

# DESIGN AND IMPLEMENTATION OF AMR USING GSM, ZIGBEE THROUGH GPRS

<sup>1</sup>S.ARUN <sup>2</sup>DR.K.RAMESHBABU

<sup>1</sup>RESEARCH SCHOLAR

SINGHANIA UNIVERSITY

<sup>2</sup>PROF, ECE DEPARTMENT

HYDERABAD INSTITUTE OF TECHNOLOGY AND MANAGEMENT

## Abstract:

Designing and implementing commercial as well as industrial systems based on Wireless communication has always been a prominent field of interest among many researchers and developers. This paper presents an implementation methodology for a wireless automatic meter reading system (WAMRS) incorporating the widely used GSM and Zigbee network. In many countries GSM and GPRS network is widely known for its vast coverage area, cost effectiveness and also for its competitive ever growing market. Using GSM as the medium for WAMRS provides a cost-effective, wireless, always-connected, two-way data link between utility company and WAMRS, the WAMRS sends information of utility usage, power quality and outage alarm to utility company, tampering detection to the utility servers.

In this paper we suggest a method where we utilize telecommunication systems for automated transmission of data to facilitate bill generation at the server end and also to the customer via SMS, Email.

**Keywords:** GSM, ZIGBEE, GPRS, Relay Control

## 1. Introduction

The wide proliferation of wireless communication propose and explore new possibilities for the next generation Automatic Meter Reading (AMR) whose goal is to help collect the meter measurement automatically and possibly send commands to the meters. Automation ranges from Connecting to a meter through an RS-232 interface for transmitting the meter measurements all the way from the meter to the utility company via GSM network.

### 1.1 History of Meters

With the development of country's economy and the improvement of national power, the power requirement is still ever increasing due to use of improper power management systems and the

conventional energy metering system. Over the past years, metering devices have gone through much improvement, and are expected to become even more sophisticated, offering more and more services. Meters in the past, and today in a few countries, were electromechanical devices with poor accuracy and lack of configurability. Theft detection was also a challenge. Such meters are limited to providing the amount of energy consumption on site.

Recent developments in this direction seem to provide opportunities in implementing energy efficient metering technologies that are more precise and accurate, error free, etc. The implementation of WAMRS provides with many vital features as compared with the analog utility meter reading with man power. Some of these features are listed below,

- Higher speed.
- Improved load profile.
- Automatic billing invoice.
- Real time energy cost.
- Load management.
- Alarm warning.
- Remote power switches on/off.
- Tamper detection.
- Bundling with water and gas.

WAMRS provides a two way communication between the electricity company and the load by sending in a lot of power parameters and control signal to reach the goal of load management and power demand control. Using WAMRS on distribution automation can supply many capabilities such as efficient meter-reading, distribution, power monitoring and control, load management and time-of-use rate. With rapid growth of mobile communication network, future application service will gradually concentrate on data transmission service. GSM has been developed maturely and has many practical applications at present. It has many advantages such as more stable network with robust features, covers virtually all parts of the world, maintenance and security of data transmission. It satisfies the need of speed for data transmission required for automatic meter reading

system.

## 1.2 Messaging over GSM Network

Global System for Mobile Communications (GSM) is the world's most popular standard for mobile telephony systems. GSM is used by over 1.5 billion people across more than 212 countries and territories. GSM also pioneered low-cost implementation of the short message service (SMS) which allows parties to exchange delay-tolerant short text messages. The popularity and wide coverage of cellular networks have attracted researchers to consider the use of SMS service.

However there are certain questionable issues regarding GSM network such as its scalability, reliability and security, especially under high load. Zerfos et al. [7] have analyzed real data taken from a real GSM network in India. SMS delivery success rate was found to be 94.9%; 73.2% of the successfully delivered messages reach to the destination within 10 seconds; about 5% of them require more than an hour and a half. Using SMS for AMR service will definitely increase the flow of messages tremendously. GSM uses several cryptographic algorithms for security. The development of UMTS introduces an optional Universal Subscriber Identity Module (USIM), which uses a longer authentication key to give greater security, as well as mutually authenticating the network and the user.

The paper consists of following sections: Section II describes the proposed system architecture. The system includes a 32-bit ARM microprocessor to deal with power data processing and relay control, which transmits the power consumption values periodically, via an existing GSM network to a master station. Section III and IV describes the hardware architecture and software separately of WAMRS. Section V concludes the paper.

## 2. System Structure

The system structure of wireless automatic meter reading system (WAMRS) is shown in figure 1. The networked meter-reading system consists of terminal measure meters, sensors, intelligent terminals, management centre and wireless communication network.

- Intelligent terminal or AMR interface, a hardware connected to a meter or a

network of meters, which gathers data from meter(s).

- Management Center, mainly a computer or a network of computers, which collects the data sent by the AMR interface.
- Communication medium or GSM network, which enables communication between the AMR interface and the center.

Meter-reading, computation and charge can be finished at the management centre of each residence. The charge message i.e. SMS or Email would send to resident at regular intervals. The GSM network establishes a two way link in between the intelligent terminal and the management center providing useful features as mentioned above.

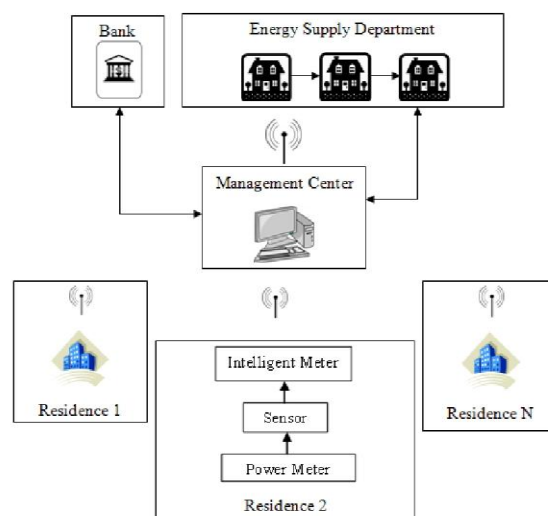
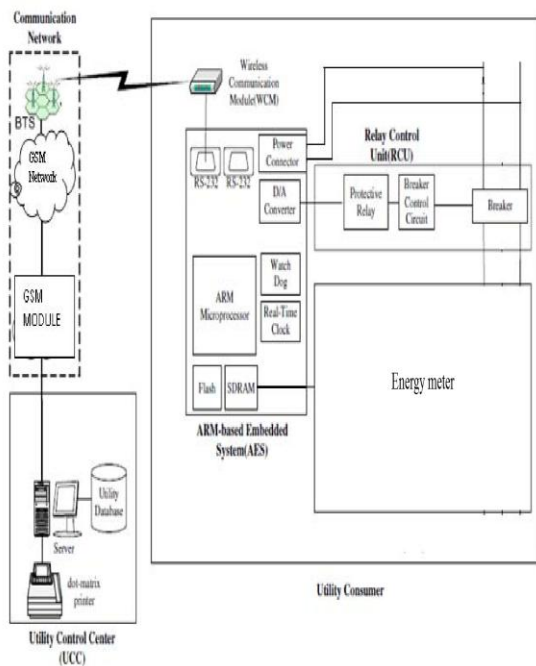


Figure.1 Structure of diagram of WAMRS

## 3. Hardware Architecture

The hardware architecture and appearance of WAMRS is as shown as Fig. 2. The energy consumption is being calculated using a standard calibrated energy meter. In order to prevent unauthorized connection, mismatch with the energy meter, a tampering detection unit is added in this block. The digital data generated from this block is then sent to ARM-based embedded system to compute power parameters.

The WAMRS can be divided into five parts; these five parts separately are power unit (PU), relay control unit (RCU), and ARM-based embedded system (AES), wireless communication module (WCM) and utility control center (UCC). The hardware description of five parts is introduced as follows.



### 3.1. Energy measuring unit (EMU)

The energy measuring unit consists of a standard calibrated energy meter along with the tampering detection circuit. If any variations other than the rated voltage or specified values are obtained, the ARM-based embedded system (AES) generates the necessary signals required for further operations.

In many countries, it is seen that the consumers attempt to obtain electrical energy illegally. These incoming losses of stolen power for utility companies are very high. It's necessary for utility meter to have the capability of tamper detection. The following events are considered for tamper

### 3.4. Wireless communication module (WCM)

The WAMRS adopts a SIM 300 GSM modem manufactured by SIMCOM limited as the wireless communication module. SIM300 is a Tri-band GSM/GPRS engine that works on frequencies EGSM 900 MHz, DCS 1800 MHz and PCS1900 MHz. The SIM300 is designed with power saving technique, the current consumption to as low as 2.5mA in SLEEP mode. The SIM300 is integrated with the TCP/IP protocol; extended TCP/IP AT commands are also developed for using the TCP/IP protocol easily, which is very useful for those data transfer applications.

detection by the method.

- Missing potential event
- Current unbalance event
- Current reversal event

If any above event occurs, the AES will record the meter status in database and inform

### 3.2. Relay control unit (RCU)

The RCU is a vital part in WAMRS. It provides the useful functionality of remotely switching the power ON/OFF to the user. It consists of a protective relay, breaker control circuit & line breaker.

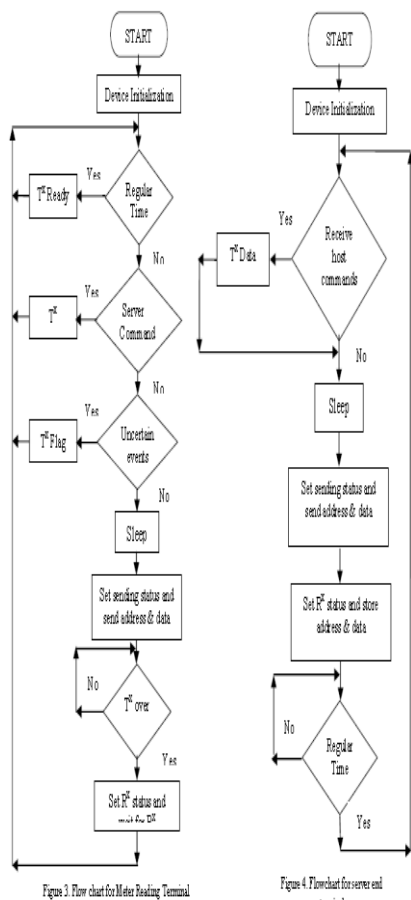
### 3.3. ARM-based embedded system (AES)

The AES is termed to the heart of WAMRS. It is designed based on a low power 32-bit ARM7 LPC2148 processor. It is a high performance low cost solution for network applications. It consist of two 10-bit ADCs, with conversion times as low as 2.44  $\mu$ s per channel, single 10-bit DAC provides variable analog output two 32-bit timers/external event counters and Multiple serial interfaces including two UARTs. The on chip features can significantly reduce the total system cost to design network devices. It has 8 kB to 40 kB of on-chip static RAM and 32 kB to 512 kB of on-chip flash memory, so it can execute longer programming code and has larger RAM to store more data.

### 3.5. Utility control center (UCC)

The UCC resides in the utility company and has a PC as control server with needed programs and storage to read and collect power parameters from AES via communication network. The specifications of server are as follows:

- 2.4 GHz Intel Pentium IV processor
- 512 Megabytes RAM
- 80 Gigabyte Hard Disk
- 15" LCD Monitor
- DVD-Rom Drive
- 100 Mbps. Network Connections
- Dot-matrix printer.



#### 4. Software architecture

The system software is implemented by C language in the Keil MCB2130 software along with flash magic. All software development tasks including editing, compiling and debugging can be accomplished using the above mentioned software's.

##### 4.1. Meter Reading Terminal Software Design

According to the hardware circuit design features, meter reading terminal software design flow chart is given and shown in Figure 3. First, the system initializes each module, and then reads the meter readings regularly, and stores them. When receiving the command, the meter sends in the current status along with the energy consumption.

In case of uncertain events such as reverse voltage, tampering, etc the WAMRS will

generate error signals by enabling pre-programmed flags. The system is usually in standby mode. The controller may read the contents of the status register to monitor data transfer status.

##### 4.2. Server End Terminal Software Design

In accordance to the function of the hardware circuit design, the software programming idea of server end terminal is as follows: first, the system completes initialization, and then sends commands to the meter reading terminal through the GSM modem. When the host WAMRS receives the signal, it will select the data and update the database at the same time, send the consumption to the consumer via SMS, Email. The overall software flow chart is shown in Figure 4.

#### 5. Conclusion

The wireless automatic meter reading system (WAMRS) presented in this paper absorbed many advanced study results in computer technology and communication technology. The meter-reading task can be finished at the management department of residence area by using this system. Meantime, the energy resources management departments can monitor the consumption of power in order to improve the utility of power. It's the basic to realize automatic deliver of energy resources.

The system has many significant excellences, such as wireless, low-workload, great quantity of data transmission high-veracity and low-expenses. The using of embedded system improves the stability of wireless data transmission. For a long distance transmission GSM telecommunication has shown excellent performance at any conditions.

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