ZigBee based Data Communication System within Future Microgrids

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Abstract:
Abstract: The customer domain of the smart grid naturally blends with smart home and smart building systems, but typical proposed approaches are "distributor-centric" rather than "customer-centric," undermining user acceptance, and are often poorly scalable. To solve this problem, we propose a detailed architecture and an implementation of a "last-meter" smart grid—the portion of the smart grid on customer premises—embedded in an internet-of things (IoT) platform. Our approach has four aspects of novelty and advantages with respect to the state of the art: 1) seamless integration of smart grid with smart home applications in the same infrastructure; 2) data gathering from heterogeneous sensor communication protocols; 3) secure and customized data access; and 4) univocal sensor and actuator mapping to a common abstraction layer on which additional concurrent applications can be built. A demonstrator has been built and tested with purposely-developed ZigBee smart meters and gateways, a distributed IoT server, and a flexible user interface.

Keywords: Microcontroller board, Energy Meter

I. INTRODUCTION

Energy meter billing is an important part of energy distribution. Each time a person from the authority side come and collect the meter reading and produce the bill to the consumer. The problem with this system is that it requires man power, time consuming and causes error. So there comes the scope of a "SMART ENERGY METER" which will provide bill to consumer both as an SMS along with other inbuilt features such as tamper proof, fault detection etc..The proposed energy meter utilizes a GSM module to transfer energy consumed to the authority side. Similarly authority side also uses these GSM service to send back the bill. Electricity stealing is also common issue now. The main disadvantage of mechanical meter was it was less reliable, less accurate and non-tamper proof. Even the present day electronic energy meters used by electricity board is not completely tamper proof. The proposed energy meter also have the feature of detecting faults in the distribution system, made by checking the status of supply at distribution transformer and that at consumer.

II LITERATURE STUDY

Taking into account that the electricity meters that are still commonly in use today have been in service for over thirty years, it is worthwhile noting that when a technology like this is replaced, it is utterly insufficient to focus solely on the reason for replacement (being variable tariffs). On a list of shortcomings that are experienced with the meters currently in use, the logistic nightmare of meter reading would be at the top. Although Eskom's prepaid electricity initiative eliminates the fortune spent on meter reading and related corruption, it still does not support variable tariffs or any other functionality. Other aspects that are worthwhile addressing are matters such as the need for the utility to forcibly decrease peak load at times by removing power to non-essential loads such as geysers or pool pumps. However, the list goes on.

The main problem is to simultaneously find a way to incentivise power users to improve their power consumption habits (DSM), in effect improving the domestic load profile and secondly to automate meter reading by means of a centralised data storage centre . This could be achieved by a system that will determine the electricity usage of a household and create an electricity bill based on variable tariff rates communicated to the meter. The meter should also display to the user the cost per time unit (R/h) of the electricity currently being consumed and transmit the consumption data back to a centralised point of some sort.

III. WORKING AND CIRCUIT DIAGRAM

An electronic energy meter is presented in this paper which is capable to communicate with central distribution office to provide great facility. Current transformer (CT) is attached with line to measure current flowing through the load and a voltage divider network is connected to the line to measure terminal voltage of load. Then it multiplies them to get power in that instant. Then it processes these values of power to calculate the total power consumed by load. Automated billing of energy meter is made possible by connecting a GSM modem to the energy meter. As the authorities request for the units of energy consumption the same is send to them through GSM service from the energy meter. Once the value reaches the board they prepare a bill and send this to the registered mobile number of the consumer also a hard copy of the bill is mailed to the address if the registered consumer. The bill is prepared using a thermal printer which requires no ink at all, thus saving of money. Automatic connection and disconnection can be done by passing a code such as a password from the board based on bill payment of the consumer through the GSM module. Once this code reaches the microcontroller at the consumers end the supply to the load can be turned off or turned on. In case of industrial consumers the maximum demand has to be recorded

by a higher official from the board. Then this person has to official reset this maximum demand after recording it. This is a time consuming as well as a tedious job. Hence it is possible for the energy meter to transmit this data to the board and store it in a special register. This register can only be opened by a higher official from the board. This can be done by communicating the maximum demand with the board through GSM module. This detail with the energy meter serial number is stored in a particular register of the boards microcontroller and can be only accessed by an higher official using his password . Once this

procedure is done then the maximum demand of the industrial consumer is reset. Detecting a fault in distribution system can be done by communicating between the distribution transformer and the consumer's energy meter. If there is supply in the transformer and no supply in the consumers end it means that there is a line fault between the consumer and the distribution transformer. This communication is done with a RF transmitter and receiver kept at two sides. When this communication interrupts energy meter will send an SMS to authorities and they can take necessary action.
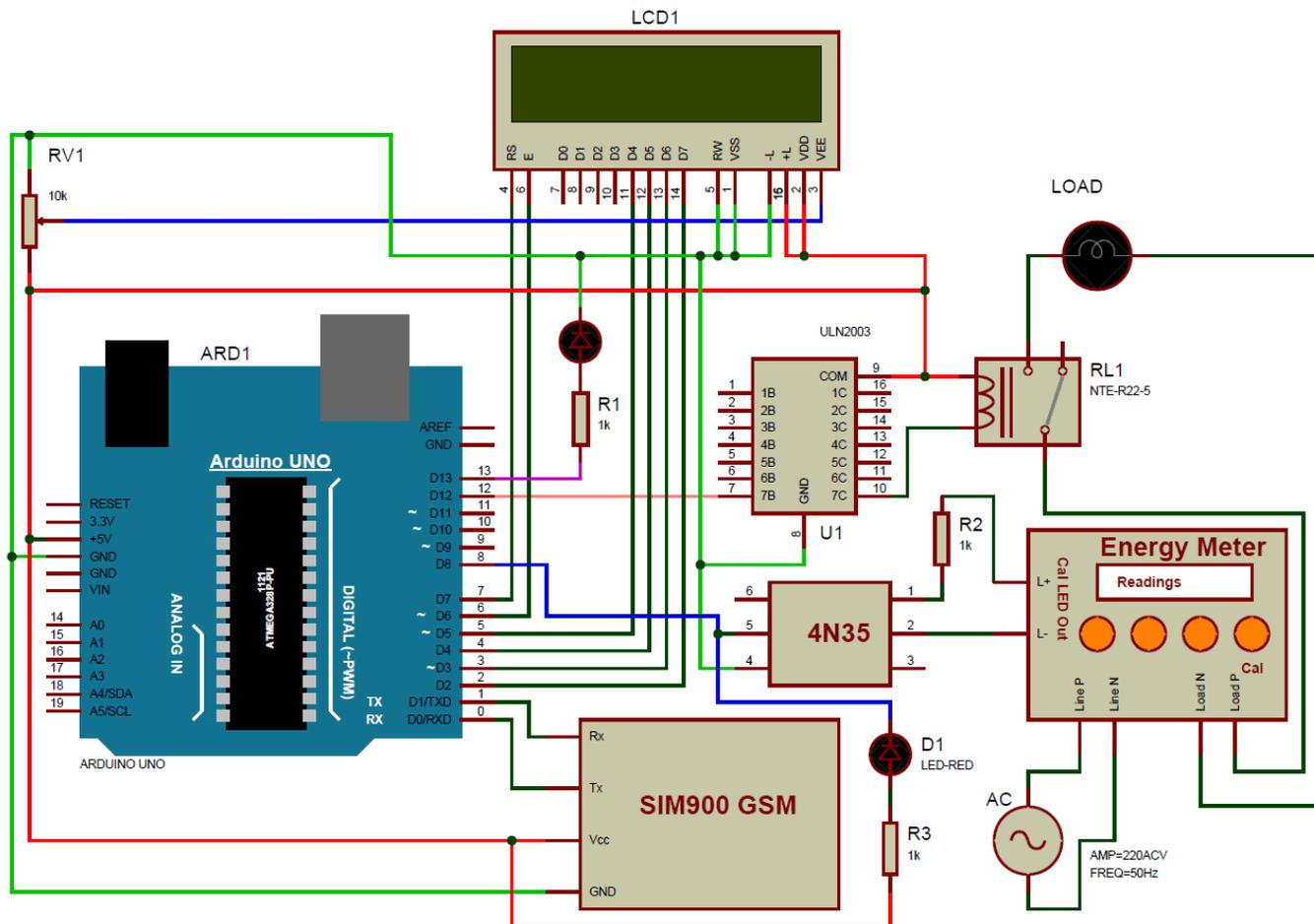

Figure 1 : Block diagram of energy meter

IV.HARDWARE DESCRIPTION

Arduino:
Arduino is open source physical processing which is base on a microcontroller board and an incorporated development environment for the board to be programmed. Arduino gains a few inputs, for example, switches or sensors and control a few multiple outputs, for example, lights, engine and others. Arduino program can run on Windows, Macintosh and Linux operating systems (OS) opposite to most microcontrollers' frameworks which run only on Windows. Arduino programming is easy to learn and apply to beginners and amateurs. Arduino is an instrument used to build a better version of a computer which can control, interact and sense more than a normal desktop computer. It's an open-source physical processing stage focused around a straightforward microcontroller board, and an environment for composing programs for the board. Arduino can be utilized to create

interactive items, taking inputs from a diverse collection of switches or sensors, and controlling an assortment of lights, engines, and other physical outputs. Arduino activities can be remaining solitary, or they can be associated with programs running on your machine (e.g. Flash, Processing and Maxmsp.) The board can be amassed by hand or bought preassembled; the open-source IDE can be downloaded free of charge. Focused around the Processing media programming environment, the Arduino programming language is an execution of Wiring, a comparative physical computing platform.

GSM (Global System for Mobile Communications):
GSM (Global System for Mobile communications) is a cellular network, which means that mobile phones connect to it by searching for cells in the immediate vicinity. GSM networks operate in four different frequency ranges. Most GSM networks operate in the 900 MHz or 1800 MHz bands. Some countries in the Americas use the 850 MHz and 1900 MHz bands because

the 900 and 1800 MHz frequency bands were already allocated The rarer 400 and 450 MHz frequency bands are assigned in some countries, where these frequencies were previously used for first-generation systems.

Relay

A relay is an electrically operated switch. Many relays use an electromagnet to mechanically operate a switch, but other operating principles are also used, such as solid-state relays. Relays are used where it is necessary to control a circuit by a low-power signal (with complete electrical isolation between control and controlled circuits), or where several circuits must be controlled by one signal.

Buzzer

A buzzer or beeper is an audio signaling device, which may be mechanical, electromechanical, or piezoelectric. Typical uses of buzzers and beepers include alarm devices, timers and confirmation of user input such as a mouse click or keystroke. It is used for beep an alarm during overload.

V Defining a Prepaid Energy Meter:

Basically like in a mobile phone recharging, the consumer buys a recharge card and gets some energy units in return of the balance amount. The balance amount will keep reducing for every unit of energy consumed and once zero, the power supply would be automatically cut off. The amount deducted for every unit of energy consumed can be controlled by the distribution unit according to the peak hours.

VI Need for Prepaid Energy Meter System:

The conventional method of electricity billing involves a person from the distribution unit reading the number of units of electricity consumed in the energy meter, conveying this information to the distribution unit and then preparing the bill according to the units consumed for a fixed amount of time. This can prove quite tedious as it involves various tasks like reading, then preparing the bill. Still accuracy cannot be guaranteed as there can be errors in human reading. Even though digital meters are being replacing conventional electromechanical meters and provide much accurate readings, still the problem of deliberately making a false reading can exist (political reasons). Despite this, the task of billing for every consumer is a time consuming job for the distribution grid. Also the consumer can deliberately consume more amount of power than required and still refrain from paying the bill and nothing can be done to severe the electric power supply.

To eliminate all these problems, the most convenient method is making the whole system prepaid similar to a mobile phone recharge or a DTH recharge.

VII. CONCLUSIONS

The complete working model of a smart energy meter was built which uses existing GSM system. The model satisfactorily worked with a two lamp load. Automatic meter reading and billing can be explained well using the system. Financial losses of electricity board can be minimized. Labour charges and effort can be reduced. The error, time delay that occurs due to manual metering can be avoided to a great extent. Electrical line fault detection has been made easy for the electricity board.

Finally but not the least this type of meter supports remote metering which is the future of energy meters.
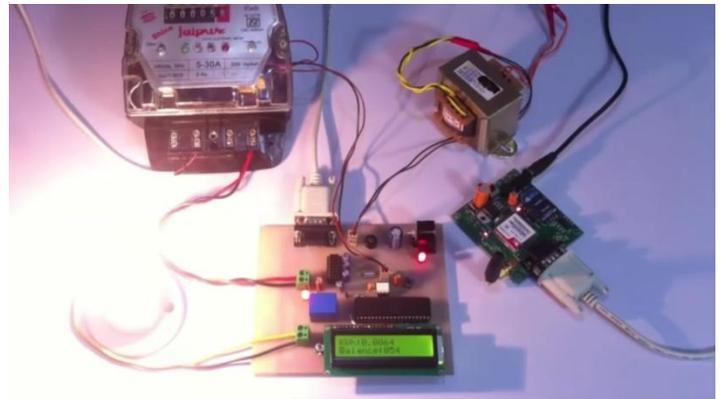

Figure 2: Hardware of energy meter

Figure 3: Hardware of billing station section

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