Remote meter reading in remotly located scattered Agricultural Areas through LPWAN technology – An effective Techno-commercial solution for DISCOMs

Hardik M. Sakariya, BE (Elect.), ACPDM
R & D Engineer
Gujarat Power Research and Development Cell,
Gujarat Urja Vikas Nigam Limited
Research Park, IIT Gandhinagar

R. B. Patel, BE (Elect.), Energy Auditor
Head GPRD and CE(Tech), GUVNL
Gujarat Power Research and Development Cell,
Gujarat Urja Vikas Nigam Limited
Research Park, IIT Gandhinagar

Abstract— Meter reading in the remotely located and scattered agricultural (AG) areas is a big issue for every distribution utilities in India. There are various factors, which cause the poor meter reading accuracy, for this category of the consumers. This, in turn, causes huge commercial loss to the utility and ultimately the utilities have to bear huge revenue loss.

To overcome this issues, Gujarat Power Research and Development (GPRD) Cell- A Government of Gujarat Initiatives- has taken up a pilot research project, of a LPWAN (Low Power Wide Area Network) based metering system. This system can be retrofitted to the existing meters. The LPWAN has main advantage of covering a long range through wireless RF which is best suited to the rural area scattered meter reading. This paper describes the meter reading difficulties, being faced by the DISCOMS for the AG consumers. Why the technological selection for LPWAN was made – its advantages and disadvantages, the comparison of various metering communication technologies and discussion on the case study of a pilot project of remote meter reading by LPWAN is under taken by the GPRD cell.

Keywords—LPWAN, Remote Meter reading, AG Consumers.

I. INTRODUCTION

Use of the IoT devices are increasing at a rapid rate, especially in the developed countries. India, being a developing economy, is also following the same footsteps. Gujarat has taken a very good initiative by implementing the "Suryshakti Kisan Yojana"-SKY. The scheme is for installation of the Solar System in the farm of farmers. The Farmer sell surplus energy to the DISCOM, after his irrigation usage. The Entire communication of all the meters installed in the premises of farmers are on the IoT base.

In India also, the development for laying the LPWAN based IoT network has already started. The giants like, Reliance, Bharti Airtel, Vodafone Idea, who are already having their cell-phone network, are planning for the development on the NB-IoT based LPWAN. Whereas the players like Tata Communications and SenRa are also making efforts to build a parallel network, called Low Power Wide Area Network based on LoRa WAN technology, to drive India's IoT ecosystem. It is certain that metering application can't stay away for more time in this race and it is much needed also.

II. CHALLENGES OF METER READING IN AG AREAS

Meter reading in the AG areas faces various challenges:

1. Consumers are scattered in a very wide area. The meter reading cost at an average is as high as around 60 Rs. per consumer and it will get escalated day by day. (30 Readings/day). Also, the approach to such locations are very difficult, which ultimately leads to blocking of revenue as the electricity bills are issued without actual meter reading in such cases.
2. In case of Gujarat, the AG consumers get 3 Phase power for 8 hours and the schedule gets rotated on weekly bases. (Evening time, Day time, Night time), therefore many a times, when meter reader visits the premises for meter reading, it is found locked. This makes the accurate meter reading quite difficult.
3. Many of the AG consumers are, also, using the automatic switch to turn the motor on, so that they don't have to go to farm or control panel for starting the irrigation. Under the Situation, premises are, also, found locked. This causes, erroneous and faulty billing.

4. In monsoon, the locations of the AG consumers are so difficult to approach that even the hired vehicle can't go to the places of meter reading. Besides, the irrigation by bore well motor is not required, if the rain is sufficient. So, the farmers keep the starter rooms locked and the meter reading becomes difficult.

The AG consumers are largely subsidized (In Gujarat, Ag. Metered Tariff is Rs.0.60/kwh) and hence the bill amount incurred for the power consumption to the consumers are comparatively quite low. However, the per unit landing cost to Discom is around Rs. 5.80 per Kwh. Remaining amount is subsidized. So, the accumulated units of the meter due to improper meter reading is causing high amount of commercial loss.

It was the need of the time that, a cost effective technical solutions should be arrived at which can address all these issues. In the era, where Gujarat has almost replaced all the electromechanical meters by the static meters, the switchover to the total smart meter solutions is not economically viable to the DISCOMs. Also, smart meter technology such as GPRS, Zigbee is not much effective and economically viable in AG rural areas where there are issues of network signal strength.

Intent of the pilot project of remote meter reading for AG consumers:-

1. To explore the technical feasibility of the LPWAN technology to penetrate through long range.
2. To overcome the present issues of manual meter reading, especially in AG areas, where meter reading is less accurate, even erroneous and difficult to take.
3. To ensure communication range and consistency of LPWAN technology in scattered rural areas. To come up with the technology, which has very low running cost, accuracy and very less Capex is required.

III. WHAT IS LP WAN ?

A low-power wide-area network (LPWAN) or low-power wide-area (LPWA) network or low-power network (LPN) is a type of wireless telecommunication wide area network designed to allow long range communications at a low bit rate among things (connected objects), such as sensors operated on a battery. The low power, low bit rate and intended use distinguish this type of network from a wireless WAN that is designed to connect users or businesses, and carry more data, using more power. The LPWAN data rate ranges from 0.3 kbit/s to 50 kbit/s per channel.

There are various LPWAN platforms and technologies developed by various developers across the globe. A few of them are as below.

- LoRa
- Dash7
- Telensa
- Nwave
- Weightless SIG
- NarrowBand IoT (NB-IOT)
- NB-Fi Protocol, etc.

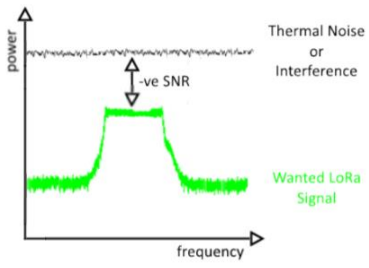
(Source : Wikipedia)

LPWAN technologies have been used in field since a long time. However, as technologies progresses, the demand of IoT based devices also increases. The IoT based devices are used in field of Smart Parking, Agriculture, smart grid, smart home and automation, asset tracking and monitoring, weather detection, etc. With the increasing trend towards smart devices, the demand for the technology, which has low initial and running cost and low power consumption, is also increases. Improvements in silicon technology have make it possible to achieve the above targeted techno-commercial aspects. These take advantage of sub-GHz unregulated radio bands for long-range connections that can be more cost effective than the regulated cellular bands.

However these LPWAN networks require their own infrastructure to be rolled out. However, this has now reached a turning point. Using the sub-GHz band for LPWAN means less base stations are required to support a large number of wireless nodes.

Advantages of LPWAN :-

1. It has quite a low power consumption. So, the battery life is as high as 10-20 years.
2. It has quite a Long Range (2-5 km in urban areas and upto 15 km in rural areas).
3. The installation cost and running cost is quite low compare to other technologies.
4. It has high robustness to interference for quite long range. For ex. LoRa is the spread spectrum based modulation technique, in which, the signal is received with a negative Signal to Noise Ratio. This enables the technology to perform in both high noise and low noise environment quite efficiently.



(Source: Semtech)

Limitations of LPWAN Topology:-

1. It has quite low data transmission rate. The data rates in the LPWAN technology varies from 250 bps to several kbps. This limits the technology from transmitting the bulky data. However, there is a facility called ADR (Adaptive Data Rates) in which High network capacity in a LPWAN network is achieved by utilizing a multichannel multi-modem transceiver in the gateway so that simultaneous messages on multiple channels can be received.

IV. COMPARISION OF VARIOUS TECHNOLOGY

The comparison chart showing key advantages and disadvantages of various communication technology is displayed here.

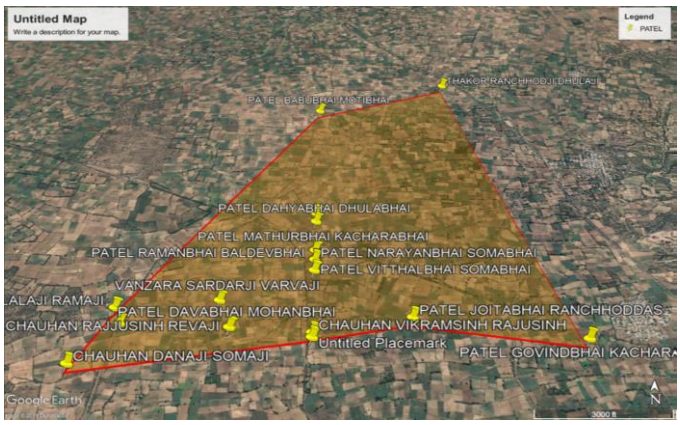
The widely used short-range radio technologies (e.g., NFC, Bluetooth) are not adapted for scenarios that require long range transmission. Medium range communication technologies such as zigbee, 6 LowPAN, etc. require much infrastructure in the application which covers wide area and require low data to be transmitted. Solutions based on cellular communications (e.g., 2G, 3G, and 4G) can provide larger coverage, but they consume excessive device energy and has high running cost.

Therefore, IoT application requirements have driven the emergence of a new wireless communication technology: low power wide area network (LPWAN).

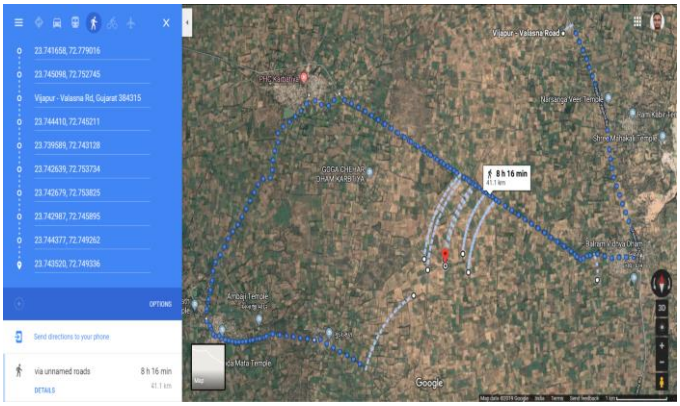
It is quite evident that, LPWAN technologies has edge over the other communication technology for application of remote meter reading in AG areas/rural areas. As the data reading frequency required for the AG areas are not as critical as HT consumers, the low data rates would not hamper the usefulness of the technology. Also, the capex requirement is very low, in case we want to retrofit the module with the existing static meter. The running cost is as low as 20 paisa/node (considering 100 meters cover under single gateway).

V. CASE STUDY

The pilot research project of the LPWAN based communication technology was conducted by GPRD Cell at Ladol Subdivision of the Vijapur division, under Uttar Gujarat Vij Company Limited (UGVCL), Gujarat. The data of consumers and geo locations were gathered for 20 scattered consumers. The aim was to cover the maximum area with the single master device (Gateway). The data frequency becomes the less critical aspect, the total area covered needed to be maximum. The Geo location captured of the consumer location were plotted on the google earth to know the total area covered in the project. The screenshot of the google earth is as below.



The total area of the polygon covered, measured on the google earth is found to be **80, 37,269 Sq. meter** and the perimeter of the polygon is found to be **12,526 meter.** The data of these 20 connections is being captured using single LPWAN gateway. The data frequency is varying from 5 min.-2 hour.

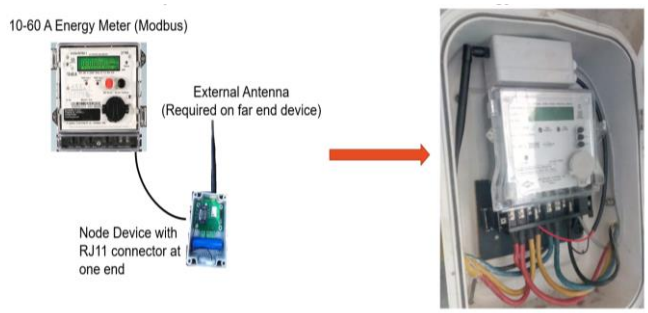


The geo locations of all the consumers were plotted on the google maps and the route distance for meter reading was calculated which comes about 41 km for 20 meters. The data frequency is been monitored since last 3 month and is found reasonably well.

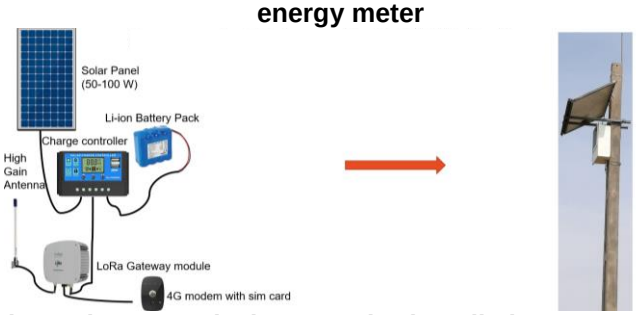
There are two parts of LPWAN system

1. Node device to be attached/retrofitted with each energy meter.
2. Master device to be installed at one location preferably center of the all nodes.

Various components of the system is as below.



(Part-1) Node device - To be attached with existing energy meter



(Part-2) Master device – To be installed at centre of various metering nodes.

VI. Conclusions and Outcome

The AG areas are always challenging for any DISCOMs to take the meter reading as well as vigilance activities. As the areas are scattered over the wide area and has very low Concrete and other obstructions, the LPWAN technology can be very useful. Also, LPWAN has limitation of quite a low data rate, which is not a big issue for an application of meter reading in AG area as the data frequency requirement is not that critical. Although, for 100 no.s of meters, the data frequency can be achieved in range of 1 Hour-4 Hour.

As the mass meter replacement plan has been rolled out in the Gujarat since 2010 in which most of the AG meters are converted in to the static meters. The technological transition from static meter to smart meter for the purpose of meter reading is financially not viable. Also, the disconnection cases in the AG areas are quite low as the bill amount is not that much high compare to consumption of expensive diesel based IC engine used for irrigation and once the consumer becomes disconnected and isolated from the network, he/she has to wait for quite a long period to become the consumer again, if he/she wants to become.

Due to the aforesaid reasons, LPWAN becomes economically and technologically quite viable option for remote meter reading in AG areas.

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Author: Biodata

Sh. R.B.Patel (Gujarat Urja Vikas Nigam Ltd., Vadodara) - B.E. Electrical, BEE-Energy Auditor

He is currently working as Chief Engineer (T) at Gujarat Urja Vikas Nigam Ltd., and as the Head of the GPRD Cell. He has over 30 years of experience in various utilities of Gujarat. Through his career, he has contributed in many research and development related activities for performance improvement of DISCOMs. His area of interest is in Transformer designing, underground system designing, GIS, Renewable Energies and energy auditing and Water and Energy conservation. He was also key inventor in the development of SDT (Specially designed Transformer), PLMT (Plant Load management transformer), WDT (Watch Dog transformer) which are registered under the Intellectual Property Rights.

Sh. H.M.Sakariya (Gujarat Power Research and Development Cell, GUVNL, IIT Gandhinagar) - B.E. Electrical, ACPDM

He is currently working as an R&D Engineer at GPRD Cell, GUVNL. He has, in total, seven years of experience. In the initial stage of the carrier, he has served with ERDA, as an Assistant Engineer for around 3 years, in which he worked in areas of Product Testing & Inspection, Condition monitoring, Fault Diagnostics, Calibration & Quality Management, Energy Audit of various electrical apparatus. Then, he joined PGVCL, in which, he was assigned the role of Lab testing engineer overseeing the operation of testing of various kind of Meters, CT PT unit, etc. Then he was selected at GPRD cell, GUVNL through internal recruitment, in which, he was assigned the role of R&D Engineer, in which, he has made research in the field of Various Power quality related issues of DISCOMs, Meter communications through LPWAN, Renewable Energy projects, Battery Energy Storage Systems (BESS), Improvement of safety by earthing systems, etc.