electrical energy measurement equipments is helpful to realize AMM (Automatic Meter Management).

## CHARACTERISTICS AND DIFFICULTIES OF ELECTRICAL ENERGY MEASUREMENT DATA ACQUISTION

The main characteristics of electrical energy measurement data acquisition are universal and dispersive. Due to the large amount of the measurement points, and the ruleless distribution of these points, remote automatic collecting of all these measurement points need a data collecting network which should be high efficient, and can provide large capacity and wider coverage.

Currently there are some useful data transmission technologies, for example, optical fiber, all kinds of cable wide band networks, PSTN, power line carrier and wireless networks like GPRS, CDMA. But there are always some limitations when all these technologies are used in AMR.

The cable transmission technologies like fiber and all kinds of cable wide band networks can provide large transmission capacity, the signal loss is very low, and have strong anti-interfering capability and good real-time performance. But on account of the reason that the distribution of electrical energy measurement points is dispersive excessively, the high cost of building fiber or cable networks is unacceptable, and it is infeasible to construct fiber or cable lines in some area.

Power line carrier networks can be built with the power lines, but power line carrier channel is bad, and there is variational impedance and un-divinable noise interference. The data transmission may be interfered easily. Furthermore, the band and transmission distance is limited. So if the functions of prepay is performed based on power line carrier networks, it is difficult to meet the requirement of real-time and reliability.

The public networks like GPRS and CDMA distribute universally, which got high data transmission speed. But as a public network, these networks have to meet the personal communications first, so in some area in which the traffic is large, the band and real-time that electrical energy measurement data transmission need may not be

insured.

## CHARACTERISTICS OF SCDMA WIRELESS BROADBAND ACCESS TECHNOLOGY

The SCDMA wireless broadband access system can provide both high-speed data and voice services to both fixed and mobile users in NLOS (non-line-of-sight) environments. Thanks to the aforementioned advanced technologies, SCDMA system offers a wider coverage, high spectrum efficiency (up to 15Mbps/5MHz), an efficient combination of high speed and low speed services, low cost terminals, support of high mobility applications, and N=1 deployment. Furthermore, the SCDMA system offers quality of service (QoS) to different types of traffic and grade of service (GoS) to different kinds of users.In contrast , SCDMA is designed to work in those (N=1 deployment) hostile environments thanks to the superb interference cancellation capability, the special design of the frame structure, and dynamic channel assignment schemes[1].

### System structure and networking performance

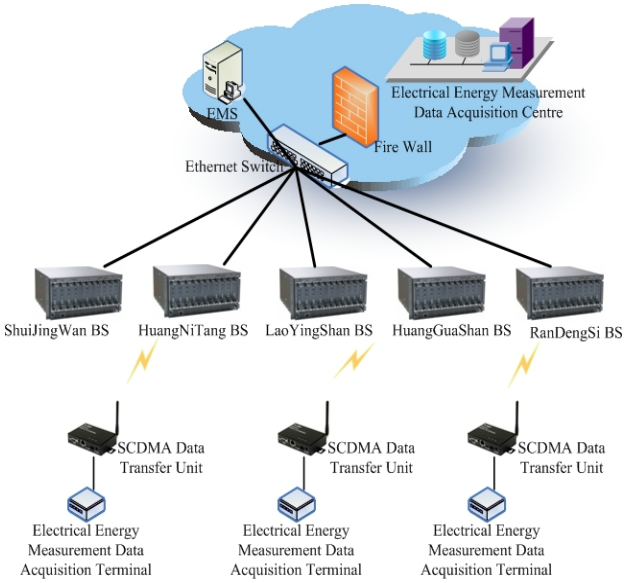


**Figure 1.** Illustration of CHONGQING POWER SCDMA communication network(phase Ⅰ)

As shown in Figure 1. The SCDMA wireless broadband base station is connected with the electrical energy measurement data acquisition centre via IP network. After the electrical energy measurement data acquisition terminal and SCDMA data transfer unit powered on, they will get one IP address. By access that IP address, the electrical energy measurement data acquisition centre can send the control instructions to the electrical energy measurement data acquisition terminal.

SCDMA wireless broadband access system has good NLOS transfer capability. Even The 400MHz system can achieve the coverage which radius is more than 50km. Therefore, it is adapted to be used in the mountainous area. About the capacity, thanks to the small band distribution granularity, the SCDMA system can efficiently surpport the low band demanded services, and a single base station can surpport 300 parallel terminals at most. Accordingly the electrical energy measurement data acquisition system based on SCDMA wireless broadband access technology has the advantage of wider coverage, large user capacity and high efficiency.

### Key technology

**Smart antennas**

Smart antenna is helpful to coverage expansion. With an 8 element antenna array, the beamforming gain can be as much as 18dB for downlink link budget.

The smart antenna technology has strong interference cancellation capability as well. Since SCDMA wireless broadband access technology uses TDD scheme, the nulling can be accomplished for both uplink and downlink to minimize the co-channel interference of neighboring base stations, enabling N=1 deployment.

**CS-OFDMA**

The SCDMA wireless broadband access system uses CS-OFDMA technology. CS-OFDMA stands for Code Spreading Orthogonal Frequency Division Multiple Access. It is a combination of OFDMA and SCDMA and hence has both benefits of OFDMA and SCDMA(which stands for Synchronous CDMA), that is the robustness of OFDMA to delay spread, and SCDMA is more resistant to intercell interference, which enables N=1 deployment.

**Adaptive modulation**

The SCDMA wireless broadband access system uses the QPSK, 8PSK, QAM16 and QAM64 modulations. These modulations are adopted depending on the channel conditions, power availability and the interference and noise level to optimize the spectrum and power efficiencies.

**Dynamic channel allocation**

For N=1 deployment, When we encounter the worst case scenarios where both terminals communicating with different base stations are located at the same places, we use a dynamic channel allocation (DCA) technique to handle such worst cases. The DCA technique first detects such cases and prevents both base stations from assigning the same channels to these two terminals by allowing communication between these two base stations via the backhaul.

**QoS and GoS**

QoS stands for Quality of Service defining differentiation in the traffic handling. GoS stands for Grade of Service. Through the EMS, we can configure each terminal priority and each service priority.

**Security and fraud protection**

We have five steps of security and fraud protections as explained below:

Step 1: When the terminal tries to access the network, it must go through the authentication process through EMS.

Step 2: Since the signal delivered to each terminal is done via beamforming, such downlink signal will be extremely difficult to intercept.
Step 3: To access the internet, the terminal will also need to pass the PPPoE server with an account name and a password.
Step 4: The SCDMA system has another important security feature of binding the IP address, MAC address, and Equipment ID. If there is any mismatch of these three addresses, the IP packets will be dropped.
Step 5: The terminal which is assigned a network ID can only access to the specific network.

## AMR ENGINEERING BASED ON SCDMA

### Design of SCDMA communication network for CHONGQING POWER

CHONGQING POWER SCDMA communication network(phase Ⅰ) was constructed with 400MHz SCDMA wireless broadband system, including 1 EMS(Equipment Management System) and 5 SCDMA wireless broadband base stations, which covered four districts of CHONGQING: BiShan, YongChuan, ShuangQiao and RongChang. Physiognomy of coverage area is mostly hill, and the total acreage is 4000sq.km. Phase Ⅰnetwork primarily covers the villages and towns in all the four districts, and the rigions in which there are service points.

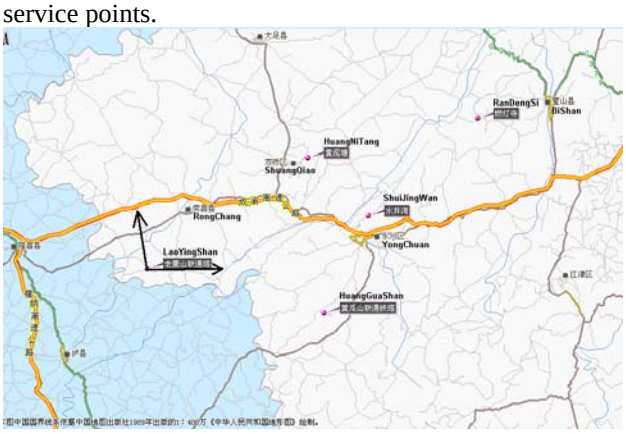


**Figure 2.** Distribution of base stations in CHONGQING POWER SCDMA communication network(phase Ⅰ)

According to the electric wave transmission theory and the test data of SCDMA testing base station, we performed the electromagnetic wave spreading analysis, and utilized HATA model and COST-231 model to estimate the coverage area. With the reconnaissance to all the four districts, five station points was determined, including 4 sector stations and 1 omni direction station. The distribution of the five stations is shown in Figure 2, and the information of the stations is listed in Table 1. The coverage of phase Ⅰ network make that the outdoor signal power is more than -90dBm in 80% area of the four districts.

| StationName | Station Type | Antenna Height(m) | Atenna Type | Altitude (m) |
|---|---|---|---|---|
| ShuiJingWan | Sector | 85 | 2*4grid atenna | 762 |
| HuangNiTang | Sector | 75 | 2*4grid atenna | 777 |
| LaoYingShan | Sector | 50 | 4*2grid atenna | 352 |
| HuangGuaShan | Omni direction | 50 | Omni atenna | 630 |
| RanDengSi | Sector | 25 | 2*4grid atenna | 870 |

**Table 1.** Station information of CHONGQING POWER SCDMA network

The holistic structure of CHONGQING POWER SCDMA communication network is illustrated in Figure 1. The electrical energy measurement data acquisition centre and SCDMA EMS are installed in the central apparatus room, via backhaul five base station access the Ethernet switch which is located in the central apparatus room. For the security of electrical energy measurement data, the SCDMA network is separated from the electrical energy measurement data acquisition centre by the fire wall.

### Terminal interface

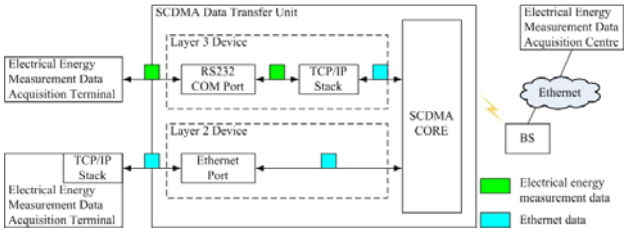


**Figure 3.** Work mode of SCDMA data transfer unit

As shown in Figure 3, SCDMA data transfer unit provides two interface mode: ethernet port and RS232 COM port.
While the SCDMA data transfer unit connects with the electrical energy measurement data acquisition terminal via Ethernet port, the data transfer unit works as layer 2 device, and transfers and receives the ethernet data packets. In this case, the electrical energy measurement data acquisition terminal need support TCP/IP.
While the SCDMA data transfer unit connects with the electrical energy measurement data acquisition terminal via RS232 COM port, the data transfer unit works as layer 3 device. By the embedded TCP/IP, the data transfer unit automatically setups the IP connect with the network, encapsulates the data received from the COM port in the IP packets, and sends these packets to the electrical energy measurement data acquisition centre. At the same time, the data transfer unit receives the IP packeds from the electrical energy measurement data acquisition centre, unencapsulates the data, and sends these data to the electrical energy measurement data acquisition terminal

via COM port. In this case, the electrical energy measurement data acquisition terminal need not support TCP/IP.

## Meter data collecting model

Based on the features of high efficiency, large capacity and wider coverage of SCDMA, the meter data collecting based on SCDMA utilize the model shown in Figure 4.

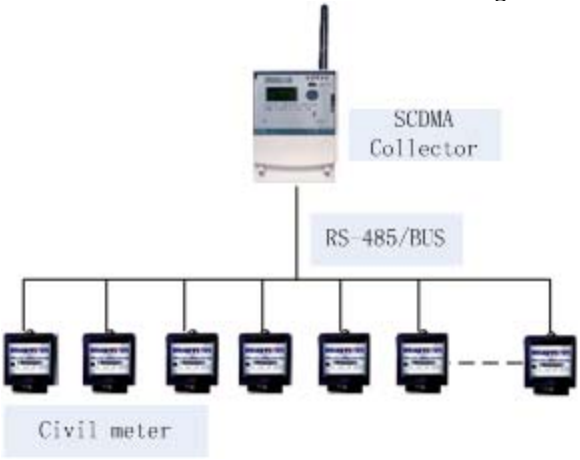


**Figure 4.** Meter data collecting model

In the electrical energy data collecting points that are concentrative like buildings, SCDMA collector collects the meter data via RS-485 bus, and the meter data will be transmited to AMR main station via SCDMA data transfer network.

## Meter reading mode of AMR main station

The protocol model of the electrical energy measurement data acquisition system based on SCDMA is illustrated in Figure 5 and Figure 6.

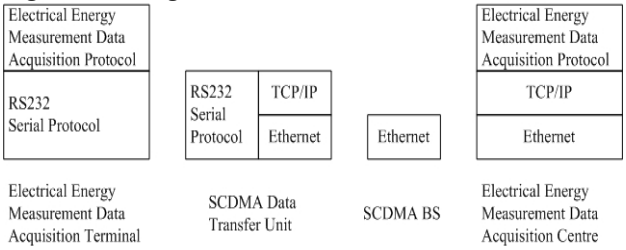


**Figure 5.** Protocol model(via RS232 COM port) of electrical energy measurement data acquisition system

In the case that the SCDMA data transfer unit connects with the electrical energy measurement data acquisition terminal via RS232 COM port, after the SCDMA data transfer unit powered on, it will get a IP address from the DHCP server, or it can use the static IP address which was set in the unit. After the electrical energy measurement data acquisition terminal powered on, it will register to the electrical energy measurement data acquisition centre(AMR Main Station)，and the electrical energy measurement data acquisition centre will records the mapping of the electrical energy measurement data acquisition terminal identity and IP address. In this duration in which the terminal is active, the electrical energy measurement data acquisition centre will communication with the electrical energy measurement data acquisition terminal via that IP address.

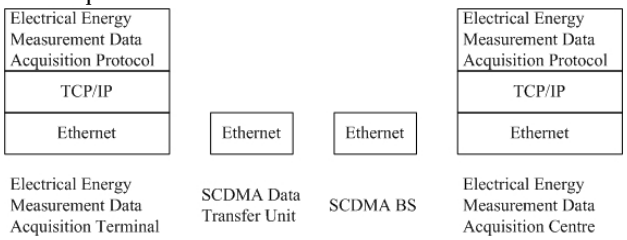


**Figure 6.** Protocol model(via Ethernet port) of electrical energy measurement data acquisition system

In the case that the SCDMA data transfer unit connects with the electrical energy measurement data acquisition terminal via ethernet port, after the electrical energy measurement data acquisition terminal powered on, it will get a IP address from the DHCP server, or it can use the static IP address which was set in the terminal. And then, it will register to the electrical energy measurement data acquisition centre, and the electrical energy measurement data acquisition centre will records the mapping of the electrical energy measurement data acquisition terminal identity and IP address. In this duration in which the terminal is active, the electrical energy measurement data acquisition centre will communication with the electrical energy measurement data acquisition terminal via that IP address.

## CONCLUSIONS

SCDMA wireless broadband access technology is able to meet the demands of high efficiency, large capacity and wider coverage of electrical energy measurement data collecting network. Thanks to aforementioned advantages, in order to cover the wider area in which the measurement points distribute, we need only a small amount of base stations. There are 5,000,000 power users in CHONGQING, and within the framework of State Grid, the amount is more than 170,000,000. It will renovate the operation mode of electrical energy supply and sales chain if that the AMR to these meters is realized. And it is helpful to promote the innovation of electrical energy sales and improve the electrical energy utilization efficiency and consumption level.

## REFERENCES

[1] Guanghan Xu, 2007, “Elucidate the evolution of TD-SCDMA from technology origin”, Telecommunications science, 2007(6):1-6.

## AUTHOR INFORMATION

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