An Efficient Energy Monitoring and Load Control Using AMR with Distributed WSN

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Abstract: Energy meter reading tedious process. Now a day energy meter reader goes to every premise and takes the reading manually then issues the bill. In manually reading human error possible and not provide reliable meter reading. To avoid this difficult task Automatic Energy Meter Reading (AMR) system is introduced. AMR is the technology that automatically collecting consumption and status of data from energy metering device and transferring the data to Electricity Board (EB) office by using Wireless Sensor Networks (WSN). After verifying customer's serial number bill will be issued then data has been stored into database. The proposed system automatically disconnect meter either load crosses concern limit or payment periods exists. It also does not provide electricity tampering and provide accurate meter reading.

Index Terms: AMR, WSN, Electricity.

I. INTRODUCTION

Electricity is one of the basic necessary parameter in day to day life. For developing countries like India power requirements are still increasing due to indecent power distribution system and traditional meter reading system. So it's important to provide the electricity to all the people. This electricity has been controlled by using energy meter. Energy meter is a device which measures consumption of electricity of any homes and premises. Still some of the countries are using electromechanical metering devices for measuring electricity with low accuracy. Most of the countries are using electronic metering devices with medium accuracy. Some developed countries are using digital metering devices for measuring electricity with high accuracy.

In traditional meter reading system, meter reader people who visit every home and take the reading. In manual meter reading system, error reading and error calculation is possible. Especially, during rainy days difficult go every house and take reading. If payment period exists, electricity board mans need to go to their houses and discontinue the energy meter supply. Traditional meter reading system mostly defends on field officers only. Some of the customers tampering the electricity, it provides significant amount revenue loss for our government. Old meter reading system security is biggest issue because easy to tampering the electricity and wrongly takes the reading.

Automatic Energy Meter Reading includes various technology for data collection such as PLC (power line communication) method, RF (Radio Frequency) Method, GSM based technology and Zigbee based technology but zigbee based AMR technology is better than other technologies. Earlier power line communication used for energy meter reading [1]. Power line communications are easily disturbed by noise. GSM based automatic meter reading provides meter reading with improved billing and reduce tampering [2]. In rural areas coverage of GSM network is biggest issues. Automatic meter reading system is convenient way to collects data and frequently reading meter and also gave power cut information [3]. Automatic Energy Meter Reading system provide remote monitoring that is control the domestic energy meter from anywhere in the world and does not allow tampering of electricity. Relaxation time is given to customers. Once payment period exceeds, automatically disconnect energy meter and information is given to customers. Similarly customers consume extra load than normal, automatically discontinue the meter. This proposed system provides accurate meter reading and flexible billing.

II. COMPARISON OF AMR SYSTEM AND TRADITIONAL METERING SYSTEM

Table 1. Shows comparison between Zigbee based Automatic Meter Reading System and Traditional Metering System. Using Automatic Energy Meter Reading Technology can control meter and monitoring the data usage of domestic electricity meter everywhere in the world. Zigbee based automatic energy meter reading or AMR are provides tampering warning feature, automatic disconnection feature, power cut information. Traditional meter reading does not provide these kinds of features.

Automatic energy meter reading system is accessing the data and receiving customer feedbacks to improve their service. Traditional meter reading system cost is very high because meter reader people need to go every houses and industries for take the meter reading.

In AMR system no need meter reader people for accessing the meter it automatically read and transferring to electricity board offices. AMR systems avoid error meter reading and error reading. It's also provides increasing security of data.

Table 1 Comparison of Zigbee based AMR and Traditional meter reading system

Sl. NO	Features	Zigbee based AMR system	Traditional meter reading system
1	Remote Monitoring	Possible(Electricity board reading the energy meter without field person visiting)	It is not possible.
2	Control Energy Meter	Everywhere in the world	Only at respective customer premises.
3	Tamper Warning	Tamper warning feature is possible. In case of tampering information is given to electricity board.	Tamper warning is not possible.
4	Automatic disconnection	Automatically discontinue the meter if payment period exceeds.	It does not provide automatic disconnect meter.
5	Maintenance cost	Less because accessing the system without field person visiting houses.	More because field man need to go every house and take the reading.
6	Data security	Avoid error meter reading and error calculation also increasing security of data	Error meter reading is possible and not provide a security
7	Man Power	No man power required	Huge man power is required

III. SYSTEM DESCRIPTION

Load consists of potential transformer and current transformer. Volatage is get from potential transformer and current is get from current transformer. Potential transformer is step down transformer which is used to convert high voltage to low voltage. Current transformer step up transformer which is used in high voltage circuits. Potential coil consumes a less and relatively equal amount of power, typically around 1.8 watts which is not registered on the meter. Similarly, current coil consumes a small amount of power in proportional to the square of the current flowing through it, typically up to 2 or 3 watts

power, which is registered on the meter. Both voltage coil and current coil is given to enegy meter.

There are two coils, one coil is connected in such a way that produces a magnetic flux in proportion to the voltage and the other produces a magnetic flux in proportion to the current. The field of the voltage coil is delayed by 90 degrees, due to the coil's inductive nature, and calibrated using a lag coil. This can produces eddy currents in the disc and the effect is such that a force is exerted on the disc in proportion to the product of the instantaneous current, voltage and phase angle between them. A permanent magnet exerts an opposing force proportional to the speed of rotation of the disc. The equilibrium between these two opposing forces results in the disc rotating at a speed proportional to the power or rate of energy usage.
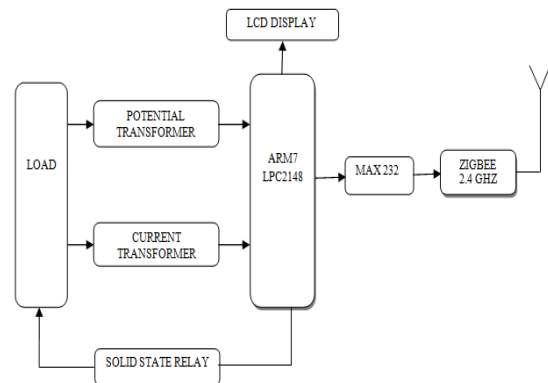

Fig. 1. Client Side

Potential transformer and current transformer get power from load. Both potential and current transformers produced power is given to signal conditioning unit. Signal conditioning unit converts this power value analog into digital value. This converted digital value is given to ARM7 LPC2148 processor which converts current and voltage values into energy as single output. ARM processor continuously monitoring and control energy meter. This digital output continuously displayed on the meter by using LCD display.

Display unit not only show output also show the power cut information and load details. This output is transmit to server by using zigbee 2.4 ghz mac protocol whenever server request for reading. Zigbee device act as transceiver that is tramit as well as receive the datas. Three kind of zigbee devices are available in market. Here using zigbee end device because less cost and transmit data longer distance. Data transmission is done in adhoc manner. Adhoc networks main aim to find shortest path and transmit the data to server. For longer distance data transmit to neighbour nodes then tramit another nearest node like that way finally reach the destination.

Relay is electrically operated switch, here using solid state relay. It provide faster operation than electromechanical relay because solid state relay made by semiconductor devices. Its main purpose isolation and disconnect the

power supply. Automatically disconnect meter supply by using solid state relay. Processor checking customer usage loads, if user consume excessive load than normal, it automatically disconnect the meter supply by using solid state relay. Similarly current value incrase more than 20 amps processor automatically disconnect the meter power supply. This informations given to both customer and electricity board.
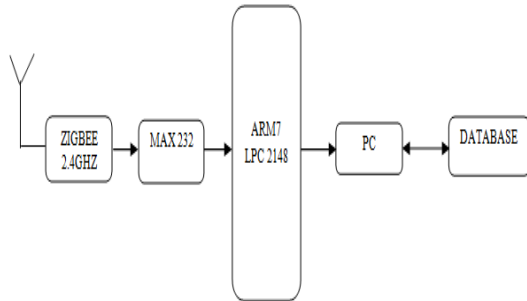

Fig. 2. Server Side

Monthly once server requesting to metering device for energy reading by using zigbee protocol. Energy meter receiving request from server then node transmit the consumed data to server by using zigbee protocol. Server side zigbee receives transmitted data. This data is given to ARM7 LPC2148 processor for verify the serial number and stored into vb database then bill will be isssued. Once payment period exists meter supply connection will be discontinued automatically for customers those who not paid the electricity bills.

First request is transferred to node side by using zigbee protocol. Then arm processor accept the request and disconnect that particular meter supply. If customer either consume excessive loads or tampering the electricity, automatically discontinue the energy meter supply and information given to electricity board offices. This informations are displayed in PC. All the processing datas are stored in database.

IV. FLOWCHART BASED DESIGN

Zigbee end device reads energy measurement information in multifunction electric meter by UART, and transmits them to the network coordinator via Zigbee wireless network, thus it can realize the wireless meter reading of the network coordinator.

Meanwhile, the network coordinator can transfer clock-correcting command to multifunction electric meter through Zigbee end device to calibrate the system clock and power parameters. Therefore, the zigbee end device should be able to communicate with the multifunction electric meter in order to read data and the coordinator in order to send data.

The coordinator also has to know which end node that sends the data so the data can be read accurately. Each of Zigbee modules has a unique 64-bit permanent address, so the addressing won't be much difficult. Fig. 3 shows the program flowchart of end device
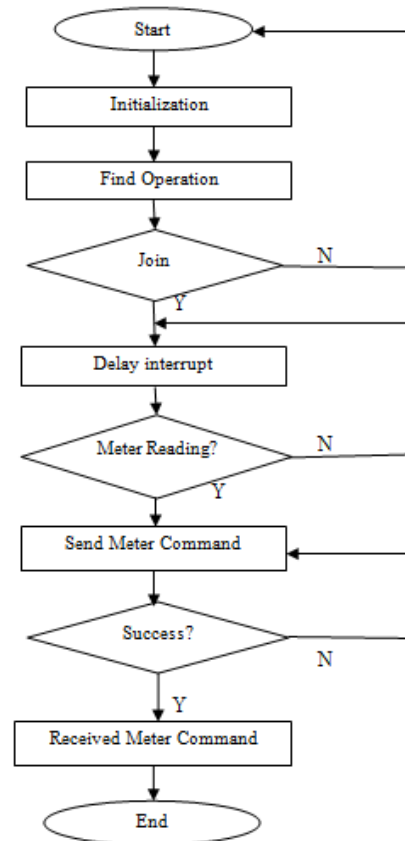

Fig. 3. AMR Flowchart

V. SIMULATION AND RESULTS

Zigbee based Automatic Energy Meter Reading simulation is done by using LabVIEW tool. LabVIEW is Laboratory Virtual Instrumentation Engineering Workbench. It is graphical programming language which allows instrument control, data acquisition, pre/post processing of data. LabVIEW is simple tool, easy to use, easy to modify and faster development time. Main advantage of labview tool is control the hardware by using software. Interfacing of hardware and software is simple in labview. It consists of front panel and block diagram. Fig. 3 shows meter side of front panel. Whatever placed in front panel appears in block diagram. This front panel consists of meter number, voltage, current, power, energy reading, real time clock and overload button. Front panel also has tampers button, send and receive buttons.
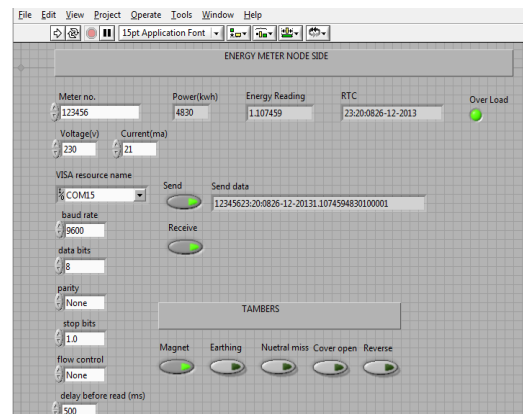

Fig. 4. Meter Side Front Panel

Power is get from voltage and current. By using power value energy meter reading value will be calculate. Send and receive buttons are used for send and receive the values defends on the server request. Fig.4 shows that meter side of block diagram. Whatever placed in front panel will be displayed in block diagram. This is working area of labview. All the calculation made in block diagram only. Labview provides interfacing between system and zigbee by using RS232 cable. Data send and receive only if send and receive buttons are on. Overload button used to show overload condition.
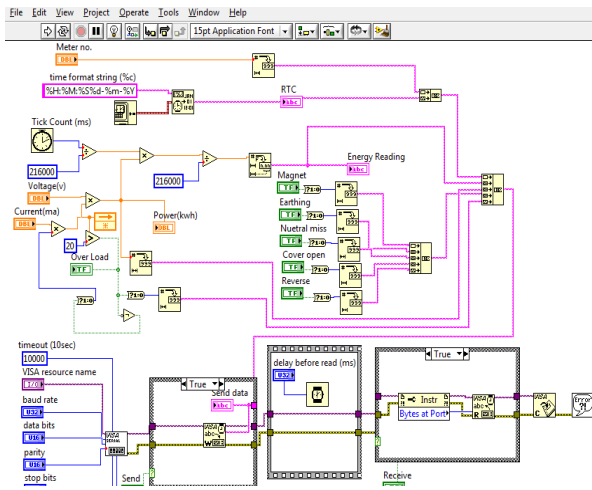

Fig. 5. Meter Side Block diagram

Fig. 6 shows that server side of front panel. Meter side reading is transmitted to server side. Server side will display client transmitted data. If client sides tamper and overload condition is occurs indication given to both client and server.
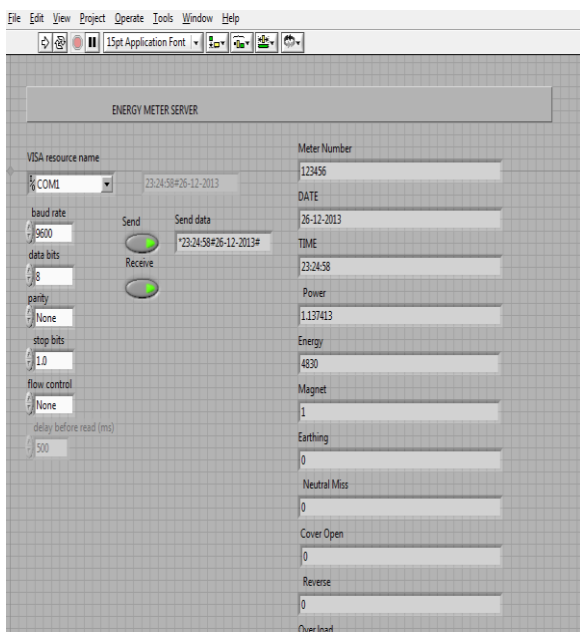

Fig. 6. Server Side Front Panel

Fig. 7 shows the block diagram of server. According to this block diagram, server side front panel shows the results. Server data receive program is done in server side of the block diagram.
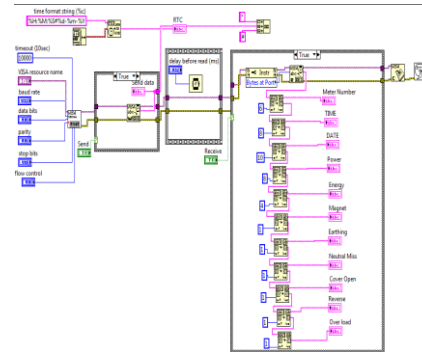

Fig. 7. Server Side Block Diagram

VI.   CONCLUSION

WSN based automatic energy meter reading simulation was done successfully. It provides great performance, very low performance, less interference and low cost. Zigbee based automatic energy meter reading automatically transmit the reading to server. It provides some features like automatic connect/disconnect feature, tamper warning feature and power cut information. It provides benefits to both customer as well as service provider.

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