Smart Energy Meter Using LoRa

Sahana.S.B[1], Swathi P[2], Rushali Poovamma PJ[3], Varshitha R[4]
[1, 2, 3, 4] Atria Institute of Technology

Abstract- *Electricity is commonly used for domestic, industrial and agricultural purposes as a fundamental necessity. Smart Meter Reading is an important part of the distribution system that can provide data from energy meter to power authority. The technology in the field of e- metering has gone through rapid technological advancements and there is increased demand for a reliable and efficient Automatic Meter Reading system. Automatic Meter Reading have been widely adopted by power authority worldwide. Nowadays, to reduce the error of human reading, manual meter reading is done and the efficiency of the billing process is improved. Customer transparency, awareness of their energy consumption, cost saving and comfort is offered by smart metering.*

Keywords- Electricity, Smart grid, IoT, LoRa, Utility.

I. INTRODUCTION

Modern society is massively dependent on electricity, and interruptions in the power supply causes a negative impact on the quality of life. Hence, there is a need for effective management of the power supply. Due to the huge difference in energy consumption and energy production, it has become a big subject for discussion. Wireless communication technology with the use of microcontroller has brought a rapid development in the field of technologies like Cloud Computing, IoT, Bluetooth, Zigbee, Wi-Fi etc. The above mentioned technologies have replaced the existing electricity bulky electro-mechanical meters. Smart metering using smart meter provides the consumer with abilities to reduce the bills and manage the power utilization efficiently. Smart meter are effective measuring devices with digital display having the capabilities of recording the amount of consumed power and when, and sending this information to meter data management system automatically for further storage and processing. The service provider appoint employees to take the readings of these meters which intern increases the manual labor. The meter readers will have to record this information monthly by visiting each house on foot. This may result in human errors while acquiring the meter reading, errors during while computing the paid bills and due bills. The utilities require precise knowledge of power, usage pattern, frequency consumption information, bidirectional communication between meters at the end user and the data management system. Smart meter is the possible solution to get the information at the faster rate with higher accuracy.

This Paper includes three sections. Section I gives a brief introduction of Smart Meters. Section II consists of explanation of different papers on Smart Meter. Section III includes Conclusion which gives the overall idea of each paper.

II. LITERATURE SURVEY

The author proposes a system which provides an in-depth analysis of LoRa and its functional components [1]. Some possible solution for enhancement and performances are determined based on the analysis and evaluations. The system aims at designing and implementing a model that enables the end user to obtain their electrical unit consumption without any human intervention. The model senses the blinking of LED on the energy meter. Once a threshold set to 25 blinks of LED, 10 watts of power consumption is transmitted on to the LCD of transmitter and receiver through LoRa.

The author introduces a system that provides a solution to reduce the cyber-attack risks in metering system which may result in leakage of user privacy [2]. A key management protocol is designed to update the keys periodically so that there is a long term security of metering system. The research aims at collecting the meter readings from the smart meters and transmitting these readings back to SAS (Substation Automation System) as per the predefined scheme. The broadcasting is secured by pairwise secret key between the SAS and smart meter. The integrity of the new key is verified if it is equal to the current key efficiently through the device. The performance of the system is evaluated by measuring the inquiry time of the active energy which is used for billing.

The Fryze's approach is used in this paper which includes power terms of two types i.e., active and non-active which divides the load current in terms of active one and reactive one [3]. Active current is calculated using active power and non-active current is calculated using Goertezel's approach. LPF (Low Pass Filter) is used to find the zero crossing time from the input signal as a typical approach while calculation of period is done by averaging the number of measured period. A common chip is incorporated in the smart meter which computes the power consumed by the meter and the meter characteristics is reported.

The deployment expectation and preference of smart phones and its applications as an interface of a human computer to the smart meter has been analyzed [4].In order to simulate the interest in energy efficiency and smart metering subjects, smart metering application could be used. The electricity consumption is constantly monitored by the smart meter. The consumption analysis of the data can be presented at any point of time. The user can have an incentive to save energy and money due to the provision of dynamic tariffs. A prototype for such smart metering application is defined using user central design approach.

In this paper GSM technology is used to modernize the billing system [5]. The optocoupler used by the energy meter generates pure signal based on the amount of load consumed by the user. The op-Amp which gives the fixed output acts as an error amplifier that can be regulated using LM7805. Hence by giving an alert which indicates the information about the number of units consumed by the load, the electricity consumption can be minimized.

In this paper a two-way smart meter implementation approach is used which will be evaluated and analyzed using Techno-economic approach and is implemented using LoRaWAN in PLN Bali [6]. The accuracy and extension of application cannot be accomplished in real time. Henceforth, with the development of technologies electric meters can now be used in both ways for prepaid or postpaid real time remote reading.

The capacity limits of LoRaWAN technology [7] is been analyzed in the application of real LoRa network simulator that includes uplink and downlink. All the meters that are located deep indoor have a network coverage in dense urban areas within 17km with 19 gateways, each of which is placed 1km apart. As soon as the considered band has no traffic, 98% of average targeted Quality of Service (QoS) could be sufficient for UL emission. A fixed channel bandwidth consisting of six orthogonal spreading factors (from SF=7 to SF=12) is implemented by chirp spread spectrum modulation which is derived from one of the spread spectrum modulation techniques. During a fixed time slot a random frame is emitted from each node that follows a pure ALOHA protocol. An interference in signal to noise ratio is determined using an algorithm of adaptive data rate. As per the recommendation by ETSI for GSM 900MHz, adaptations of Okumura-Hata model is used in urban, sub-urban and rural areas.

The hardware architecture and the solutions adopted for communication protocol is illustrated for smart grid management[8]. The completion is done through web based application by energy monitoring for a smart utility. The CAN protocol comprising of data link layer ISO/OSL model is used. Service like multi master capability broadcast communication is performed automatically by CAN controller chip. The working includes SD card which hosts Linux Kernel based operating system. The connected loads which communicates with smart concentrators via CAN bus are continuously monitored by power meters.

A smart meter for automatic metering and billing system is implemented using Zigbee technology[9]. Zigbee is a technology with low power consumption, effective communication and zero traffic, ranging between 10 meters to 2 kilometers. The electric energy consumed and wireless protocol for data communication is measured by smart energy meter having energy meter chip. The exchange of information has become fast, secured and accurate due to the availability of wireless communication. From the total amount of power consumed with respect to time, the corresponding amount is deducted and displayed. For the working of smart energy meter, KEIL IDE, Embedded C and Flash Magic are the software tools used.

Smart meters are used in many aspects such as communication capabilities, calibration, calculation hardware, software and sophisticated measurement [10]. Smart metering implementation and various algorithms has potential to perform various parameters like power system fault detection, isolation and quick restoration with high accuracy. Addition of communication link to the smart grid network is done with the help of Advanced Metering Infrastructure which provides intelligent management, better maintenance, etc. Bidirectional dataflow between the end users and utilities is provided by the Advanced Metering Infrastructure. Consumer is informed about their energy usage. Both the consumer and the industry are provided with energy efficiency gain and better management of billing and consumer related issues are remote controlled. The two functionalities found here are Time-of-user (TOU) and Bi-directional communication.

The shortening of distribution networks and the electric city transmission is proposed by the author [11]. Current and voltage harmonics, micro gates and voltage function are very common stationary and transient events included under power quality disturbances. Measurement method for both single phase and multiphase system are defined by IEC 61000-4-30 but the choice of parameter to be measured is not imposed. A single device integrated with energy counter, one to monitor the production and other to record the consumption is proposed in the system. Implementation of transducer electronic data sheets is done for storing, reducing, identifying the calibration data and

correction data. Intensive and user friendly graphical interface provided by the system. Groups and histograms usage makes the result to be understood easily and comparison between data and information can be performed easily.

A complete end to end solution, minimizing the service errors and helping to distribute quality power is smart metering[12]. Power consumption can be controlled by limiting the user from exceeding power usage in specific time duration. A processing unit involved in user is PIC6F877A. Hall effect current transducer and the step down voltage transformer are two measuring instrument linked to main power line, which senses current and voltage respectively. Enabling of full-duplex serial data transmission between the devices T300 GSM model and the microcontroller or main server is carried out by standard system called RS-232. The wireless communication medium the remote hub and user end device is enabled using SMS and GSM. Faster respond for all small outages results in good customer service and the management and planning processes are improved by energy consumption.

The author replaces traditional meter reading by automatic energy meter reading system which is based on GSM technology[13]. Electronic energy meter of each entity is integrated with wireless communication module to remote access the usage of electricity. Implementation of Watt meter is carried out for data transmission to remote central office on monthly basis which is done through dedicated telephone line. As the proposed energy billing is automatic, human effort is not required. The amount to be paid can be directly known to the consumer during billing process. Storage of data for offline processor can be done using EEPROM, Atmel 24C256. Development of the web protocol database used in Microsoft SQL server 2015 is done using Microsoft visual studio 2018 IDE.

The author outlines various issues and challenges involved during the design deployment, maintenance and utilization of the smart meter infrastructure[14]. It explains how important it is to introduce smart meters in developing countries. All components which are given identifiers must be secured using cryptographic techniques. Components must support “traffic prioritization” i.e., delivery of data is prioritized on the basis of its time and direction sequence and these components should be cost effective. It involves the energy meter based on Bluetooth, which collects and transmits the energy consumption data to central base station. The combination of MAC algorithm with this technology helps in achieving the satisfactory delay times and through put. Therefore, data transfer rate is reduced without affecting the MAC layer. In case of multiple communication devices and to determine the quality of signals TCP/IP technology is used. The total consumption time required for interpreting the data can be reduced and the status of distribution network can be obtained by Parallel processing and implementation of FPGA hardware. Monitoring and controlling the appliances of consumer is employed by power strip smart meters.

A local interface for smart meters is proposed by the author[15]. Also, a specific architecture for a proper consumer oriented implementation is proposed for smart meter network. When it is preferred to use a master slave solution as per the chosen architecture, in power distribution network it frequently happens to guarantee a hierarchical reading which is deterministic. At the concentrator level, the master unit is placed in the distribution substation. Cabling is not required and inclusion of significant data coming from other meters is easy. They are equipped with wireless nodes and for both metering and home automation the protocol is available. Users expect the ability to access the power consumption data through internet which is accustomed by web service usage.

The detection and controlling of energy meter from power theft based on microcontroller Atmega328P is the procedure followed by author[16]. GSM feature is interspersed for dealing difficulties like non-technical losses, billing difficulties and voltage fluctuation complication. Digital energy meter, GSM modem, SSR and Arduino which checks current and voltage sensor readings are included in this proposed system. Using GSM technology, data can be read and sent via wireless protocol, the supply can be managed and controlled to meter through SSR. Using this procedure, monitoring of power consumption, power quality and its accuracy can be done directly by consumers in their mobile. The development of Arduino using IDE works with cross-application concepts included in Java

The author analyzes the performance of proposed smart meter systems and efficient transmission[17]. It also analyzes how the new developments explored by the utilities benefits themselves and consumers by remotely monitoring the power consumption. Power Line Communication is the methodology followed to analyze which includes an arrangement used to pass the data to be transmitted from high voltage transmission lines to low voltage transmission lines. Its aim is to lower the cost and create efficient media of communication. MATLAB and Arduino which runs on MAC, Linux and Windows are the software tools used

The computational needs of futuristic smart energy meter and its performance analysis in Real Time Operating System platform with single core and multi core microcontrollers is studied in this paper[18]. Different types of

its application are implemented as modular tasks by grouping them into different classes by sensing, computation, storage and communication. LPC1768 based Mbed microcontroller and LPC4357 based MCB4357 board are used for implementation of futuristic smart energy meter. The current and voltage is measured and the energy consumption in a household is calculated by the proposed meter and it can also control various appliances on demand. Information regarding the development of sophisticated RTOS is also provided.

In the proposed system the units and details from the energy meter is taken using a GSM model through the interface between the microcontroller and energy meter[19]. Execution of logical functions, storing of the data in SQL database, sending the utility bill to the consumer cell phone number monthly, for cutting down the electricity connection in case of the non-payment of the bill remotely and re-providing the connection immediately after the payment of the bill. This system establishes the billing cycle and energy during the cycles by taking the readings periodically from the energy meter. A PCB which is custom-designed is used as a base for interfacing. The execution and embedded assembly language programming is done using a microprocessor. The PCB is also interfaced with a GSM module for sending and receiving SMSs. For the switching of meters, relay is used and opto-isolator along with PCB is interfaced with the energy meter.

This system proposes real time metering data that leads to leakage of sensitive information[20]. An identity-based aggregation scheme(PIP) in bilinear groups is proposed to confirm the privacy and security of metering data in smart grid. The PIP scheme provides the aggregate of metering data before transferring the data to ESP for decryption. The over-heads of communication is reduced in this way. The metering data which is received in batch is also made able to be validated by the collector. Hence, this is much more efficient than verifying it individually.

III. CONCLUSION

The suppliers database maintenance and bill generation utilities are supported by various existing contemporary systems. This paper[1] creates a similar system but for the user end that provides a variety of purposes that enables the user to take control of their electrical consumption by enabling the user to know their electrical unit usage even without having to call their electricity service provider. A system with equal emphasis and maintenance of related database has been implemented in this project. All the calculations related to the system is handled by the database while monitoring the pulses and equating them to commensurate consumption units is the principal function of the hardware. This system also monitors the electrical usage of appliances continuously, availability of consumption data is provided instantly, history of consumed data available to the user is recorded and guidelines for reducing electricity consumption is also provided. Hence, this system educates the customers by providing real time data on generation and usage of electricity.

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