Designing and Control Mechanism of ZigBee based Automatic Meter Reading

[1]Dr.Shaik Meeravali, [2]Nagireddy.S, [3]Rajitha S

[1]. Department of Electronics and communication Engineering,

RRS College of Engineering and Technology, Muthangi,

Faculty of Electronics and Communication Engineering,

Jawaharlal Technological University, Hyderabad, India.

[2]. .Master Of Scholar, RRS College of Engineering and Technology, Muthangi,

[3]. Bachelor of Engineering, Stanley College Of Engineering And Technology For Women

[

Abstract- *Designing and Controlling commercial as well as industrial systems based on Wireless communication have always been a prominent field of interest among many researchers and developers. Because of the traditional way of metering error and low efficiency, Automatic Meter Reading (AMR) system is designed. The AMR is implemented using an ARM7 and ZigBee Based power meter Communication Module. The design presents a new methodology to control the power consumption and controlling of the meters. This system avoids the human intervention in Power Management. If the Consumer doesn't pay the bill in time, the power connection will be disconnected from the remote server automatically. It displays the corresponding billing information on LCD and sends data to the server through the ZigBee Module. The entire programming is based on Embedded C Language. The proposed mechanism provides efficient meter reading, power control mechanism, avoiding the billing error and reduces the maintenance cost.*

Keywords *— Automatic Meter Reading, ZigBee, ARM7 Microcontroller.*

I. Introduction

In current trend the power consumption increased to a great extent. It became challenging to control the power consumption as per the growing requirements.

Controlling the power consumption is also an important task as providing the power supply presently; the human operator goes to the consumer's house and produces the bill as per the meter reading. If the consumer is not available, the billing process will be pending and human operator again needs to revisit the pending houses. Going to each and every consumer's house and generating the bill is a laborious task and requires lot of time. It becomes very difficult especially in rainy season. If any consumer did not pay the bill, the operator needs to go to their houses to disconnect the power supply. Automatic meter reading, or AMR, is the technology of automatically collecting consumption, diagnostic, and status data from water meter or energy metering devices (gas, electric) and transferring that data to a central database for billing, troubleshooting, and analyzing. This technology mainly saves power supply providers to reduce the expenses of periodic trips to each physical location to read a meter. Another advantage as mentioned in [2] is that billing can be based on near real-time consumption rather than on estimates based on past or predicted consumption. This timely information coupled with analysis can help both utility providers and customer's better control the use and production of electric energy, gas usage, or water consumption.

AMR technologies [2] include handheld, mobile and network technologies based on telephony platforms (wired and wireless), radio frequency (RF), or power line transmission. Various AMR methods and technologies are proposed using SCADA (supervisory control and data acquisition), Wi-Fi,[7], ZigBee[3],GPRS[5] etc. The main drawback of AMR or automatic meter reading is controlling. AMR using ZigBee technology[4][6] is created against the background of drawing up a specification that lays down the controlling of power consumption as well as controlling the devices in the AMR[8]. The goal involved in drawing up the specification was the primary wish to find a maximally simple structure also suitable for implementation in [1]. The operator in the control room is not able to control the power consumption, and also not able to control the devices manually, i.e. tripping of the power to the consumers those who were not paid any bill for a long time, displaying the amount. Thus this paper provides a solution to reach the above constraints and the outline of the paper is as follows. The existing system is described in section 2. The proposed control mechanism is described in details in section 3. Section 4, describes proposed system architecture and operational description. Conclusion is summarized in section 5.

II. Distributed Energy meter Reading

The existing approach Distributed Energy meter Reading taken from [9], is a Scheme for the Application of Smart Message Language in a Wireless Meter Reading System.
This Wireless Meter Reading System is based on WI-FI and is made up of Intelligent Data Procurement Terminal, Wireless Repeater, Access Point and Control Center. The concept of this system is SML (Smart Message Language) based wireless meter reading. The SML protocol for remote meter reading possesses an optimized structure (shown in below figure1) for use in both classical communication routes (PSTN, GSM, etc.) and in package-oriented network operation. For that purpose the structure of SML Message is as follows.

A. SML Message Structure
The basic structure of SML system is divided into four main elements:
(1)Smart Message Language defines a file structure/

document structure for recording the useful loads between the end points.
(2)SML Binary Encoding defines a packed binary coding for SML.
(3)SML XML Encoding defines the coding of SML in XML.
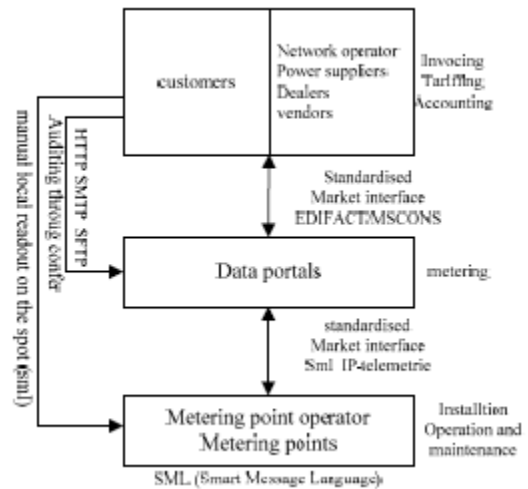(4)SML Transport Protocol, required for serial point-to-point links.

Figure1. The System Concept of SML [9]

The system operation using SML concept is explained in next section

B. Operation
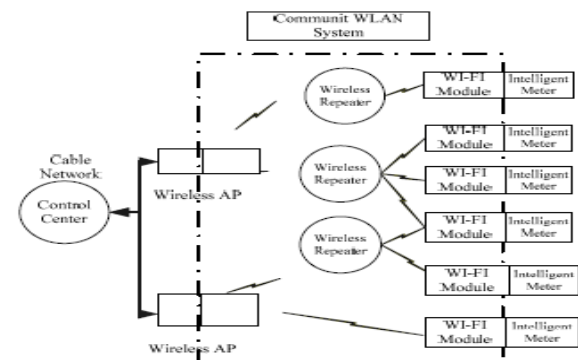The architecture shown below illustrates the operation of this SML concept through WI-FI.

Figure2: Meter Reading Systems Architecture [9].

The system can be divided into three main parts: Intelligent meter, WI-FI WLAN and Control Center. The WI-FI communication module collects the information of the meter which is then sent to the Access Point after being processed. Access Point transmits the data to the control center where the data

is processed and stored into the database via wired network. Users can know the data information by using the PC management software. Control Center sends commands such as data procurement, data storage, alarming and so on to control the whole system.

The function of each part of the system is as follows: AT91SAM7X256 is the control center of communication module whose main function is connecting the intelligent meter and the WI-FI Wireless LAN, transmitting the meter data and state information to the Wireless LAN and receiving commands via WLAN. To guarantee the communication quality and rate, the communication rate is set to 100kpbs and the size of data is limited to 512 byte/point. Considering the privacy and security, WPA and Address Code Check is used. As this approach is good with SML but unable to control the power transfer and also there is no visualization of units consumed. So a new controlled mechanism is proposed to avoid the above mentioned drawbacks.

III. Proposed Control Mechanism

This proposed control mechanism of AMR gives a solution to power transfer control and visualization of power units consumed. The AMR system requires means of communication for transmitting and receiving their data. The information collected from each meter, must arrive reliably and securely to the utility provider, for billing and analyzing. In another way any command from provider office that addresses each node and each meter must arrive reliably and securely to its destination. The Hardware Architecture of proposed control mechanism is given below. Figure3 gives transmitter Block diagram and Figure4 gives receiver block diagram.
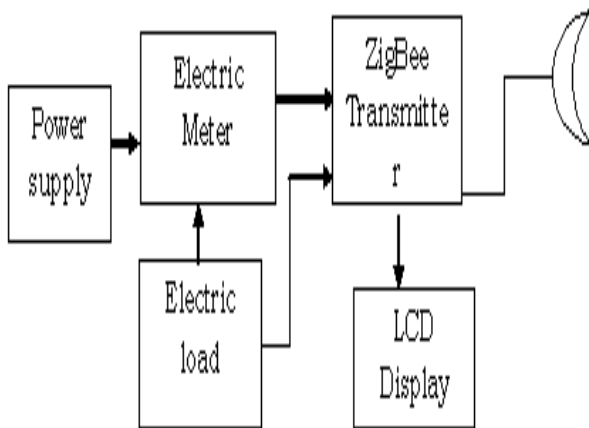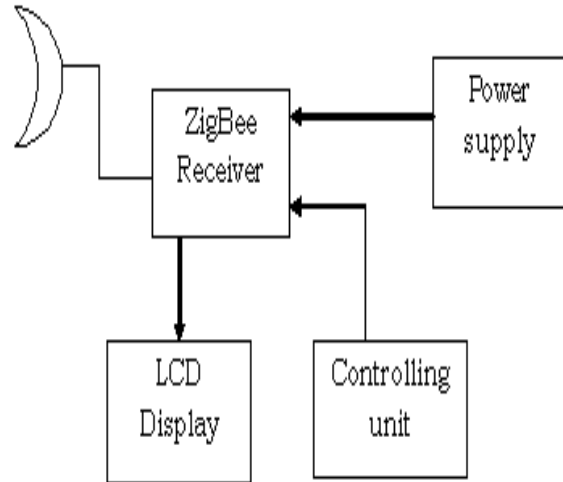

Figure3: Transmitter Block Diagram

Figure4: Receiver Block Diagram

The Hardware architecture of Automatic Meter reading Consists of power supply module, ZigBee processor, LCD module, Controlling unit as shown in figures 3&4.

A. Transmitter Section

The required operating voltage for AMR controller board is 12V. Hence the 12V D.C. power supply is needed for the AMR board. The functionality of power supply is to drive the electric meter. It supplies the electric power to the electric load. The power variations in electric meter are in accordance with electric load. The electric meter/energy meter is integrated with electric load and which produces the analog signal can be converted into digital signal and that digital signal in the form of pulses and outputs average real power information based on the load. The electric load refers to the power consumed by a circuit. The outputs are interfaced with Zigbee Transmitter module to communicate with the Receiver. High degree of immunity to false triggering from noisy supplies is attained due to built in hysteresis and filtering operations in power supply. Communication Module consists of Zigbee wireless communication module. It is used to transfer the data of the user meter through Zigbee wireless module. The user can monitor power consumption details and amount to be paid on LCD.

B. Receiver Section

Depending on the data received from the Zigbee Transmitter module, it sends information of the user meter to Control unit through wireless communication module. In addition to that, the same

information is sent to the user through LCD. Depending on the information received from the Zigbee Receiver module, control unit to shut off or resume the electric power supply. The controlling can be done by tripping, i.e. power supply is going to on/off automatically without visiting the consumer's pending houses again and again. This control unit also helpful in displaying the amount.

The automatic meter reading o/p seen in PC if it is interfaced with the transmitter section. While bill not paid within the given period of time the load will disconnected by the electricity board by pressing switch in the control unit of Receiver Section.

IV. Architecture and operational Description

Automatic Meter Reading is a process that the meter data is read and processed automatically via special equipment using wireless communication and computer network technology. Compared with the Existing meter reading, it effectively saves human resources and can get real-time consumption of every user, helping the management. The communication data rate is set 250 kbps and the frequency band is 9.6GZ.

The proposed AMR system is divided into two sections i.e transmitter section and receiver section. The working of AMR can be explained through below flowcharts.
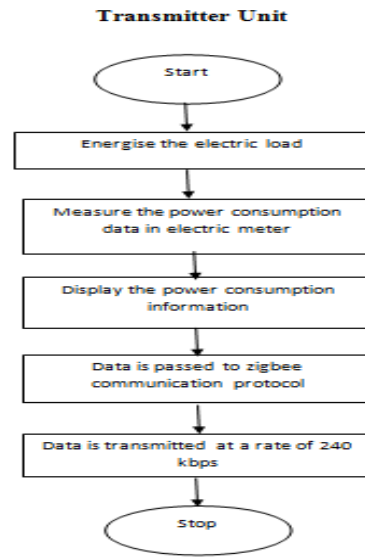
A. Transmitter Flowchart

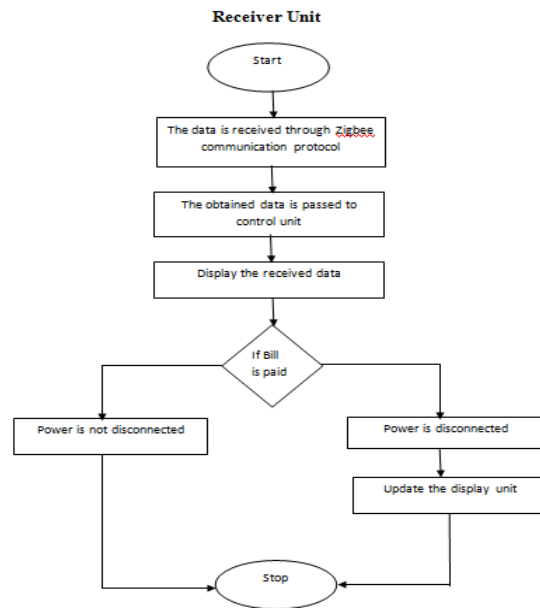Figure5: Flowchart for T^x Unit

B. Receiver Flowchart

Figure6: Flowchart for R^x Unit

The AMR is designed based on Zigbee Communication protocol. The importance of that protocol is explained below.

ZigBee:

ZigBee is new wireless technology guided by IEEE 802.15.4 Personal Area Network standard. It is primarily designed for the wide range controlling applications and to replace the existing non-standard technologies. It currently operates in 868 MHz band at a data rate of 20Kbps in Europe, 914MHz band at 40kbps in USA, and the 2.4GHz ISM bands Worldwide at a maximum data-rate of 250kbps. It is used to verify whether user's truncation is possible or not. One of the main advantages of this ZigBee communication is that it provides a noise free communication, the amount of noise added in this type of communication is very less compared to the other wireless communications.

V. Results and Discussion

The Proposed system is tested in the place of conventional power meter and achieved good results. The figures 5&6 show the actual photographs of proposed automatic meter reading system. The LPC 2148 module is interfaced with ZigBee module, LCD module, power data collection module, the relay controlling unit.

For demonstration purpose 60W bulb is used to examine our system. The bulb is connected to measure the average real power information. When consumer will not pay the bill, power is controlled by officials in the control unit (Receiver section) which proves the accuracy of the system in terms of power calculation and automatic controlling.

Figure7: AMR Transmitter unit

The figure 7 shows that initial stage of transmitter section when power is off. Here Electric bulb acts as a load. This circuitry is ready for operation.
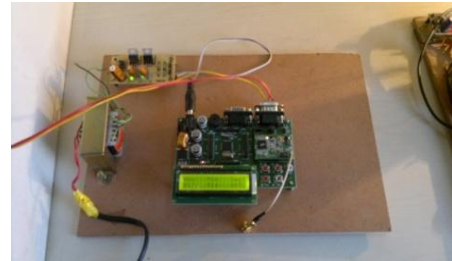

Figure8: AMR Receiver unit

The figure 8 shows initial stage of receiver section. All components are well connected and ready for operation .

Figure9: AMR display unit

The LCD display in figure 9 is used to show the power consumption details and bill details in both Transmitter Section and Receiver Section in order to avoid the human manipulations on meter.

Figure10: Controlling Mechanism

The figure 10 depicts that controlling of power from receiver unit i.e whenever consumer fails to pay the bill, the power will be disconnected through control unit.

Figure11: AMR readings on PC

The amount of power consumed in units and the amount need to be paid and required information will be showed on PC in figure 11 when interfacing is done through transmitting unit.

VI. Conclusions

In the present work Zigbee based Automatic Meter Reading (AMR) unit is designed to continuously monitor the meter reading and to shut down the power supply remotely whenever the consumer fails to pay the bill. It avoids the human intervention, provides efficient meter reading, avoid the billing error and reduce the maintenance cost. It displays the corresponding information on LCD for user notification.

VII References

[1] Duan Qichang,and Dong Ping , "Network Data Transmission and Information Exchange of the Wireless Meter Reading System," Techniques of Automation and Application, vol.28, pp.39-41,March 2009.

[2] Das V. V., "Wireless Communication System for Energy Meter Reading," Advances in Recent Technologies in Communication and Computing, 2009. pp. 896-898 ,October 2009

[3] JI Jin-shui. ZigBee wireless sensor network technology based on system design[J]. Computer Engineering and Design. 2009，

[4] LIU Rui-xia, LI Chun-jie, GUO Qing, WEI Nuo, KONG Xiang-long. Cluster Routing Protocol Based on ZigBee Mesh Network Computer Engineering. 2009

[5] HE Ming-xing. Based on the ZigBee and GPRS Technologies of wireless sensor network gateways design Industry and Mine Automation. 2009，

[6]WEI Shu-fang, SUN Tong-jing, SUN Bo, GUO Yuansheng. The Application of ZigBee - based Wireless Sensor Network in Coal Mine[J]. Control and Automation Publication Group. 2009

[7] Fangchang Zhang, Xiaodan Liu, and Weiyan Hou, "Design and Implementation of Measurement Meter Reading System Based On Wi-Fi," utomation & instrument, vol.25, June 2010.

[8]Vinu V Das, 2009."Wireless Communication System for automatic Meter Reading", 2009 International Conference on Advances in Recent Technologies in Communication and Computing.

[9] Hou Weiyan, Wang Jiahui, Zhang Fangchang, "A Scheme for the Application of Smart Message Language in a Wireless Meter Reading System", Third International Conference on Measuring Technology and Mechatronics Automation, IEEE-2011.

Author's Profile

FIRST AUTHOUR

Dr. SHAIK MEERAVALI,

Professor and Head, Department of electronics and communication Engg, RRS college of engineering and Technology, Muthangi, Andhra Pradesh, India.

Second author

Master Of Scholar, RRS College of Engineering and Technology, Muthangi, Andhra Pradesh, India

Third author

Bachelor of Engineering, Stanley College Of Engineering And Technology For Women, Hyderabad, Andhra Pradesh, India