

# A Study on Power Line Communication

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**Abstract-** In this paper, we give an overview of the power line communication (PLC) technology.

This paper presents an overview of the research, applications, standards and importance of the power line communication.

Power line communication is an emerging home network technology that allows consumers to use their already existing wiring system to connect home appliances to each other and to the Internet. Noise in power line communication and impulsive noise are presented in this paper. The PLC channel is discussed to such an extent.

**Index Terms-** Power line communication (PLC), Noise, Impulsive noise, Electromagnetic Compatibility (EMC).

## I. INTRODUCTION

To transmit electric power from a small number of sources (the generators) to a large number of sinks (consumers) in the frequency range of 50-60 Hz power lines were design.

Electrical power lines are usually classified into the high (>100kV), medium (1-100kV) and low (<1kV) voltage network.

Power line communication which is also known as Power line carrier, power line digital subscriber line (PDSL), mains communication, power-line telecommunications, or power line networking (PLN) uses the existing electrical network for communication. So the cost of installation is lower than other communication system and availability of communication service can be everywhere outlets exist.

Power line communication is an emerging home network technology that allows consumers to use their already existing wiring system to connect home appliances to each other and to the Internet.

For communication purpose electrical power supply network is used in power line communication. Reduction in operational costs and expenditures for communication is the main thing in power line communication.

For internal communication of electrical utilities, remote measuring and control task high, medium and low voltage supply have been used. PLC is also used in internal electrical installation within buildings and homes called in home PLC for various communication application.

PLC modems are used to make communication in power supply networks. Data signal from conventional communication devices, (computer, telephone) is converted by PLC modem in a form that is suitable for transmission over power lines.

Although, power supply network is not designed for data communication. The PLC transmission channel has some

negative properties as frequency-dependent attenuation, changing impedance, fading and unfavorable noise condition. However, to provide higher data rates PLC network has to operate in a frequency spectrum of up to 30 MHz [13].

PLC network produces electromagnetic radiation and disturb other services operating in the same frequency range.

PLC is divided into two groups: narrowband PLC allowing data rates up to 100 kbps and broadband PLC allowing data rates beyond 2 Mbps [13].

With the inevitable arrival of broadband access, the demand for digital voice, video, internet data within the home increases continuously. PLC technology allows the uses of existing and widespread power distribution infrastructure to provide high speed networking capabilities along with many other benefits.

The rest of the paper is organized as follows. In section II applications of power line communication are presented. Advantages and disadvantages are discussed in section III. Section IV describes the standard. Channel and its related are presented in section V. The paper finishes with the discussion and conclusion in section VI.

## II. APPLICATIONS

In 1838, Englishman Edward Davy proposed a solution for remote measurements system between London and Liverpool. In 1897, first patent was submitted by him for the remote measurement of electrical network meters communicating over electrical wiring [1].

Some special applications out of many are:

*Automatic meter reading:* In this technology, data from energy meter is automatically collected and transfer to the central database for bill and analysis.

The main aim for the automation of meter reading is not to reduce labor cost but to obtain data rate that is difficult to obtain. In most of the places, users have demanded that their monthly bill be based on actual reading, instead of the bill which is based on prediction.

This is the technology which saves periodic trip and billing is based on the real consumption not estimated.

Since, the installation of first ac transmission line in 1886. To measure the energy that consumers pay for was very important.

Mr. Paraskevagos created first AMR system in 1974 by using technology developed by Theodore George [19].

PLC presents an interesting and economical solution for AMR.

*Home networking and Internet Access:* More number of computers is connected in a building by using existing network as a Local Area Network (LAN).

There is no need to install new wire or cable to connect all the computers due to the availability of low voltage power network which connects all the networks and save the installation cost and time.

*Home Automation:* for remote control of lighting and appliances it is power line communication technique which is used. Power line communication uses existing wiring in the home.

*Transmitting radio programs:* Over power line some time power line communication was used for transmitting radio programs. It is known as carrier current system when operated in the AM radio band [21]. For communication large portion of the radio spectrum might be used for high frequency communication.

### III. ADVANTAGES AND DISADVANTAGES

As a coin has two sides, every technology has some advantages and disadvantages. Similarly power line communication has advantages and disadvantages which are given as

#### A. Advantages

Most private dwellings do not have dedicated neither low nor high-speed network cabling installed, and the labor costs required to install such wiring is often quite high. Power line communication uses the existing electrical network for communication. So the cost of installation is lower than other communication system and availability of communication service can be everywhere outlets exist.

For internal communication of electrical utilities, remote measuring and control task high, medium and low voltage supply have been used. PLC is also used in internal electrical installation within buildings and homes called in home PLC for various communication application.

If there is the availability of multiple power outlets in every room, the home power line infrastructure represents an excellent network to share data among intelligent devices, also with high data transfer rate, up to a few hundreds of Mbps

#### B. Disadvantages

*Minimum-security levels:* power lines do not necessarily provide a secure media

*Data attenuation:* due to the presence of numerous elements on a power line network, data attenuation is likely to be an issue

*High costs of residential appliances:* the cost of a power line network modem is not always competitive with the cost of a standard modem used to connect to a phone line network.

*Noise:* the greater amount of electrical noise on the line limits practical transmission speed (vacuum cleaners, light dimmers, kitchen appliances and drills are examples of noise sources that affect the performance of a power line-based home network) [24].

### IV. STANDARDS

HomePlug and CENELEC standards are the most popular standards for high data rate and low data rate PLC system. Several competing standards are evolving as indicated below:

*European Telecommunications Standards Institute (ETSI) power-line telecommunications (PLT):* This provides necessary standards for voice and data services over the power line transmission. Interoperability aspects are also discuss [2].

*Home-Plug Power-Line Alliance:* It is a global organization consisting of some 65 member companies. The main aim of this is to enable and promote rapid availability, adoption and implementation of cost-effective, interoperable and standards-based home power-line networks and products. The resulting standards are expected to offer best performance. The Home Plug Power-Line Alliance has defined some standards like,

- (a) Home Plug 1.0 – specification for connecting devices via power-lines in the home,
- (b) Home Plug AV – designed for transmitting high definition television (HDTV) and VoIP around the home,
- (c) Home Plug BPL – a working group to develop a specification for to-the-home connection and
- (d) Home Plug Command and Control (CC) – command and control a specification to enable advanced, whole-house control of lighting, appliances, climate control, security and other devices[3-5]

*Institute of Electrical and Electronics Engineers (IEEE):* the standards are due to the IEEE BPL Study Group. Some of those standards are:

- (a) IEEE P1675 ‘Standard for Broadband over Power-line Hardware’ is a working group working on hardware installation and safety issues.
- (b) IEEE P1775 ‘Power-Line Communication Equipment – Electromagnetic Compatibility. (EMC) Requirements – Testing and Measurement Methods’ is a working group focused on PLC equipment, EMC requirements and testing and measurement methods.
- (c) IEEE P1901 ‘IEEE P1901 Draft Standard for Broad-band over Power-Line Networks: Medium Access Control and Physical Layer Specifications’ is a working group for delivering BPL. The aim is to define medium access control and physical layer specifications for all classes of BPL devices – from long distance connections to those within subscriber premises [6-8, 9].

*POWERNET:* It aims at developing and validating a ‘plug and play’ cognitive broadband over power-lines (CBPL) communications equipment that meet the regulatory requirements concerning electromagnetic radiations and can deliver high data rates while using low transmit power spectral density and working at low signal-to-noise ratio[10,11].

*Open PLC European Research Alliance:* It aims at improving/developing PLC services and system standardization [12,13].

*Universal Power-Line Association (UPA):* The UPA aligns industry leaders in the global PLC market to ensure deployment

of interoperable and coexisting PLC products to the benefit of consumers worldwide [14,15].

## V. THE CHANNEL

In PLC channel, reflection occurs when a signal propagate from one location to another at every impedance discontinues along the propagation path.

Impedance mismatches generally because of different cables of different characteristic impedances. Electrical appliance plugged into the power line network from the terminate points and branching points where more than two cables are connected.

There is an adverse effect on high signal in power line network as the power line was not design to transmit high frequency signal. It was design for energy transmission. Some distortion factors are there in power line as attenuation, multipath and noise.

*Attenuation:* Attenuation of power line is mainly influenced by cable losses and multipath.

Attenuation is the loss of power of the signal during its propagation and it also depend on the physical length of the channel and transmission frequency band.

*Multipath:* Multipath caused by the impedance mismatch.

Multipath can be understood as the transmitted signal reaches the receiving circuit by two or more paths with different delay.

Impedance is influenced by characteristic impedance of the cables, topology of the channel and nature of connected loads. Multipath model and its scenario is described by M. Zimmerman and K. Dostert [22].

*Noise:* As the power lines were not design to transmit for data transmission they only design for energy transmission. Also the numbers of appliances having different properties are connected to the power network.

An intensive investigation has to be obtain before using this medium for information transmission. Unlike the other telecommunications channels, the power line channel does not represent an Additive White Gaussian Noise (AWGN), whose power spectral density is constant over the whole transmission spectrum.

An interesting description is given in [23] which classify the noise as a superposition of five noise types.

*Colored background noise:* Power spectral density of this is relatively lower and decrease with frequency. This is caused due to superposition of various noise sources of lower intensity. The parameters of this noise vary over time in terms of minutes and hours.

*Narrowband noise:* This type of noise consists of sinusoidal form with modulated amplitude. Several subbands are occupied by this type of noise which are small and continuous over the frequency spectrum.

*Periodic impulsive noise, asynchronous to the main frequency:* This type of noise is in a form of impulses that usually has a

repetition rate between 50 or 200kHz. Switching power supplies cause this type of noise. Noise occupies frequency that are close to each other because of high repetition rate.

*Periodic impulsive noise, synchronous to the main frequency:* This type of noise is also in a form of impulses with repetition rate of 50 or 100Hz and is synchronous with main powerline frequency. This is generally caused by power supply operating synchronously with the main frequency, such as the power converters connected to the mains supply.

*Asynchronous impulsive noise:* Asynchronous impulsive noise is the noise whose impulses are mainly caused by switching transients in the network. Their power spectral density can reach values of more than 50dB above the level of the background noise, making them the principal cause of error occurrences in the digital communication over PLC networks.

## VI. CONCLUSION

PLC is a technique that allows exchange of data by means of electric power supply network that are presented in every dwelling, office and in every building.

In this we came to know about the application, advantages and disadvantages of PLC technology and gained some idea of the standards, noise and channel.

We hope this paper gives an overall understanding of the topic in concise and quick way to the reader and researcher in the power line communication.

In this we find PLC is attractive research area many studies are still necessary to be better understand and improve the performance of power line for high bit rate transmission .

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