IoT Based Prepaid/ Post-paid Energy Metering System

Rahul Rajesh B
Sambhram Institute
Bengaluru-560097

Nayab Z Sharief
Sambhram Institute
Bengaluru-560097

K Ezhilarasan
Asst.Professor,
Dept. of ECE,
Sambhram Institute

Mohan Kumar S
Sambhram Institute
Bengaluru-560097

Sourabh Kothari
Sambhram Institute
Bengaluru-560097

ABSTRACT
The currently existing domestic energy meters in India had some swift technological advancements when the static meters were introduced which could calculate the power consumed without any rotary motion by using a discrete IC. This was a remarkable step in the field of electronic metering which reduced a few blemishes of the previously used dynamic meters. Despite this improvement, the procedure carried out to read the energy meters and get the billing details is done manually by an authorized member of the board at the beginning of every month. The metering we propose here automatically senses the used energy, records these readings and stores it in a cloud network where it can be monitored continuously in real time constraints. A system which will provide duteous billing info and monthly usage statistics to the user through a web server will be more suitable in the information age we are today. In addition to this, the system is made flexible by giving the user an option to renovate his conventional post-paid meter to work as a prepaid one. IOT is the technology used to make this interconnected system work in a smart and resourceful way. The system not only solves the problem of manual meter reading but also provide additional features such as power disconnection due to outstanding dues, power reconnection after making the necessary payments, power cut alert, tampering alert etc. instantly.

General Terms
Automatically, Web server, duteous billing, flexible.

Keywords
Cloud network, prepaid, post-paid, IoT, tampering alert, power alert.

1. INTRODUCTION
The system should be designed in a versatile way where it can process the data quickly and also simultaneously upload this data to a web server. This calls for the use of a high speed processor which can be interfaced with a Wi-Fi module. For the power readings and watt hour consumption there is no need to create a separate circuit as the currently used house hold energy meters will more than suffice the needful. A basic display unit is required (for offline) apart from the one present on the energy meter which displays the total lifetime usage statistics. On the contrary, the display unit that we implement is placed a safe distance away from the energy meter and displays monthly usage statistics. We would also require a keypad where multiple options are given to the user. These are the basic materials required for the working model. Power cut alert system and tampering alert system requires the use of different sensors like infrared, LDR, etc. which are readily available in the market. On the software side of things, we need to create a web application which should continuously run to display the usage figures to the consumer anytime anywhere. The whole system is integrated and coded in a way that the reading from the energy meter is accurate enough for the cost calculation and the quality of internet is in the high latency range for quicker uploading.

2. LITERATURE SURVEY
We got the basic working idea to get the appropriate reading from the energy meter accurately and also the idea of an SMS service by a GSM module as implemented by Rahman [1]. We are updating this model by replacing it with a Wi-Fi module so that it includes even more features with the help of internet. The idea of a smart prepaid energy meter is presented in Nabil [2]. We took the idea of prepayment schemes and implemented it in a way that it can also work for post payment schemes as well. The idea of an illegal load recognition is yet to be implemented. The notion behind [3] was to create an intelligent monitoring system with a web application. The idea of using an ARM based processor was taken from this paper. Internet connectivity was realized through Ethernet cabling whereas we updated our system through a wireless fidelity module which performs the same in an even more efficient way. The IOT system working with different types of server and cloud side analytics were presented in [5]. The advanced communication protocols like MQTT with different available brokers were researched on for their connectivity and reliability and the best broker was selected. From [4], similar to [3] a prepaid architecture, a microcontroller based in built new type of energy meter is created using ADE7755. Manisha [6] proposed an interconnected smart grid for automation of the billing process which is being implemented here. The team of Karen Rose [8] gave an overview of how IoT will be useful to connect different sensors and make them smart by using the internet and also the challenges faced using these inter networked devices.

3. PROPOSED METHOD

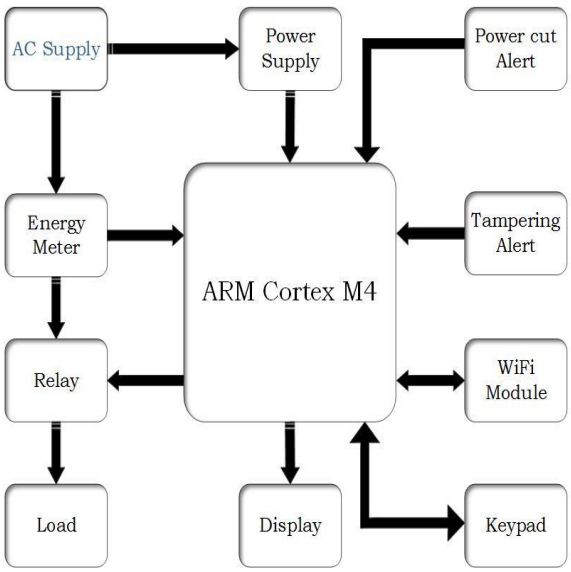

Fig 1: Block Diagram

The hardware architecture of our project mainly consists of an energy meter, an ARM cortex M4, a relay network, a Wi-Fi module, a display system and a security system including LEDs and a keypad. The load is driven by the relay network which in turn is connected to the processor and energy meter. Once the load is turned on, the energy meter starts to store the different parameters such as output power, voltage and current ratings etc. This information is passed on to the **processor unit** (ARM Cortex M4) where the data is used to find the proportional cost of consumption. This data is **encrypted** and passed on to the web server through a Wi-Fi module (CC3100 Booster pack) and is stored in the cloud for **real time monitoring**. This is the basic working of the circuitry. Whenever a customer wants to see the billing information **offline**, he can do so only after proper authorization procedure is followed. The authorization procedure is installed to provide privacy for the user. The security system asks for the user to login using his current password (provided at the time of installation). Once logged in, the user can have access to information regarding his current consumption, billing details etc. The software part of the system includes an integrated web server which details out every possible data provided by the processor. The entire system can be configured to work as a prepaid or post-paid metering system. The actual cost for a KWH consumption varies depending on the area of usage. We are taking the reading from CAL LED which detects the power usage. For the newly available energy meters, the RS232 cable will provide the necessary information. For apartments in urban area, 1 unit = Rs.5/- i.e. 1 blink = Rs.0.003125/. For the prepaid metering system, we use the inverse procedure of the above mentioned pattern. First the amount paid by the customer is loaded into the processor. The energy meter updates the ARM with the current power consumption data. This data is compared with the **prepaid amount** and the remaining usage statistics is displayed onto the server page. Once a minimum amount is reached, a SMS is sent to the user. The customer can refill his/her online power wallet or can change his scheme to post-paid by either online/offline. Offline transformation requires he/she to follow the routine authorization scheme and an option will be provided via LCD display. The meter is refreshed once the prepaid amount has reached its **minimum state**. Power facilities and alerts will be provided for extra days until deadline is reached and the power is cut-off from the load. For the post-paid metering system, we use traditional methods to detect the power flow through the load and calculate the proportional cost to display it on to the server where the customer can view their bills. The customer can view their bill data anytime. The server then provides a **softcopy** of the bill through SMS after a monthly cycle is completed. After this the meter is refreshed and new usage statistics is displayed. The server also monitors **deadline** for bill payment and stipulates necessary alerts. Once the deadline is reached, the system specifies additional days of warning where the processor adds on a fine for each day. Failure to pay the bill results in the processor communicating with relay networks **to shut down** the particular load associated with the respective meter. The load will be provided with electricity only when the bill is paid. The bill can be paid online/offline depending upon the user's convenience.

4. FLOWCHART

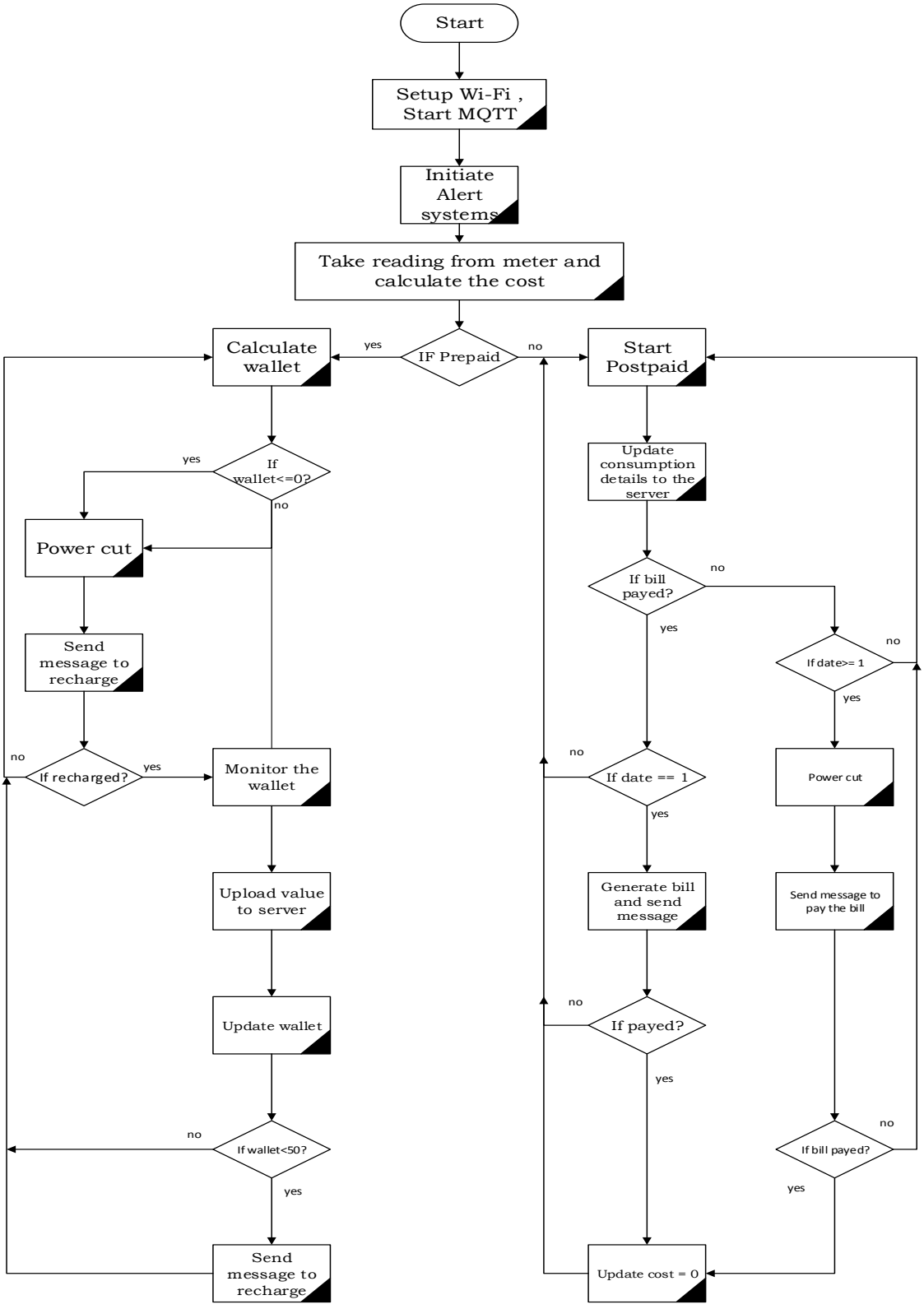

Fig 2: Flowchart

5. EXPERIMENTAL RESULTS

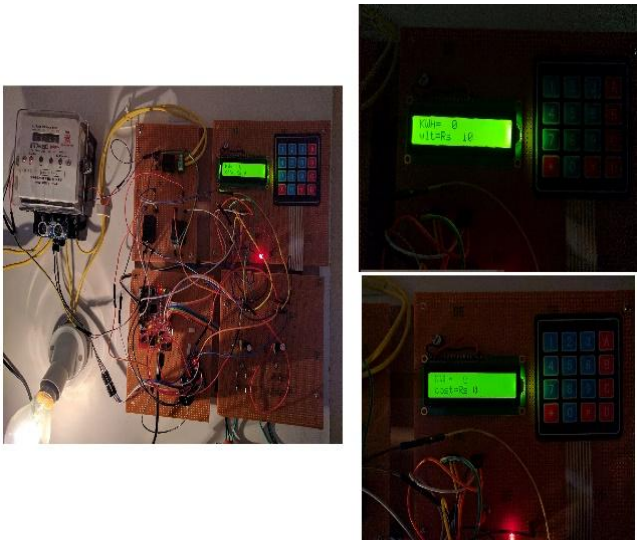

Fig 3: Working Model

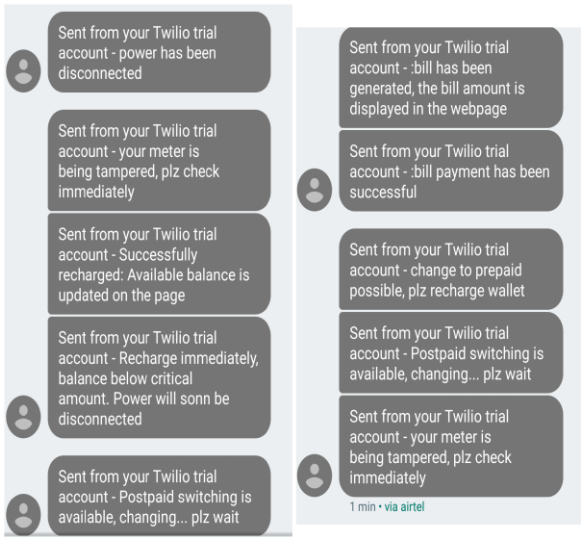

Fig 4: SMS alerts

6. CONCLUSION AND FUTURE SCOPE

Our project required good internet connectivity for reliable and efficient service and is an integral part of smart grid and smart city applications. The entire software system was designed using Node Red palette in IBM Bluemix. This added a versatility to the system that other web servers could not handle. Not only measurements regarding the amount of electricity used is notified, but the meter also allowed the customer to control the maximum consumption using internet communication. In this way the combination of such a smart meter with an appropriate communication infrastructure has provided remote access and feasibility. The system can be enhanced further to detect electricity theft. Also, the design can be modified to work with multiple energy meters in high rising apartments or organizations connected to the same network.

7. ACKNOWLEDGMENTS

I express my sincere thanks to Dr. H.G.Chandrakanth, Principal, SaIT, for providing me with the necessary technical and administrative support. I would like to thank Dr. C.V.Ravishankar, HOD, Department of Electronics and Communication, for his support and encouragement that went a long way in successful completion of this paper work.

I also thank our project guide and coordinator Prof. K.Ezhilarasan, Asst.Professor, Dept. of ECE, SaIT for his suggestions and constant support which has been vital in the positive outcome of this project working and paper presentation.

8. REFERENCES

[1] Md. Masudur Rahman, Noor-E-Jannat, Mohd. Ohidul Islam, Md. Serazus Salakin,"Arduino and GSM Based Smart Energy Meter for Advanced Metering and Billing System", 2nd Int'l Conf. on Electrical Engineering and Information & Communication Technology (ICEEICT) 2015.

[2] Nabil Mohammad*, Anomadarshi Barua, Muhammad Abdullah Arafat†," A Smart Prepaid Energy Metering System to Control Electricity Theft", International Conference on Power, Energy and Control (ICPEC) 2016.

[3] Carmine Landi, Pietro Merola, Giacomo Ianniello,"ARM Based Energy Management System using Smart Meter and Web Server", IEEE 2011 conference.

[4] Golam Mostafa," Development of a Single Phase Prepaid Electrical Energy Meter using 89S8252 Microcontroller Architecture", Proceedings of 2015 3rd International Conference on Advances in Electrical Engineering.Forman, G. 2003. An extensive empirical study of feature selection metrics for text classification. J. Mach. Learn. Res. 3 (Mar. 2003), 1289-1305.

[5] Manisha V Shinde and Pradip W Kulkarni, "Automation of electricity billing process", IEEE2014Y.T. Yu, M.F. Lau, "A comparison of MC/DC, MUMCUT and several other coverage criteria for logical decisions", Journal of Systems and Software, 2005, in press.

[6] Rozita Teymourzadeh, S Mahmud, Ivan and Ahmed J.A. Abueida, "RFID based prepaid power meter", IEEE 2013