Remote Monitoring of Energy using LoRA

[1]V. Vijayarama Raju ,[2]M.Rekha, [3]P.Srividya Devi

[1]Professor,Department of EEE, GRIET, Hyderabad, India.
[2]Assistant Professor,Department of EEE, GRIET, Hyderabad, India
[3]AssociateProfessor,Department of EEE, GRIET, Hyderabad, India

Abstract
The quantity of electric energy utilised by a home, a business, or an electrically powered device is measured by an electricity metre, also known as an energy meter. Electric meters located at customers' locations are used by electric utilities for billing purposes. These metres are often calibrated in billing units, with the kilowatt hour being the most popular one (kWh).The interface of LoRA-enabled energy metre readings with Arduino nano, Heltec ESP32, and RA-02 LoRA module 433 MHz applications, which have applications where one can enable the data of smart energy metres that can be accessed through long-range areas, is discussed in this paper. A wireless communication technology called LoRA is marketed as a long-range, low-power, low-bit-rate infrastructure for the Internet of Things. End-devices communicate with gateways that are connected to the internet using LoRA over a single wireless hop. These gateways function as transparent bridges that pass messages between these end-devices and a central network server.

In addition to being a desirable option for long-distance outside connectivity, LoRA-based Low Power Wide Area Network (LPWAN) Technology is also incredibly practical for use inside of buildings. Additionally, it allows for low-power transmission across a distance of more than 10 kilometres. The sub-GHz radio frequency bands used by LoRA are 433MHz, 868MHz, 915MHz, and 923MHz. In order to access the energy metre reading using our mobile devices, we must first interface the Quasar L&T smart energy meter's RS-485 with a LoRA generic module (consisting of a LoRA module-433MHz coupled to an Arduino Nano on a single board) and a gateway module (Heltec ESP32 LoRA -433 MHz).

Keywords: LoRA, Heltec ESP32, RS485,Arduino Nano, IoT

1. INTRODUCTION

As the use of smart energy metres increases today, all metres, including their upkeep and functionality, should be regularly checked. The operation of the energy metre needs to be continuously monitored; else, there will be a lot of issues. However, the biggest issue is when the task needs to be started properly and followed by a thorough check of the metres[1]. So, LoRA communication can be used to solve this issue. While LoRA WAN controls device connection with the application back-end and offers an end-to-end encryption and authentication method through an established infrastructure typically provided by the gateways, LoRA delivers straightforward point-to-point message delivery[2]. One can use their smartphones to check the reading on the energy metre thanks to LoRA communication. If there is any overcurrent in the metres, which can happen, this can be simply monitored with the aid of the application that can be loaded in smart phones or any other devices like laptops and PCs. This is the other most significant issue that this LoRA connection can run into.

Attempts to manage the power system network with varying levels of automation, managing outages, etc. have been made in response to the increased demand for electricity, distributed generation, integration of renewable energy, and developments in IoT networks[3]-[4]. The smart grid will assist in managing and monitoring different consumer usage parameters on a nearly real-time basis by overlaying the conventional electrical grid with an IoT network that includes smart metres. The requirement for wireless communication is the key component of this system[5]. There is a need of communication protocol that is appropriate for sending data about single-digit unit usage nearly instantly and at high data transmission speeds. We decide to use LORA modules due to their fundamental wireless communication range and communication speed parameters.

The server houses a database that keeps track of unit use, computes bills, and handles a few other utilities. The final state of this system is a user interface that notifies the user on a regular basis about their energy usage and offers a cumulative analysis of their usage in relation to the optimal usage. This should make it easier for every family to adhere to their plan. One energy usage cap.

There are numerous ways to follow the information from an energy metre reading, including Bluetooth modules, WIFI modules, Lans,[7] and more. This study focuses mostly on local area networks, making it simple to assess how well it might be used in larger substations. Due to its very convenient usage and dependable connectivity, the current market is in high demand for the trendy technology known as LoRA. The long range, open frequency band, and low power of LORA communication through the protocols are its key advantages.

The exceptionally low power consumption of the LORA protocols contributes to the end nodes' longer lifespan. The LoRA application uses a 50Kbps data rate. Because LoRA uses an unlicensed or free frequency, communication costs are very low[8]-[10].

Lack of basic regulations and standards in some houses, as well as in other households and even in the workplace environment, is just one of many factors that contribute to resource waste. Standards may take the shape of directions on power consumption or rules governing the use of standby equipment or outdated devices[14]-[15]. The development of sensors, along with their connection capabilities and the analytical capabilities that result from this new data, created the Internet of Things as one way to combat these problems (IoT).

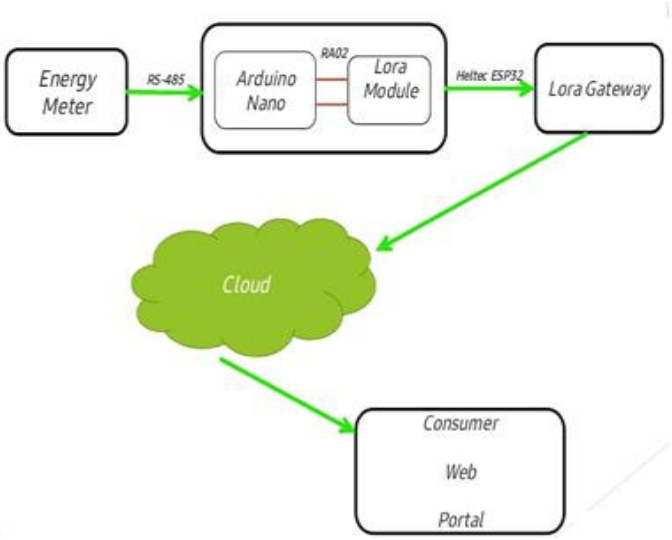


Fig 1: Block Diagram of the system

2. SYSTEM DESCRIPTION:

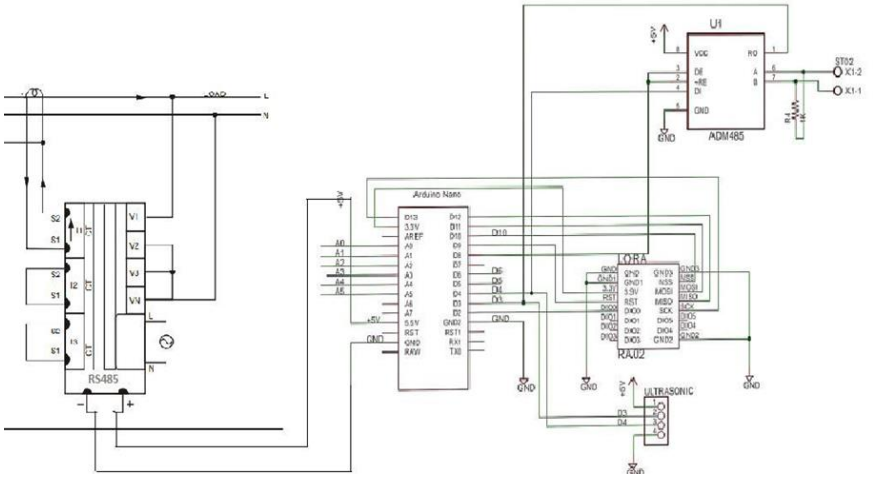
LoRA and Ra02 make up the hardware configuration. Long RAnge is known as LoRA. It allows for low-power transmission across large distances—up to 10 km—in rural areas. It Radio frequency ranges like as 433 MHz, 915 MHz, 868 MHz, and 920 MHz are used by LoRA[13]. Geolocation features on LORA devices are used to locate devices through gateways. For Internet of Things (IoT) devices in a variety of applications, LoRA enables long range connectivity. 433 MHz is the frequency range that is employed. The contact between electric currents flowing in metal conductors used with a transmitter or receiver and radio waves travelling over space is known as an antenna. For serial communication, RS485 is used.

Fig 1 depicts the block diagram of the entire module. The energy metre, which is used in this project as a single phase, two wire connected energy metre, is the first component of the hardware circuit connections, the built-in connections for the RS485 converter and pulse o/p. Currently, packets are transmitted to Firebase by interacting through a Heltec gateway ESP32, packets are sent to LoRA receiver by programming from receiver, and from Firebase, data should be extracted to an app for digital metering. The programme is uploaded to an

Arduino board in order to bring the readings from the energy metres. The RS232 impulses are changed into RS485 by the nano RS485 converter.

3. HARDWARE IMPLEMENTATION:

The Heltec esp32 serves as the LoRA packet's receiver. It makes possible for antenna-based communication. When a programme is applied to it, a WiFi module that receives data from LoRA and transmits it to a firebase. Fig 2 represents the connection diagram of the hardware connection. Here RS485 is a serial communication port similar to the Universal Serial Bus(USB). The readings from the smart energy meter is communicated toArduino Nano through RS485



.

Fig: 2 Connection of the hardware modules

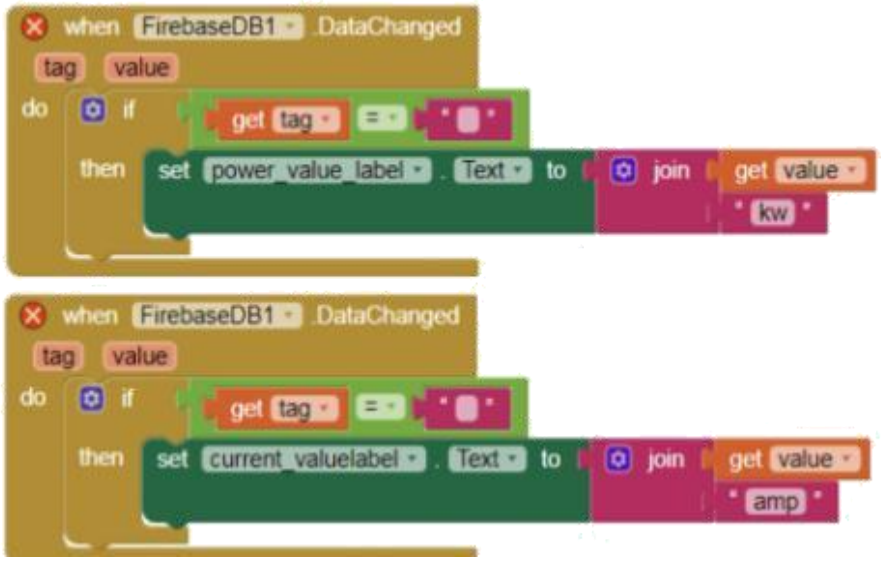


Fig: 3 Scratch program for MIT App

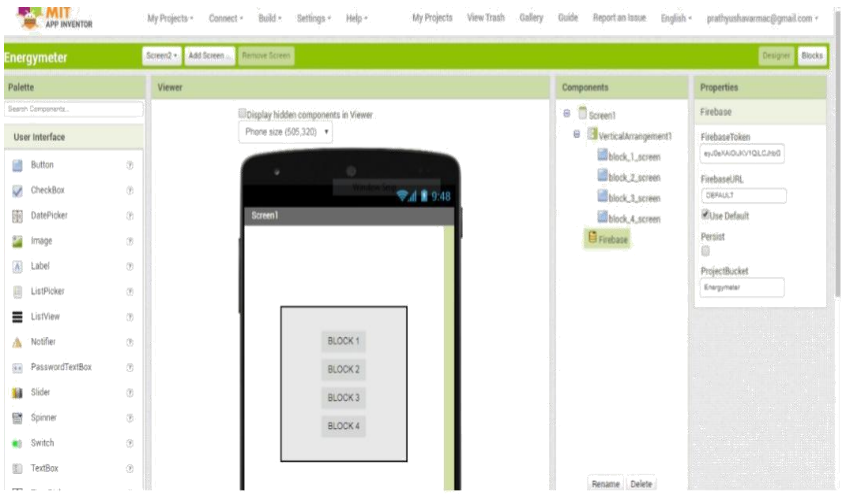


Fig 4 :Mobile application Graphical Interface

Then the signals through the NodeMCU gets passed through the LORA where the information is collected and passed through the LORA gateway (heltec gateway)to the LORA Receiver and to the cloud server where you can watch it from any mobile where we have installed the MIT app.This board is much useful when we are interested in using Wi-Fi and Bluetooth as this are less expensive to Arduino boards. (As there adapters for Wi-Fi and Bluetooth are of high cost). Heltech esp32 board consists of 32MByte Flash, Wi-Fi antenna, and 0.96-inch blue OLED display, lithium battery charging circuit and CP2102 USB to serial chip. Fig 3 represents the scratch program for MIT application of a smart phone i.e the program is written for the action to be taken when the user clicks on the block1,block2,block3 and block4 buttons which is shown in the fig 4. Fig 5 shows the hardware device of the LoRA and the mobile displaying the reading of energy meter.

Fig 5: Visualization of Energy consumption values using LoRA &MIT App Inventor

4. CONCLUSION:

Smart energy meter using LoRA-WAN and IoT applications provides the accurate readings to the user without the accurate wastages in the energy and not consuming time as we can see there are many advantages of this project , like one can watch the power consumed in the home when they are far from home over a wide long ranges. Knowing the precise power consumption of each equipment is possible with mobile electricity monitoring. It can assist us in persuading others to conserve energy, avert any unforeseen appliance failures, and improve operational effectiveness.

References:

[1] U. Noreen, A. Bounceur and L. Clavier, "A study of LoRA low power and wide area network technology," 2017 International Conference on Advanced Technologies for Signal and Image Processing (ATSIP), 2017, pp. 1-6, doi: 10.1109/ATSIP.2017.8075570.

[2] Guibene, W.; Nolan, K.E.; Kelly, M.Y. Survey on clean slate cellular-iot standard proposals. In Proceedings of the 2015 IEEE International Conference on Computer and Information Technology; Ubiquitous Computing and Communications; Dependable, Autonomic and Secure Computing; Pervasive Intelligence and Computing (CIT/IUCC/DASC/PICOM), Liverpool, UK, 26–28 October 2015; pp. 1596–1599.

[3] Oliver, M.; Escudero, A. Study of Different CSMA/CA IEEE 802.11-Based Implementations. Available online: http://www.eunice-forum.org/eunice99/027.pdf (accessed on 8 September 2016).

[4] Margelis, G.; Piechocki, R.; Kaleshi, D.; Thomas, P. Low throughput networks for the IoT: Lessons learned from industrial implementations. In Proceedings of the 2015 IEEE 2nd World Forum on Internet of Things (WF-IoT), Milan, Italy, 14–16 december 2015; pp. 181–186.

[5] M. Saari, A. M. Baharudin, P. Sillberg, P. Rantanen, and J. Soini,"Embedded Linux controlled sensor network," in 2016 39th International Convention on Information and Communication Technology, Electronics and Microelectronics (MIPRO), no. CTS - Computers in Technical Systems. IEEE, pp. 1185–1189, 2016.

[6] D. H. Kim, J. B. Park, J. H. Shin, and J. D. Kim, "Design and implementation of object tracking system based on LoRA," 2017 International Conference on Information Networking (ICOIN), pp.463–467, 2017.

[7] Abu-Rub, H.; Holtz, J.; Rodriguez, J.; Baoming, G. Medium-Voltage Multilevel Converters—State of the Art, Challenges, and Requirements in Industrial Applications. IEEE Trans. Ind. Electron. 2010, 57, 2581–2596.
[8] V. O. Matthews, A. O. Ajala, A. A. Atayero, and S. I. Popoola, "Solar Photovoltaic Automobile Recognition System for Smart-Green Access Control using RFID and LoRA LPWAN technologies," Journal of Engineering and Applied Sciences, 2017.
[9] M. Centenaro, L. Vangelista, A. Zanella, and M. Zorzi, "Longrange communications in unlicensed bands: the rising stars in the IoT and smart city scenarios," IEEE Wireless Communications, vol. 23, no. 5, pp. 60–67, oct 2016.
[10] F. Orfei, C. Benedetta Mezzetti, and F. Cottone, "Vibrations powered LoRA sensor: An electromechanical energy harvester working on a real bridge," Proceedings of IEEE Sensors, pp. 51–53, 2017.
[11] A. J. Wixted, P. Kinnaird, H. Larijani, A. Tait, A. Ahmadinia, and N. Strachan, "Evaluation of LoRA and LoRAWAN for wireless sensor networks," in 2016 IEEE SENSORS, vol. 0. IEEE, pp. 1–3, 2016.
[12] G. S. Ramachandran, F. Yang, P. Lawrence, S. Michiels, W.Joosen, and D. Hughes, "PnP-WAN: Experiences with LoRA and its deployment in DR Congo," in 2017 9th International Conference on Communication Systems and Networks (COMSNETS). IEEE, pp. 63–70, 2017.
[13] K. Mikhaylov, J. Petäjäjärvi, and T. Hänninen, "Analysis of Capacityand Scalability of the LoRA Low Power Wide Area Network Technology," European Wireless 2016, pp. 119–124,2016.
[14] W. San-Um, P. Lekbunyasin, M. Kodyoo, W. Wongsuwan, J.Makfak, and J. Kerdsri, "A long-range low-power wireless sensor network based on U-LoRA technology for tactical troops tracking systems," in 2017 Third Asian Conference on Defence Technology (ACDT). IEEE, pp. 32–35, 2017.
[15] L. Li, J. Ren, and Q. Zhu, "On the application of LoRA LPWAN technology in Sailing Monitoring System," 2017 13th Annual Conference on Wireless On-Demand Network Systems and Services, WONS 2017 - Proceedings, pp. 77–80, 2017.