NOVATEUR PUBLICATIONS
INTERNATIONAL JOURNAL OF INNOVATIONS IN ENGINEERING RESEARCH AND TECHNOLOGY [IJIERT]
ISSN: 2394-3696
VOLUME 6, ISSUE 12, Dec.-2019

THE COMMUNICATION TECHNOLOGY (PLC) ON SMART GRIDS AND A SAMPLE APPLICATION

MEHMET CINAR
Tatvan Vocational School,
Bitlis Eren University, Bitlis, Turkey
* mcinar@beu.edu.tr

ABSTRACT
Conventional electricity networks are established on the basis of the transmission of electricity produced in power plants to the end user through transmission and distribution systems. Energy and information flow in these systems is one-way. Two-way energy and information flow has been mentioned in the concept of smart grid, which has been put forward especially after the 2000s. Smart grid; It is an efficient, reliable and self-healing power system in case of emergency. In the recent years, smart meters have been used in the establishment of smart network infrastructure. Smart meters are capable of transmitting instantaneous measurement values to the system center, allowing the remote meter parameters to be changed-updated using any communication infrastructure. One of the technologies enabling smart meters to communicate with the system center is PLC (communication over power lines). Powerline communication technology is a method that allows the exchange of information over the existing energy network without the need for additional wiring. PLC technology is thought to be an indispensable part of smart grid with its wide coverage, low cost and high addressing capabilities. PLC; By using the existing energy distribution line, applications such as voice and data transmission, automatic data collection, load control and remote control of systems between receiver and transmitter systems are aimed. Especially with the PLC technology, it is aimed to reduce the loss and leakage rate by installing the meters in the houses in rural areas and reading the meter values remotely. In this study, PLC technology is mentioned. The advantages and disadvantages of PLC's communication band ranges, usage areas and other communication techniques are detailed. A sample application is explained.

KEYWORDS: Smart Grid, PLC, Communication techniques

INTRODUCTION

One of the biggest problems in the field of energy today is that energy resources cannot be used at desired efficiency levels. The main reason for this is that the supply / demand balance cannot be adequately controlled and the surplus energy produced cannot be stored. Especially for renewable energy sources, these problems are more important and stand out as the main factor in the energy efficiency. In order to overcome this problem and increase efficiency, the energy supply / demand balance should be continuously monitored and predictable. At this point; In order to determine the needs of providers, distributors and users, to observe consumer behaviors statistically and to make predictions about these behaviors, the concept of smart network has been proposed. [1]

Within the scope of the establishment of smart network infrastructure, many countries around the world have started to use smart meters. Smart meters are meters that allow remote meter parameters to be changed / updated using any communication infrastructure and capable of transmitting measurement values to the system center instantly [2]. Nowadays, smart meters that support many wired and wireless communication infrastructures and standards are available in the market. These meters have various advantages and disadvantages compared to the communication infrastructure they support. When the features such as costs, coverage areas, expansion features and ease of integration to developing new technologies are taken into consideration, PLC (communication over power lines) structure is the most preferred communication infrastructure in smart network institutions. With the advancing technology, communication bandwidths and communication distances have been increased to cover larger areas. With the development of the Internet of Things concept, it is expected that the importance of smart network regions will increase and the structure will gradually turn into a smart city concept.

Under these developments, it is seen that PLC technology will be an indispensable part of smart networks with its wide coverage, low cost and high addressing capabilities [3].

THE STUDY

Power Line Communication (PLC) is a system that uses conductors used for electricity distribution as well as data transmission. PLC systems are based on the idea of networking without the need for new cables. Powerline Communication (PLC) systems are attractive because of the fact that there is an electrical network in almost every place where computers are located and the network connection can be established by using an electrical outlet close to the computer.

2.1 HOW DOES PLC WORK?

PLC systems operate by transmitting a carrier signal on power lines. This modulation and demodulation is carried out by means of terminal devices connected to the power supply. Alternative electric current and radio waves at different frequencies can be transmitted without interfering in data transmission. Power Line Communication (PLC) technologies use different methods of networking such as Passport and PowerPacket.

2.1.1 PASSPORT METHOD

The first Passport technology developed in HomePlug technology used Frequency Shift Keying (FSK). In this method, two separate frequencies, one for "1 biri and one for" 0 ", were used for data transmission. The frequencies used were in a narrow band just above the frequency range in which line interference occurred.

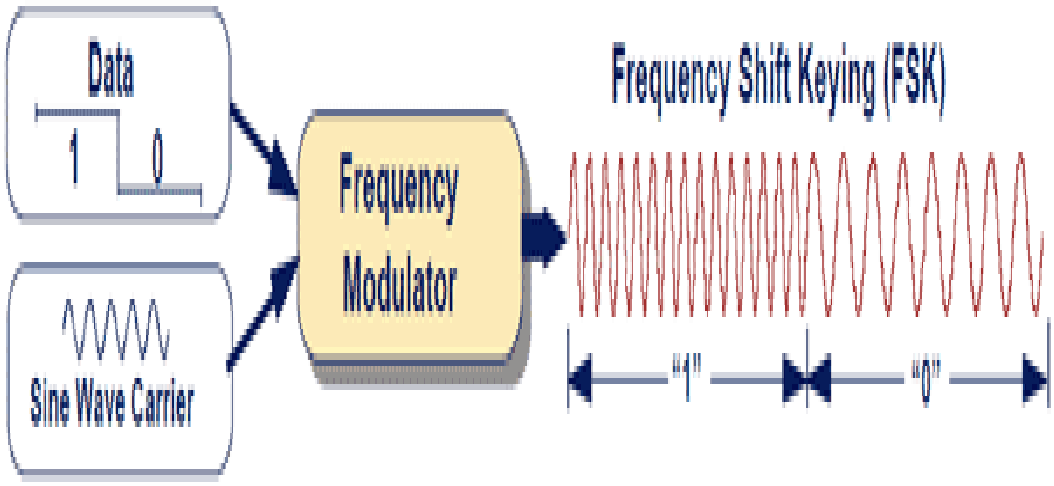

Figure 1. Passport Management System

The main disadvantage of this method was that it was affected by electrical fluctuations and decreased performance when multiple electrical devices were used at the same time. Since only two separate frequencies are used instead of multiple frequency channels, the data flow can be interrupted when one of the frequencies is subjected to external influences; thereafter, re-requesting and retransmission of data that could not be received by the receiver caused poor performance in the network. As a solution to this problem, line healing power strips are used between the computer and the electrical outlet to reduce noise. Another problem with the Passport method was poor data security [4].

2.1.2 POWER PACKET METHOD

PowerPacket technology has solved many of the disadvantages of the Passport method. With this technique, the frequency range of 4.3–20.9 MHz is divided into 84 separate channels by Orthogonal Frequency Division Multiplexing (OFDM), a kind of frequency division multiplexing method, and data packets are transmitted simultaneously on each channel over several carrier frequencies. With PowerPacket technology, the data transfer rate can reach up to 14Mbps.

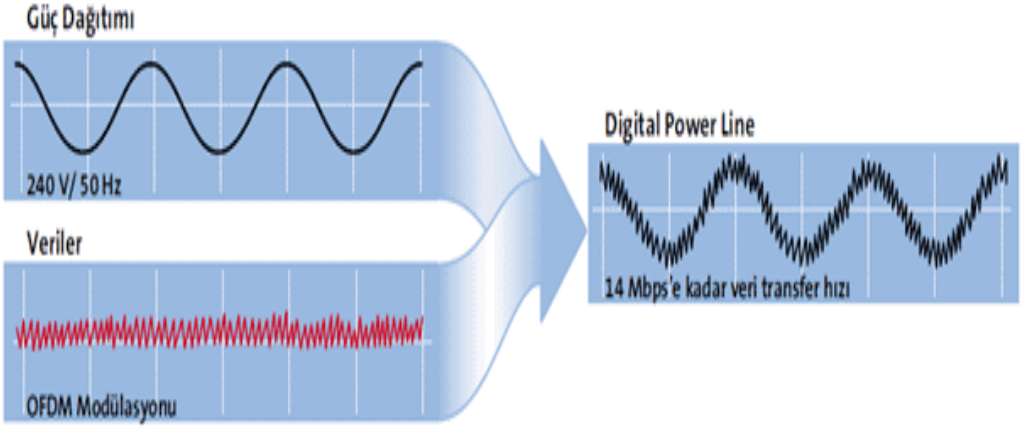

Figure 2. PowerPacket Management System

Electromagnetic noise may even occur due to the use of more than one electrical device at the same time on the power line, and the operation of a high-power device near the cable. However, unlike the Passport method, which uses only two frequencies for data transmission, this does not interfere with the entire data transmission in the PowerPacket method. Each frequency is monitored by a dedicated PowerPacket integrated circuit against interference and sequential data loss. If a voltage pulse or noise in power use disturbs one of the frequencies, the channel's SNR (Signal to Noise Ratio) decreases, the transmission rate slows but does not stop. The PowerPacket integrated circuit recognizes this distortion and the problem is largely solved by ensuring that the data transported at this frequency is automatically jumped to another carrier frequency instead of the problematic frequency, ensuring the continuity of the data flow without any data loss. Some other advantages of PowerPacket technology are; Elimination of the problem of incompatibility with non-Windows platforms, greatly reduced the effect of old cables, line voltage and frequency independent operation, can be listed as solving the security problem with encryption [5].

2.2 PERFORMANCE OF PLC COMMUNİCATİON SYSTEM

Considering that hundreds of homes are usually connected to a single transformer, theoretically the network is considered to have a very wide coverage. In practice, however, there are a number of natural obstacles. For example, even the electricity meter at the entrance of the house weakens the data signal beyond the meter, so that it cannot be received without problems. Especially in PLC technology with limited connection quality, every Home-Plug device added has a negative effect on performance. Data packets are lost if two clients' access requests conflict at the sender location on a network. When this is detected by the recipient, it is requested to resend the missing or problematic packets. To prevent further conflicts, the sender waits for a randomly determined period before attempting a new send. Since each added device implies a potential conflict, the probability of problematic transmission of packets increases, which affects the data transfer rate.

2.3 SAFETY OF PLC COMMUNİCATİON SYSTEM

As mentioned in the Performance section, the coverage area of PLC networks is usually on the inside of the electricity meter. Theoretically, someone who wants to infiltrate the network needs to reach the power line to which their computers are connected, and in this respect PLC networks can be said to be very secure. However, in practice, if the cables are laid in the same pipe as the neighbors, uninsulated power lines can be affected and there is a potential risk that your data can be accessed from the neighboring power lines. However, it cannot surpass the electricity meter of PLC networks. The fact that the system is not very convenient to network with the other side of the meter does not mean that no data can pass beyond the meter. Therefore, relying on the cabling structure and not using any encryption will pose a security risk. In the Home-Plug standard, security is provided by 56-bit DES encryption or by 128-bit AES encryption [6].

2.4 APPLİCATİON AREAS OF PLC COMMUNİCATİON SYSTEM AND A SAMPLE APPLİCATİON

PLC; networks can be used as an alternative to wireless networks that are weakened by walls in offices and schools, as well as for supporting wireless networks. PowerPacket technology is compatible with wireless

and HomePNA (Home Phoneline Networking Alliance) solutions, making it ideal to use powerline networks as backbones in multi-technology networks. Although wireless networks are "wireless erişim, access point devices must be plugged in. It can integrate wireless access points into the PLC network without the need for a connection other than an electrical outlet. PLC systems can also be used in smart homes, in-house networks and in-car networks.

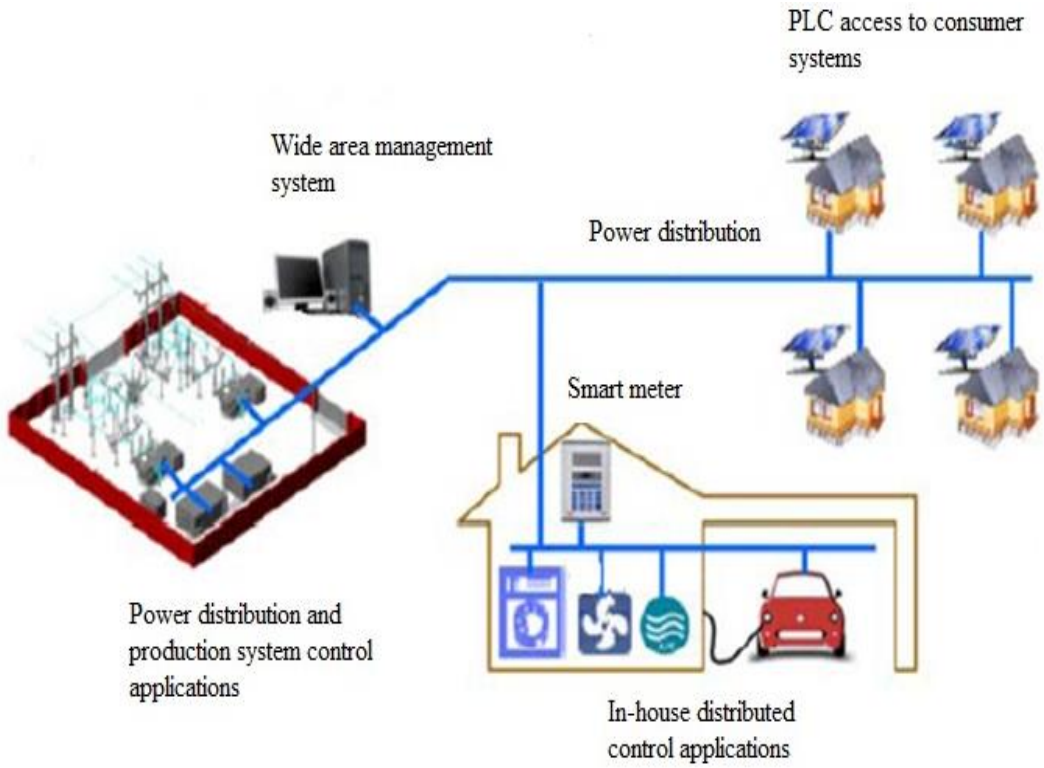

Figure 3. Wide and narrow area PLC communication system for smart grid applications

CONCLUSION

With the use of PLC technology, especially in electrical networks, instantaneous load data can be read remotely, switching-off operations of remote energy can be prevented, the use of illegal electricity can be prevented, authorized personnel can be detected if an intervention is made to the external meter and authorized personnel can be accessed remotely.

REFERENCES

1) Ahmad Usman, Sajjad Haider Shami, "Evolution of Communication Technologies for Smart Grid applications", Renewable and Sustainable Energy Reviews, Vol 19, 191–199, 2013
2) Sabine Erlinghagen, Bill Lichtensteiger and Jochen Markard, "Smart meter communication standards in Europe – a comparison", Renewable and Sustainable Energy Reviews, Vol 43, 1249–1262, 2015.
3) Vehbi C. Güngör, Dilan Sahin, Taskin Kocak, Salih Ergüt, Concettina Buccella, Carlo Cecati, and Gerhard P. Hancke, "Smart Grid Technologies: Communication Technologies and Standards", IEEE Transactions On Industrial Informatics, Vol. 7, No. 4, 529-539, November 2011.
4) Anim Amarsingh, Haniph A. Latchman and Duotong Yang, "Narrowband power line communications: Enabling the smart grid", IEEE Potentials, Vol 33, No 1, 16-21, 2014
5) Melike Yigit, V. Cagri Gungor, Gurkan Tuna, Maria Rangoussi and Etimad Fadel, "ower line communication technologies for smart grid applications: A review of advances and challenges", Computer Networks, Vol 70, 366–383, 2014.
6) Karthik Shivaram, Nikhil Rajendra, Kavi Mahesh, Balasubramanya Murthy K.N. and Padmavathy Jawahar, "Power Line Communication Based Automation System Using a Handheld Wi-Fi Device", IEEE 16th International Symposium on Consumer Electronics (ISCE), Harrisburg, PA, 1-6, 2012.