International Journal of Research in Engineering and Science (IJRES)
ISSN (Online): 2320-9364, ISSN (Print): 2320-9356
www.ijres.org Volume 10 Issue 3 ǁ 2022 ǁ PP. 68-71

Review Article, Broadband Power Line Communication and Internet of Things in Smart Building Applications

Ali Md Liton[1], Zhou Jia Qi[2], Liu Yi Jun[3]
1, 2, 3 Department of Information and communication engineering, Chongqing university of posts and Telecommunications. Chongqing, china
Corresponding Author: ALI MD LITON

Abstract
Broadband Power Line communication is considered as one of possible communication technologies for the buildings communication infrastructure in the concept of Smart Building. This paper describes the PLC broadband communication and internet of things in Smart building application. Firstly, the necessity of information and communication technologies ICT for smart grid is discussed and channel models for LV power lines especially transmission line based models are explained. The created prototype will be used mainly in Smart buildings applications to increase energy efficiency and power management or in local networks as a possible alternative to existing technologies.
Keywords BPLC, IoT, Power quality, Smart grid

Date of Submission: 09-03-2022 Date of acceptance: 25-03-2022

I. INTRODUCTION

In the era of internet, when ICT services are becoming predictable segments of all sorts of our lives, the essential of communications is increasing day by day. As long as the connectivity of appliances in a home, it is possible to inaugurate a continuous control over such devices and appliances throughout the home. PLC technology is used in high and low bit rate applications. It is frequently limited by one type of wire but can exploit a distribution network and the idea wiring. Electrical utility companies use PLC for low bit-rate data transfer < 50 Kbits in the 3-148 kHz frequency band to monitor some home automation products, such as smart meters. These systems have industrial applications, e.g., large-scale control in automation and manufacturing systems providing a useful common communications network connecting a large number of devices [3] and energy control applications, networking technology for smart grids, smart cities, smart buildings, and smart mobility. These examples demonstrate that there is no need for additional wires to power devices, smart meters in buildings to communicate with the neighborhood data concentrator. PLC can traverse the power line wires to reach the data concentrator. For this reason, most utilities around the world have chosen PLC for their smart grid projects and most cities have chosen permeating adding and PLC for their smart street lighting another point to consider about a PLC network is that changes within the network happen often. Thus, changes in topology or signal transmission affect communication; but the PLC network is able to purge these changes, [4]which makes PLC different from other types of networks. PLC is the technology that can be compared to wireless solutions in terms of the cost of building a communication infrastructure, [5] because power lines are already built and are available everywhere. Thus, the main advantage is the saving of funds for building a communication infrastructure. PLC technology can be divided into two basic variants.

II. BACKGROUND OF BPLC

2.1 Narrowband PLC

This technology operates in the 3–500 kHz frequency band, which includes the European CENELEC band 3–148.5 kHz, the US FCC band 9–500 kHz, the Chinese band 3–500 kHz and the Japanese ARIB band 10–450 kHz [5,6]. According to the data bit rate, this technology can be further divided into.

2.2 Broadband PLC

Broadband technology operates in the 1.8–500MHz frequency band and features data rates at the physical layer from a few Mbps to Gbps. It is sometimes also referred to as Broadband over Power Lines (BPL). Broadband technology standards are covered by several organizations such as Universal Powerline Association (UPA), Open PLC European Research Alliance (OPERA), Consumer Electronics Power line Communication Alliance (CEPCA), Institute of Electrical and Electronics Engineers (IEEE), International Telecommunication Union (ITUT-T) and Home Plug Powerline Alliance.

2.3 Power Quality

The distributed power system has been increased with solar and wind power local facilities, which make the grid more heterogeneous and difficult to be controlled. Thanks to power monitoring systems measuring at many different places through PLC without any additional communication lines could allow a continuous monitoring of the PQ (Power Quality) [7]. A huge issue is also monitoring of power quality in a building complex of a critical infrastructure hospital complex

2.3.1 BPLC and Internet of Things

Services over the Internet of Things (IoT) have changed based on the needs identified for person-to person, person-to-thing, and other interactions, Reduce worldwide energy use. Today´s awareness of climate change requires the current infrastructure to be more efficient. With inventive technologies, our cities can be made more. The concept of smart [8,9]cities is based in part on IoT and PLC with an overall goal of implementing a smart environment based on smart cities, smart homes, smart buildings, and smart mobility. A green or smart building and or home requires inventive solutions for building an infrastructure which makes use of omnipresent computing, IoT, and PLC, including the operation of buildings and or homes will be more simple, safe, reliable, environmentally friendly, and cost effective by using smart devices in conjunction with IoT and PLC. Thus, having a reliable communications network infrastructure, such as a permeating networking system that allows programming of smart devices, is a major concern. These factors make ubiquitous networks and PLC good candidates for a network infrastructure for smart building application because of their ready availability and almost no PLC installation cost.

2.3.2. THE ROLE OF PLC IN THE SMART GRID

There are many examples of applications where PLC can be used for utility applications. In the next subsections, we will review the salient applications of PLC for the Smart Grid at all voltage levels from HV lines down to and within the home

2.3.3 PLC for High Voltage Networks

Although the greatest transformation from today's grid to tomorrow's Smart Grid is expected to take place mostly on the distribution side, also the transmission side will have to undergo progressive changes which some believe will be slower than for the distribution side and will also occur at an evolutionary speed. The availability of a reliable communication network on the transmission side is critical for the support of several applications, remote station surveillance, and power system control. There are established PLC technologies operating over AC and DC HV lines up to 1,100 kV in the 40-500 kHz band that allow data rates of few hundred kbps and play an important role in HV networks due to their high reliability, relatively low cost and long distance reach.

2.4.1 PLC for Medium Voltage Networks

An important requirement for future Smart Grids is the capability of transferring data concerning the status of the MV grid where information about state of equipment and power flow conditions must be transferred between substations within the grid. Traditionally, substations at the MV level are not equipped with communication capabilities so the use of the existing PL infrastructure represents an appealing alternative to the installation of new communication links. In the case of fault location, fault isolation and service restoration, substation IEDs must communicate with external IEDs such as switches, recloses, or sectionalizes.

2.4.2 PLC for Low Voltage Networks

Most PLC Smart Grid applications on the LV side are in the area of AMI, vehicle-to-grid communications, DSM, and in-home energy management. Those applications will be addressed in the next sub-sections customer devices and systems. Furthermore, AMI enables utilities to interact with meters and allows customer awareness of electricity pricing on a real-time basis. On the other hand, smart meters are important tools for the utilities to reduce their operational costs and losses because they provide capabilities that go beyond simple AMR.

2.4.3 Topological Analysis of Power Grids

The study of the topology and electrical characteristics of the power grid provides a two major benefit: (1) it provides a deep understanding of the network dynamics, hence the information traffic in the PLC based network; (2) it complements fading channel models by including topological aspects that affect a PLC-based network. Recent results on the topological characteristics of the transmission side of the power grid were reported in [10,11, 12].These transmission power grid topology has sparse connectivity, well emulated by a

collection of subgraphs connected in a ring, each of which closely matches the characteristics of a small world network.

Smart Grid

A smart grid is an electrical grid that uses analog or information and communications technology ICT to gather and act on information, such as information about the behaviors of suppliers and consumers. These automated actions improve efficiency, reliability, economics, and sustainability of electricity production and distribution while decreasing the cost of power distribution and consumption [13].

LAYER PROTOCOLS

In PLC home networks, the power line media can be accessed by multiple devices simultaneously. To decide which device gets the floor to send its data, a medium access control MAC protocol is needed. There are many existing protocols that can be implemented on the power line network. Carrier sense multiple access, CSMA with collision avoidance CSMA, CA, time-division multiple access TDMA, and hybrid protocols such as TDMA, CSMA are all potential candidates. The most popular wired MAC protocol.

Kind of Smart Grids

Smart grids have three major categories:

1 Power generation **2** Power distribution **3** Power consumption

Smart grid policy in Europe is described in Smart grid European Technology Platform [14]. The roll out of smart grid technology implies a fundamental reengineering of the electricity services, a smart meter is an electrical meter that records consumption of electric energy in intervals of an hour or less and communicates that information back to the electric power company, at least daily, for monitoring and billing and interface to gas and water meters.

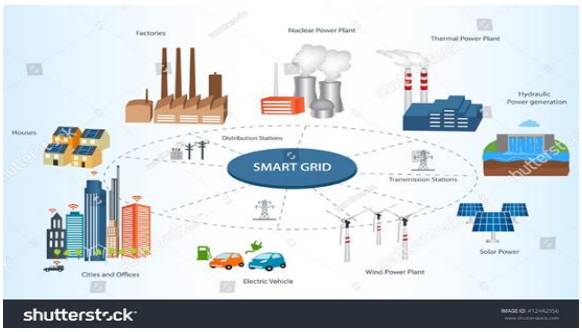

Figure. Smart grids application scenario

III. CHANNEL MODELS FOR LV AND IN HOME POWER LINES

LV PLC systems are categorized into two categories, access network, and connection customers from home to the base station and providing the Internet connection and second in home PLC ensuring LAN connectivity for devices inside the home. Even though these systems are at the same voltage level, they provide different communication services and channels show different [15] communication characteristics. This communication channel has frequency varying and time varying attenuation. Channel models depend on network topology and loads which are connected to the distribution branches. This channel medium has colored background noise depending on location, narrowband noise caused by AM broadcast signals and impulse noise caused by switching operations. Due to the noisy loads, there is also interference in the medium.

3.1 BPLC and IoT Connection in Smart Building

Traditionally, power lines are used for conveying electrical power to devices. Power lines were not designed for delivering high-frequency signals, so the electrical and frequency response requirements of a power line are not as critical as those of data network cabling. The poor quality of a power line is not ideal for signal transmission because the channel contains noise and interference. The medium is made of different conductor types; therefore, a variety of characteristic impedances will be encountered. Building automation and automated building control systems are nothing new- facility owners, operators and managers have long benefited from the operational and cost efficiencies of automating infrastructure such as security, lighting, heating, ventilation and air conditioning HVAC, and more. Smart buildings, which connect building operations through the Internet of Things IoT, simplify tasks like controlling building temperature, security and maintenance through mobile devices and computers. The types of IoT sensors used in facilities management, building automation and smart

building applications are limited only by your imagination. Information flows started and high demand for IT OT convergence arose.

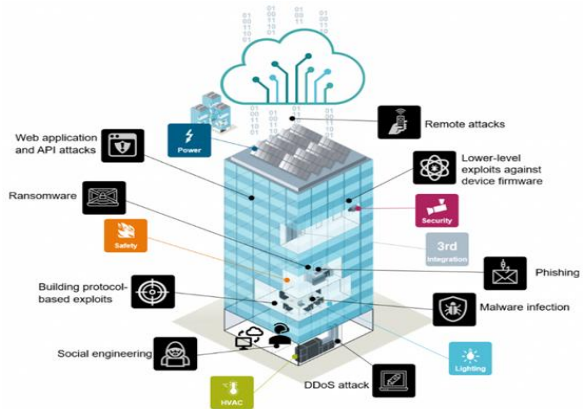

Fig. PLC with IoT Base Smart Building

3.2 Benefit of smart building application.

1 Improve building energy efficiency and sustainability
2 Reduce maintenance costs with predictive maintenance
3 Optimize space utilization
4 Enhance tenant security, comfort and safety

IV. CONCLUSION

Power Line Communication and Internet of Things can be seamlessly embedded into a smart building application for smart grids, a major factor in the adoption of the new smart technology paradigm of smart cities, smart homes, smart buildings, and smart mobility over the next few years. Thus, Ubiquitous Computing, Power-Line Communication and Internet of Things are ideal for a problem oriented solution for smart building applications.

REFERENCES

M. Daoud and X.
[1]. "IEEE Draft Standard for Broadband over Power Line Networks: Medium Access Control and Physical
[2]. FERREIRA, Hendrik. Power line communications: theory and applications for narrowband and broadband over power lines. Chichester: John Wiley, 2010, xxvii, 507 s. : il. ISBN 978-0-470-74030-9.
[3]. Power line communication apparatus including AC power socket US9172433B2 Available from URL: https://patentimages.storage.googleapis.com/8e/cd/e8/5529a49258b639/-US9172433.pdf
[4]. H. Meng, Y. L. Guan, and S. Chen, "Modeling and analysis of noise effects on broadband power-line communications," IEEE Trans. Power Del., vol. 20, no. 2, pt. 1, pp. 630–637, Apr. 2005
[5]. "Powerline Telecommunications (PLT); MIMO PLT; Part 1: Measurement Methods of MIMO PLT," February 2012.
[6]. R.Hashmat, P. Pagani, A. Zeddam, and T. Chonave, "A channel model for multiple input multiple output in-home power line networks," in Proceedings of the IEEE International Symposium on Power Line Communications and Its Applications (ISPLC '11),pp. 35–41, April 2011.
[7]. L. Selander, "Call Me Call Me for Some Overtime - On Organizational Consequences of System Changes," Dissertation, The School of Economics and Management, Lund Univ., Lund, Sweden, 2008.
[8]. Al Dakheel, J.; Del Pero, C.; Aste, N.; Leonforte, F. Smart buildings features and key performance indicators: A review. Sustain. Cities Soc. 2020, 61, 102328. [CrossRef]
[9]. Horvat, G.; Balki´c, Z.; Žagar, D. Power Line Communication throughput analysis for use in lastmile rural broadband. In Proceedings of the 2012 20th Telecommunications Forum(TELFOR), Belgrade, Serbia, 20–22 November 2012; pp. 245–248. [CrossRef]
[10]. Kakimoto, Y.; Yoshikawa, H.; Jogo, T.; Wakisaka, T.; Kozako, M.; Hikita, M.; Sato, H.; Tagashira, H.; Soeda, M. Construction and Experimental Verification of Novel Online Partial Discharge Monitoring System Using Power Line Communication. IEEE Trans. Dielectr. Electr. Insul. 2020, 27, 2165–2171. [CrossRef]
[11]. Smart Grids European Technology Platform, www. | smartgrids.eu, Retrieved October 11, 2011
[12]. J. Torriti, Demand Side Management for the European Supergrid, Energy Policy, Vol. 44, pp. 199-206, 2012.
[13]. G. Bumiller, L. Lample, H. Hrasnica: Power line communication network for large scale control and automation systems, IEEE Communications Magazine, Vol. 48(4), pp. 106.113, 2010
[14]. W. Ahmed: Power line Communication Energy Management System, Project work at TU Clausthal, Fall term 2013
[15]. Al Dakheel, J.; Del Pero, C.; Aste, N.; Leonforte, F. Smart buildings features and key performance indicators: A review. Sustain.Cities Soc. 2020, 61, 102328. [CrossRef]