Asian Journal of Electrical Sciences
ISSN: 2249-6297 (P) Vol.5 No.2, 2016, pp.1-4
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DOI: https://doi.org/10.51983/ajes-2016.5.2.1984

Communication Technologies in Prepaid Smart Meters: A Systematic Review

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Abstract - **In today's world, electromechanical or digital energy meters are used for energy metering and billing. It consumes considerable time and labour. Tradition billing system was slow, costly and lacked in flexibility as well as reliability. Today, accuracy in electrical billing is highly desired. The smart energy meter gives real time consumption as well as accurate billing. Wireless Energy Meter is able to send its data via wireless communication to personal computers or a remote device where monitoring and analysis of the data can be easily made. In smart metering, different techniques in communication system like WIMAX, Zig-Bee and GSM etc are more popular**.

This paper presents a brief review of the work carried out by the various researchers in the field of Advanced Metering Infrastructure (AMI) techniques and also the various communication systems being used in smart metering technology. They are differentiated by various factors involved in daily energy requirements. They are also compared among one another and it is shown by various parameters to demonstrate this comparison.

Keywords: **Communication Technology, Prepaid Smart Meters**

I. INTRODUCTION

Prepaid Smart energy meter is one of the latest technology advancement in the field of measurement of consumption of power useful for the various sections of the society. Pre-payment of electricity enables the users to know how much they are capable of using the electricity. These types of meters are very rapidly being employed in South Africa, Sudan and Northern Ireland [1].

AMI is a system of utility meters that measures the consumption and provides the information to the utility companies, as well as the subscribers interested in keeping the usage cost low, or wanting to supply the electricity back to the grid [2]. For the energy efficiency issues of smart metering devices, most smart metering devices adopt wireless communication such as Zig-Bee and Wireless Sensor Network (WSN) based on IEEE802.15.4 [3].

Over the time AMI has developed metering reading substitute (AMR) to today's two-way communication and data system. This work presents a comparison among different technologies in the area of smart meters which is advanced method as compared to existing methods providing efficient transmission and evacuation of power [4].

II. THE CONCEPT OF SMART METERING AND SMART GRID

The term 'smart grid' is generally used to represent the integration of supply, grid and demand elements connected to a digital upgrade of power grid with a reliable, resilient, secure. It provides manageable standards-based open information infrastructure which can provide two-way communication to offer numerous benefits for both the power suppliers and consumers.The Smart Grid uses intelligent devices and a digital communication upgraded power system to enhance the performance of transmission and distribution grids. Not only the efficiency and reliability can be improved and active roles from end users can be increased in Smart Grid in order to save consumer's money [5].

AMI consists of a set of equipments, network, computer systems, protocols and organized processes necessary to collect and send data related to electricity consumption of the consumers using power and distribution grid. AMI technology enables the utility to do several functions accurately and correctly [6].

III. ADVANCED METERING INFRASTRUCTURE (AMI)

The infrastructure includes smart meters at the consumer end, communication network at different levels of the infrastructure to connect two ends, Meter Data Management Systems (MDMS) and the means to integrate the collected data into software application platforms and interfaces at utility provider or head end [7]. The intelligent multi-agent AMI can be programmed to provide the standard performance indicators of the system viz. Specific, Measurable, Accurate, Relevant, Timely, Evaluative and Recordable. The utility companies install a single device at the conventional position of the concerned utility meter and receive the standard consumption trends at set intervals [2].

The customer is equipped with an advanced solid state electronic meter that collects time-based data. These meters can transmit the collected data through available network. The metered data are received by the AMI host system. Subsequently, they are sent to a MDMS that manages data storage, provides the information in a meaningful form to the utility service provider. AMI enables two-way communication; therefore, transfer of command or price signals from the utility provider to the meter or load controlling devices are also possible [8].

IV. VARIOUS COMMUNICATION TECHNOLOGIES IN SMART METERING

Different communication technologies are used in smart metering. Figure 1 gives summary of various technologies reported in research work in the area, Figure 2 shows overview of the prepaid metering system, Figure 3 depicts frequency details used in between different technologies and Figure 4 shows comparison of distance reached by signals in various technologies [8-14].

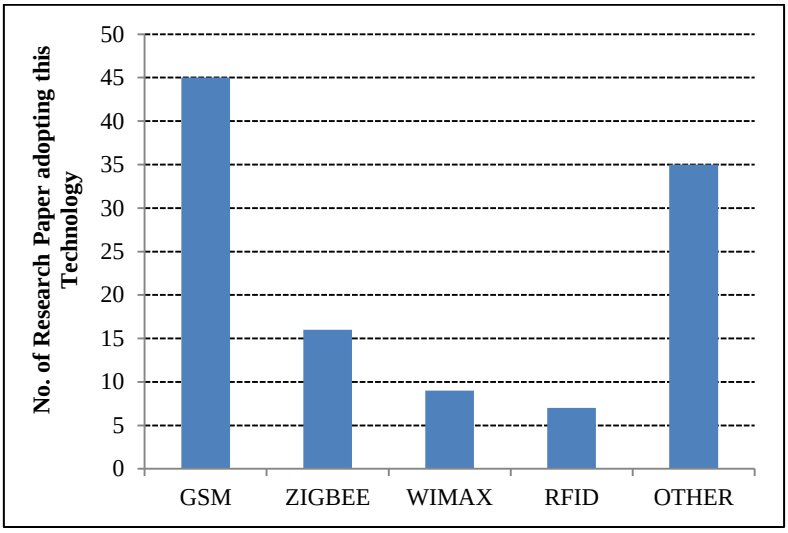

Fig.1 Composition of various technologies in research work in the area of smart energy meters

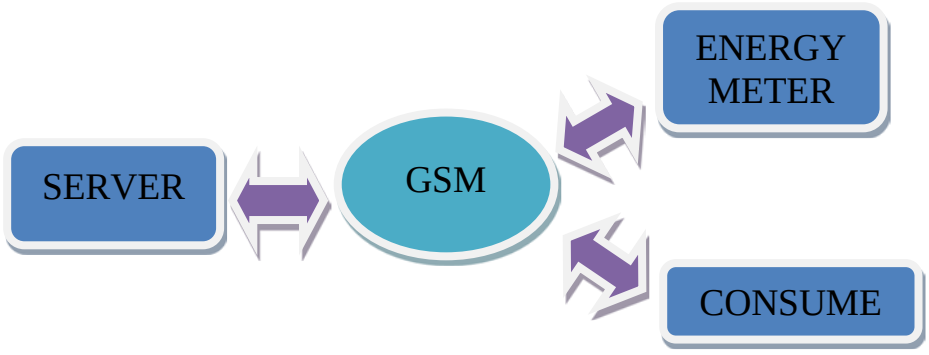

Fig.2 Overview of the prepaid metering system

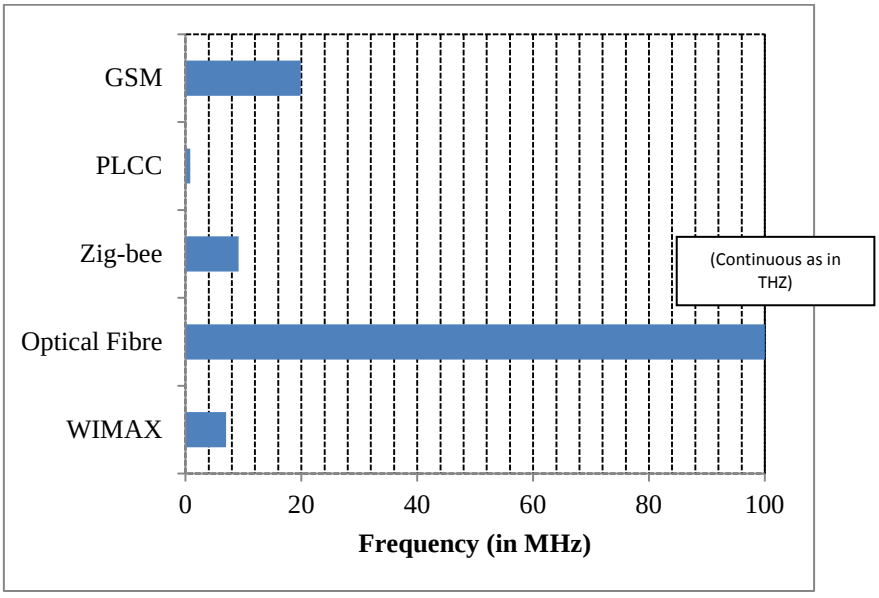

Fig.3 Details of frequency used in different technologies

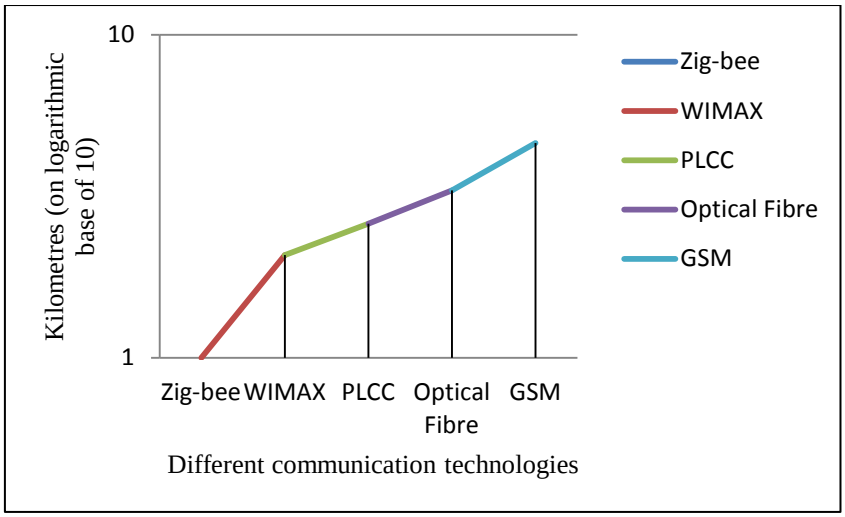

Fig.4 Comparison of distance reached by signals in various technologies

TABLE 1 COMPARISON OF DIFFERENT COMMUNICATION TECHNOLOGIES [15,16,17]

Description	WIMAX	Optical Fibre	Zig-Bee	PLCC	GSM
General Usage	Point-to-point wireless transport for voice, data, video etc.	Because of its advantages over electrical transmissions, optical fibres have largely replaced copper wire networks.	Low data rate, long battery life and secure networking; In-between Wi-Fi and Bluetooth	Also known as power line communication, Broadband over Power Lines; Systems for carrying data on a power conductor for WAN applications	Very wide network reach and can be used easily on remote locations
Frequency Range	2.3, 2.5, 3.5 GHz licensed bands; 450 MHz, 700 MHz also used	180 THz to 330 THz [1]	868 MHz, 915 MHz, 2.4 GHz (unlicensed); Direct Sequence Spread Spectrum coding	1.7-80 MHz Most providers rely on the 1-30 MHz spectrum bandwidth for BPL transmission	1850 to 1990 MHz
Peak single user Data rate	Typical 4-16 Mbps	15 to 101 Tbit/s (1.05 Petabit/s is also achieved in a special case) [17]	20 to 250 kbps, depending on frequency band.	Low-frequency (100-200 kHz) carriers: Few hundred bits per second; Higher data rates mean shorter ranges. Speeds up to 10 Mbps have been achieved.	Upto 2 Mbps
Coverage Capabilities	3-4 miles; longer distances capable with lower bit rates	Upto 100 km on a single network	Up to 50 meters	Distances of more than 15 km can be achieved over a medium voltage network	Several kilometres (in low traffic conditions)
Cost	Moderate	Depends upon the distance and other conditions	Low - intended as a low cost, low power product for low bandwidth applications	High cost of implementation and lack of vendors	Cheapest
Technology Maturity	Mature; 500+ deployments worldwide	Latest with the scope of future developments	Fairly new; specifications ratified in 2004, ongoing specifications still in process.	More popular in Europe than North America	Research is being carried out (4G LTE is the latest technology)
Type of Signal	RF signal	Optical signal	RF signal	Electrical signal	Digital, Circuit-switched network signal

V. CONCLUSION

This paper presents a brief description of various methods used in the area of implementation of smart energy meters and gives a comparison amongst different technologies. This comparison of different technologies in communicating the data between the user and the power utility, shows GSM is an effective medium of communication and a good initiative in the area of smart energy meters. Although the frequency spectrum is low and it is slow, but it is considered keeping in view the low cost structure (cheapest) and several kilometres range. This conclusion has been drawn in keeping the mind the various factors necessary for the consumers in using prepaid smart meter.

REFERENCES

[1] http://networking.layer-x.com [15 April 2016]

[2] Daniel Bondarenko and Hossam Gaber "Simulation Analysis for the Design of High Performance Smart Meter", IEEE International Conference on Smart Grid Engineering (SGE'12), UOIT, Oshawa, 2012.

[3] Kwang-Soon Choi and Sukil Hong, "New Design Approaches and Implementation of Smart Metering System", IEEE ISCE, JejuIsland (South Korea), 2014.

[4] P. Gokula Krishnan and K. Arunachaleswari, "Distributed Generation Grid Infrastructure using Smart Meters Modeled with Renewable Energy Sources and Power Trading" ISSN: 2277-9655, IJESRT, December, 2013.

[5] C. Gao and M. A. Redfern, "A Review of Voltage Control in Smart Grid and Smart Metering Technologies on Distribution Networks", 46th International Universities' Power Engineering Conference, ISBN 978-3-8007-3402-3, Soest (Germany), 2011.

[6] Mehdi Arian, Mohammad Ameli, Vahid Soleimani and Shiva ghazalizadeh, "Intelligent Migration from Smart Metering to Smart Grid", IEEE 978-1-4244-9690, PEAC, Wuhan (China), 2011.

[7] Libiao Qiao, Xiaojun Liu and Baochen Jiang, "Design and Implementation of the Smart Meter in Vehicle-to-Grid", IEEE 4th Conference on DRPT, Weihai (Shandong), 2011.

[8] Alan S. Fung, Farah Mohammadi, and Kaamran Raahemifar and Ramyar Rashed Mohassel, "A Survey on Advanced Metering Infrastructure and its Application in Smart Grids ", IEEE CCECE, Canada, 2014.

[9] Asadullah Khan, Muhammad Ali, Ishtiaq Ahmad, AmjadUllah, Haseeb Ur Rahman and Hafeez Ur Rahman "WIMAX Implementation of Smart Grid Wide Area Power System Load Protection Model in MATLAB/SIMULINK", scientific research Smart Grid and Renewable Energy, vol. 3 no. 4, pp. 282-293, November 2012.

[10] Prachi Sharma, Suraj Pardeshi, Rohit Kumar Arora and Mandeep Singh, "A Review of the Development in the Field of Fibre Optic Communication Systems", International Journal of Emerging Technology and Advanced Engineering (IJETAE), vol. 3, Issue 5, May 2013.

[11] Bourdillon O. Omijeh and Godwin Ughalo, "Design and Simulation of Single Phase Intelligent Prepaid Energy Meter", Innovative Systems Design and Engineering, vol. 4, No.1, pp. 17-29, January 2013.

[12] Stebbins, Wayne L., "Highly efficient energy metering and trend analysis techniques for maximum control", Textile, Fibre and Film Industry Technical Conference, 1992, IEEE 1992 Annual, Charlotte, NC, pp. 4/14/8, May 1992.

[13] T. B. Smith, "Electricity theft: a comparative analysis", Energy Policy, vol. 32, no. 18, pp. 2067-2076, Dec. 2004.

[14] B.O. Omijeh and G.I. Ighalo, "Modeling of GSM based Energy Recharge Scheme for Prepaid Meter", IOSR Journal of Electrical and Electronics Engineering, ISSN: 2278-1676 vol. 4, Issue 1 (Jan. - Feb. 2013), PP 46-53.

[15] Patel Umang and Modi Mitul, "A Review on Smart Meter System", International Journal of Innovative Research in Electrical, Electronics, Instrumentation and Control Engineering (IJIRRRICE), vol. 3, Issue 12, December 2015.

[16] http://techyv.com [Date: 15 April 2016]

[17] https://en.wikipedia.org [Date: 15 April 2016]