

Analysis of Implementation Of Various Smart Energy Meters

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ABSTRACT

In the present scenario, there is no option for the electricity board to regulate the load distribution during peak hours. As a result, even today, a number of customers are suffering due to Low Voltage during peak hours. Power is saved at the mercy of customers only during peak hours. A large amount is spend for obtaining the meter readings every month. Meter readers find it difficult to collect the readings from remote areas. The need for increased power monitoring and analysis system in residential and commercial units is becoming important to protect electrical appliances from damage with over voltage/current and save electricity. The wireless energy meter product specification is the energy meter with increased functionality of a monitoring system.

Keywords— The Global System for Mobile Communications (GSM) , Automatic Polling Mechanism (APM), IPC (Inter-Process Communication), Home Energy Hub.

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I. INTRODUCTION

With the rapid developments in the Wireless communication technology by the use of microcontrollers, there are many improvements in automating various industrial aspects for reducing manual efforts. The traditional manual Meter Reading was not suitable for longer operating purposes as it spends much human and material resource. It brings additional problems in calculation of readings and billing manually.

Now-a-days the number of electricity consumers is increasing in great extent. It became a hard task in handling and maintaining the power as per the growing requirements. Presently maintenance of the power is also an important task as 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. 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. These processes are time consuming and difficult to handle. Moreover, the manual operator cannot find the Unauthorized connections or malpractices carried out by the consumer to reduce or stop the meter reading/power supply the human error can open an opportunity for corruption done by the human meter reader. So the problem which arises in the billing system can become inaccurate and inefficient.

II. CONCEPT BEHIND

The meters send the meter readings to a central server. The central server then stores the information in database for analysis and sends the bill to the customer either on the

mobile phone or to their mail accordingly. The data collection can be done very quickly and efficiently. Data can be collected after any desired time interval such as hourly, daily, weekly, or monthly basis.

As there is no human intervention in the entire process, there is no chance of human error and corruption. In the extremely bad weather conditions like heavy snow, rain, storm, etc the system will not hamper on collecting data as long as networks are stable. The development cost of the remote meter will be higher than conventional meter but the electric supplier revenue will increase in the successive months because it will eliminate the possibility of corruption done by the customer or as of a reader. Remote meter can be used in residential apartments and especially in industrial consumers where bulk energy is consumed.

III. VARIOUS TYPES OF WIRELESS ENERGY METER METHODOLOGIES

There are various ways to implement the smart energy meters. Below mentioned are the some of the methodologies which have implemented using various available technologies:

A. Automated Wireless Meter Reading System for Monitoring and Controlling Power Consumption:

In this, the ARM7 LPC2148 microcontroller module takes the data from the energy meter and performs the necessary control operations like breaking the circuit through Relay control unit and the required information is send to the mobile phone via the communication module GSM. The MAX-232 which was inbuilt in the ARM7 is used as a serial communication interface for the GSM modem for transmitting the data from the controller to the mobile phone. In the Load bank section a 60W incandescent bulb is used as a load for the purpose of energy consumption of the user.

The user can obtain the status of the energy consumption and the billed amount by sending the corresponding commands from the mobile phone to the GSM modem. Then it sends the commands to the microcontroller section and the required information is sent to the user mobile through the GSM modem. If the consumer fails to pay the billed amount in time, the disconnection and reconnection can be done by sending their corresponding commands to the controller. Whenever a request is obtained by the user to the controller and the data has been sent the DC buzzer gives a beep sound as an indication that a request has obtained and sends the data to the user.

The proposed system is tested in the place of conventional power meter and achieved good results.

B. A Novel Remote Meter-Reading System Based On Virtual Instrument

In this paper, they have discussed about the remote meter reading system, which is developed in order to monitor the factory district energy automatically, & decrease the production cost. They have made use of virtual instrument and software architecture and the remote meter-reading software which is developed under labview platform. The information

about meter classes and history data are connected to database.

The paper tells that based on certain requirement they have developed the network meter reading measurement. This system is actually based on network technology, automatic meter reading technology and modern management ideas, which is going to realize the energy consumption management which is to be controllable, adjustable and predictable.

They have made use of RS-485 interface that is going to connect to switch nearby through module, which can invert RS-485 bus interface to Ethernet. The paper tells for the establishment of software model, they have provided the facility of system information updating, adding and querying, all this information is stored in the center database. This system is divided into three logical layers:

1. Application layer
2. Meter test component layer
3. Hardware layer

In this paper, they have also mentioned that the front user interface of remote meter reading software uses graphical programming language LabVIEW, while the data storage and management uses SQL server 2005 database.

The paper has also discussed the fault analysis that they have faced while experimenting. When running virtual serial port program, virtual serial ports which is connected to one meter cannot find, but the cable is conducted with measured by the line test meter. The analysis shows that it is due to the problem of signal attenuation between lines. To solve this problem, the Ethernet switch is added between the modules and switches. After creating each virtual serial port and running the remote meter-reading software developed in this paper, real-time monitor accumulated and real-time readings of each meters is realized, and it can be used for analyzing previous energy consumption and estimating energy consumption trend for future.

C. Wi-Fi Energy Meter Implementation Using Embedded Linux in ARM 9

They include design and implementation of a Wi-Fi wireless meter reading system. ARM 9 and Linux are adopted for the implementation of wireless terminal. The communication between the wireless terminals is there and management software is realized by the program based on Winsock. Access 2003 is used for the storage of information. Smart message language is used to design the data structure aiming to make data communication maximally simple and suitable for implementation in low power embedded systems and solve the communication problem between different equipment. This wireless meter reading system is based on Wi-Fi communication technology which is made of Intelligent Meter, wireless terminal, and wireless repeater access point and control center.

D. Intelligent Migration from Smart Metering to Smart Grid:

This paper discusses about the necessity of developing from smart metering to smart grid and utilizing it for consumption management, black-out management, demand response, distributed energy resources, Grid optimization, Load management, technical loss, theft

Detection, quality of service, utilizing the maximum capacity of power line, balancing the distribution network, freeing the distribution network and a great number of other advantages are there. The main aim of this paper is to smart up the grid. The paper has presented the concept that Smart meters must be capable of metering basic and other useful parameters. These meters must be able to provide proper communication ports to respond to requests for

Collecting necessary data, to commands issued by the central access server to switch on or off, and, in case of any manipulation, to report any events and faults. This meter must Have an interface to connect the In Home Display (IHD) for customer awareness. A smart meter should be capable of showing the total cost of the consumed energy. Also, it should be able to register data related to consumption per hour, allowing the subscribers to manage their consumption.

The paper also discusses that using Home Area Network (HAN), indoor displays to show the information about the consumption; this system can inform the subscriber as to how to use energy in peak time, which can reduce the subscribers charge. AMI consists of a set of equipment, networks, computer systems, protocols and organized processes which are employed to collect and send data related to electricity consumption of the subscribers using

Power and distribution grid . The paper also discusses the goal of establishing a Smart Grid. It is actually to transfer electrical energy from plants to subscribers, using digital technology for improving energy efficiency, cost reduction, reliable increase in generation, distribution and consumption.

E. Distributed Event-Driven Simulation Environment for PRIME Based Metering Networks Planning:

In this, a prime network is composed of sub networks, each of them defined in the context of a transformer station. These subnet woks have a tree structure and are composed of two types of nodes: base node (one base node per sub network) and service nodes. These service nodes are points of the mesh of the sub network and they have to register to the base node in order to share their metering information. In this way, a service node has three possible states: disconnected, terminal and switch. They start at disconnected state and pass to terminal state when they establish a connection with the base node. After that, they can promote to switch node to forward the data they receive and allow other nodes that do not heard the base node to connect to it.

In this paper it is presented a simulation environment that takes into account very low level details of the inner working of a PRIME node, which makes it able to provide a high level of realism. As it is related in the next section, the developed simulator is Linux based and take advantage of some Linux IPC (Inter-Process Communication) systems. It employs distributed-event approach [2], which rely in Open- MPI (an

open source implementation of the MPI standard), for accurately simulating real PRIME networks with a precision of up to 10 μ s and a good performance. The simulator uses the real PRIME-stack code that is currently loaded into actual commercial meters and it emulates the working of the main hardware parts of a typical meter.

F. Design and Implementation of Bluetooth Energy Meter:

This paper presented the design of Bluetooth enabled energy meter. They proposed two methods of retrieving the data from the wireless energy meter. They two methods are Automatic Meter Reading (AMR) and Automatic Polling Mechanism (APM). AMR is a mechanism where the Energy Meter sends the recorded power consumption of a household after the specified period of time to a 'wirelessly' connected meter reader, which can be a personal computer (PC). When the wireless link between the Energy Reader, e.g. PC, and a Bluetooth energy Meter is set up, the PC will send a "start" command to the Energy Meter. Upon receiving this command, the Energy Meter will start sending the energy consumption value of the particular household periodically. The transfer will stop when the PC send a "stop" command to it.

On the other hand, APM is another method where an Energy Reader will poll each and every individual Bluetooth Energy Meter automatically regularly in order to get the meter reading of the corresponding households. Master will poll each and every individual Bluetooth Energy Meter automatically in order to get the meter reading of the corresponding household. The Master will then have a record of all the energy consumptions for all the households.

G. Electricity Theft Control Using Smart Prepaid Energy Meter:

In this paper, their main aim is to develop an intelligent metering system, that can be efficiently be used for controlling the amount of electricity consumed by the consumer and through this they monitor that how much power consumption is made by each user.

They have also focused upon the smart card secure solution for a prepaid electricity system. They have made use of microcontroller along with the power meter which provides efficient and control amount of electricity which is consumed by the user.

They have also developed billing software which is web oriented GUI and is specially designed for e-billing , manages all received SMS readings, updates the database regularly and computes the monthly bill amount and notify the consumer his bill details through SMS.

This paper only discusses simulations and models based on data and prepaid meters for determining the feasibility and method of operation for remote check meter. The results shown in this report were simulation based. They include a methodology that insists data processing and data mining methods to detect the customers with abnormal consumption of electricity.

This paper has also defined the spot monitoring of energy meters to verify whether the electricity theft has happened or not and also continuously compares the determined meter reading with the traditional meter reading to avoid the relaying of the values.

This paper also tells that it has implemented the black tracking of algorithm to determine the power deviation between the meter data and delivered power data.

This paper shows the hardware detailed design which consists of a microcontroller, energy meter, relay, buzzer, LCD, smart card reader, relay and LED indicators. The results discussed in this paper are that any designed meter is able to send the usage value at a predefined time and the status is displayed in LCD for the next 5 minutes after sending. Also, the consolidated bill prepared sent to the users mobile, for a particular month of usage, for a particular customer is also displayed.

H. A Brief Analysis of Recent Developments in Smart Grid:

This paper discusses about smart grid which is an advanced version of previous power grids. It tells, the main idea of smart grid which is basically used to reduce power losses, costs of advanced monitoring systems, communication technologies that convert and better power security system. This paper discusses about the existing grid into smarter grid and gives the vision of future smart grid. This paper also discusses about various smart techniques used in distributed generation i.e. Firstly to convert the voltage of DG and secondly to control the frequency of DG. Other than this the paper discusses about smart techniques used in meters. These various smart techniques are:

1. Advanced metering infrastructure.
2. Communication network with multi-level quality of service (Qos) in smart grid.
3. Theft detection techniques used in smart metering infrastructure.
4. Communication technologies for smart metering infrastructure.

So, this paper concludes that for improvement in smart grid as a whole, there is a need for the improvements in constituent parts like smart meter, distributed generation and communication system.

The various conclusions drawn of this paper are:

1. Developments in voltage control can be categorized as
 - a. Modified framework
 - b. Improved equipments
 - c. Better management schemes
 - d. Frequency control should be obtained from fuzzy logic and fuzzy and PSO based technique for PI controller parameter tuning, distributed frequency control strategy and randomized demand response.
 - e. Smart healing capability should be there

IV. CONCLUSION

In this review paper, we have studied various methods for implementation of smart energy meters, and made analysis how they work.

In the paper "Automated Wireless Meter Reading System for Monitoring and Controlling Power Consumption", the user can obtain the status of the energy consumption and the billed amount by sending the corresponding commands from the mobile phone to the GSM modem.

The proposed system is tested in the place of conventional power meter and achieved good results. In the second paper

"A Novel Remote Meter-Reading System Based on Virtual Instrument", it tells about how to monitor the factory district energy automatically, & decrease the production cost. They have made use of virtual instrument and software architecture and the remote meter-reading software which is developed under labview platform. In the third paper "Wi-Fi Energy Meter Implementation Using Embedded Linux in ARM 9", Smart message language is used to design the data structure aiming to make data communication maximally simple and suitable for implementation in low power embedded systems and solve the communication problem between different equipment. In the fourth paper "Intelligent Migration from Smart Metering to Smart Grid", the main aim of this paper is to smart up the grid. The paper has presented the concept that smart meters must be capable of metering basic and other useful parameters. These meters must be able to provide proper communication ports to respond to requests. In the fifth paper "Distributed Event-Driven Simulation Environment for PRIME Based Metering Networks Planning", it presents a simulation environment that takes into account very low level details of the inner working of a PRIME node, which makes it able to provide a high level of realism. In the sixth paper "Design and Implementation of Bluetooth Energy Meter", it discusses that master will poll each and every individual Bluetooth Energy Meter automatically in order to get the meter reading of the corresponding household. The Master will then have a record of all the energy consumptions for all the households. In the seventh paper "Electricity Theft Control Using Smart Prepaid Energy Meter", their main aim was to develop an intelligent metering system, that can be efficiently be used for controlling the amount of electricity consumed by the consumer and through this they monitor that how much power consumption is made by each user. In the eighth paper "A Brief Analysis of Recent Developments in Smart Grid", this paper discusses about smart grid which is an advanced version of previous power grids. It also tells about the main idea of smart grid which is basically used to reduce power losses, costs of advanced monitoring systems, communication technologies that converts and make better power security system.

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