International Journal on Emerging Technologies **8**(1): 105-108(2017)

ISSN No. (Print) : 0975-8364
ISSN No. (Online) : 2249-3255

A Review Power Line Communication Systems Using MC-CDMA Transmission Techniques

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(Received 19 April, 2017 accepted 25 June, 2017)
(Published by Research Trend, Website: www.researchtrend.net)

ABSTRACT: Power line communication (PLC) is cable characteristics, impedance variations and noise signals from various sources. Most importantly, noisy characteristics of power line channels make it difficult to transmit data in an effective and reliable way. More often data transmitted through power line channels is corrupted by three main types of noise, the background noise, the impulse noise and the permanent frequency disturbances. Also Attenuation multipath fading effects is one of the major setbacks in power line communication over a long distance.

Keywords: Multipath fading effects, Orthogonal Frequency Division multiplexing (OFDM) , Power line communication,

I. INTRODUCTION

Electricity utility companies distribute electricity to households and industries and with the help of energy meters, appropriate electricity bills are sent to consumers. Considering the numerous households and industries being supplied with electricity, manually reading energy meters by utility companies will require a lot of human resources which perhaps could have been invested in other sections of the company. A smart meter is usually an electrical energy meter that records consumption of electric energy in intervals of an hour or less and communicates that information at least daily back to the utility company for monitoring and billing purposes. Unlike the traditional automatic meter reading system, smart meters enable two-way communication between the meter and the central the feasibility of transmitting communications signals over the power line, known as power line communications (PLC), has been questionable. Investigations on PLC have waxed and waned over the years, but in the last five to ten years, the advent of the Internet has prompted renewed interest. There is now a need for easily accessible, high-speed broadband communication. Because of the existing infrastructure, the power line is being considered as a possible communication channel. This subset of PLC is known as "broadband over power line the concept of PLC is certainly noteworthy. The power infrastructure already exists nearly everywhere, eliminating the need for new lines. Such everyday unmanned devices as traffic signals, well-pumps, street lights, lighthouses, and subway cars could have the capability to be controlled over an existing network. There is still plenty of bandwidth available on the lines to support this activity. Within the power distribution network, there are three types of distribution lines high voltage, medium voltage, and low voltage. Running with continuous voltages from 1 kV to in excess of 100 kV and covering long distances, the high and medium voltage lines are primarily used as ties between different grids [11] on the low voltage network, at voltages less than 1 kV, the widespread distribution of the electric grid becomes an inherent advantage. Although noise and signal attenuation are problems on these networks, they still hold the potential While the applications for PLC are practically endless, there are several that have been proven to provide the most cost effective utility: load management, automatic metering, and Load management is a technique employed by the power company to maintain a stable grid. For a distribution system to function, the load must be matched by the generation. Currently, large kilowatt generators must adjust instantly to shifts in load. However, load management could be used to instead redirect current over different transmission lines and to different grid sections. A signal can be sent over the power line to a switching station or capacitor bank to make required adjustments that would otherwise require a secondary form of communication.

This improves the overall grid stability and reduces operating costs. Automatic metering is another practical PLC application. Rather than having an employee manually go from house to house and business to business reading the electric meter, the meter sends a signal back to a receiver. Its unique identification number and current usage to date is broadcast and consequently recorded. Although cost to the power company is reduced significantly, the communication speed so far has proven quite slow. In one application in the United Kingdom, the data transmission ran as slow as 1 bit/sec.1The main application of interest is BPL. With a high rate of data transmission, the power line could provide internet access, voice over IP, and other broadband services. This is beneficial to the consumer because the common power outlet becomes a gateway to the Internet and a home LAN with no need for additional wiring. The power company then has the advantage of opening up a competitive service in a market where it previously had no interest.

II. HISTORY

The idea of power line communications in the early days of electrical distribution. Then, the focus was on telegraph and telephone communications. Because of the lack of necessary technology, these early methods 1970s, research was concentrated on automatic meter reading and load control. High-speed transmission could be obtained over short distances. However, only low-speed transmission could be attained over long distances. One of the first PLC systems to appear was a metering system created in 1972 by General Electric. It operated in the range of 35 to 40 kHz and, at these frequencies, was not susceptible to destructive harmonics of the mains. However, losses from propagation and distribution transformer couplings proved to be a substantial barrier. 1980s, an improved metering system was developed named It was first implemented by Virginia Power in the Williamsburg area in the early 1980s. The frequency of this next generation device was shifted down to the 5-10 kHz range. Here, the propagation and coupling losses were much more acceptable. Unfortunately, the interference due to harmonics at this frequency by the late ‘80s, yet another system, known as the Rockwell System, was developed. In addition to metering, this system provided for load management and distribution automation. While it operated at the same frequencies as the Rockwell System employed a filter with sin(x)/x characteristics that helped eliminate the problem with harmonics. The system proved to have a good signal-to-noise ratio (SNR), but cross-talk issues between substations now, the interest has shifted to bringing high speed internet to every corner of the globe. Yet, decades of new devices have put more noise onto the power line while they draw power and continue to make reliable high-speed, long distance communications elusive to engineers. In the future and even today, with advances in technology, these problems can be overcome.

III. IMPEDANCE

The impedance of the electric distribution system is quite difficult to characterize. It is defined for a given frequency and can range anywhere from a few ohms to a few kilo-ohms. Depending on a given load and the network topology, the impedance can generally be characterized somewhere between 90 and 100 ohms.7 However, the low-voltage residential circuit is more difficult to characterize.

Vines et al.8 experimented with line impedance in the mid-1980s and were able to draw conclusions at low frequencies that Pavlidou et a l.7 were able to adapt to higher BPL-capable frequencies. In measurements from 5 to 30 MHz, the following was determined:

• The magnitude of the impedance increases with frequency in the range of 5 to 20 MHz.

• The mean value of the impedance increases from about 5 Ω at 20 MHz to about 120 Ω at 30 MHz.

• There is a strong fluctuation between the maximum and minimum value of the impedance.

• Resonances can occur on the residential network above 40 kHz. This makes the impedances of higher frequencies more unpredictable. Power line carrier (PLC) communications is an area of research that has been studied for many years, although

it has never reached the mainstream of communications research activities. Commercial systems have been difficult to implement and simple in capability. More recent research has focused on solving many of the problems facing PLC communications using the latest communications technologies, with new high-speed devices soon to reach the market. gives an overview of current PLC systems and standards, details the challenges limiting the capacity of current systems, and explores the modern communications methods applicable to PLC methods. Focus is given to low voltage (<1kV) PLC technologies. That is, those that are applicable for domestic home network use. PLC communications is a well-known and reasonably common method of communication in domestic households. In fact, it is high-speed PLC opens up new field for telecommunication services without additional cabling.

The conditions for the high-speed data transmission in the low voltage power distribution

Network are unfavorable due to frequency selective properties, varying impedance, considerable noise, high attenuation and other effects. Characteristics of PLC channel make it extremely

difficult to achieve a high-speed transmission with the conventional single-carrier approach, which requires a complex adaptive equalization to compensate for the strong frequency selective behavior of the power lines

IV. NOISE AND DISTURBANCE

Common causes of noise on electrical power networks include corona discharge, lightning, power factor correction banks and circuit breaker operation. On the low voltage network, much of this noise is filtered by medium/low voltage transformers, so the most common interference in low voltage domestic networks can be attributed to the various household devices and office

Equipment connected to the network. Noise and disturbances on the electrical power network can be generally classified as follows: [1] (i) Wave shape disturbances these include

a. Over-voltages, both persistent (>2 seconds) or surges (< 2 seconds).

b. Under-voltages, both persistent or surges.

c. Outages.

d. Frequency variations.

e. Harmonic Distortions.

ii) Superimposed disturbances

These include

a. Persistent oscillations, either coherent or random.

b.Transient disturbances, both impulse and damped oscillations. Wave shape disturbances are usually of little effect on PLC systems. Transceivers are usually robust enough to cope with minor over-voltage and under voltage disturbances. Naturally, in the case of (i) (c), total line outages will make information transmission impossible. Yet the outage of a piece of distant equipment will effect the performance of a domestic PLC system. Harmonic disturbances can be a major source of disturbance, yet these occur at frequencies below those designated for PLC communications by statutory authorities . Frequency variations can cause major problems in PLC systems, as many simple systems rely on the mains carrier (50Hz sine wave) for synchronization between transmitter and receiver. Frequency variation in this wave will cause transmission error. Modern systems overcome this obstacle by avoiding reliance on the mains carrier for synchronization. On the medium voltage network, class (ii) Noise is attributed to large factories with extensive plant or machinery, and industrial users with poorly filtered appliances. On the low voltage network, a number of household appliances are most often responsible for superimposed disturbances.

Vines et al [3] further categorise type

(ii) Noise as

A. Noise having line components synchronous with the power system frequency

B. Noise with a smooth spectrum;

C. Single event impulse noise, and;

D. Non synchronous noise.

A. Noise having line components synchronous with power system frequency. The usual source of this noise (hereafter called Type A noise) are triacs or silicon controlled rectifiers (SCR's), found domestically, for example, in light dimmers or Photocopiers. The spectrum of this noise consists of a series of harmonics of the mains frequency (50Hz). There are three ways to combat this kind of noise [1]

• As the frequency spectrum of class A noise is regular, successful communication may be possible with modulation schemes that avoid, or have nulls, at these frequencies.

• Filter these noise components out using accurate notch filtering. So far a qualitative description of noise on the low voltage network has been given. With an understanding of the noise inherent on domestic power networks, various suggestions can be made for the development of a PLC communications system

• Appropriate error correcting codes should be implemented to cope with noise types A, B and

• To avoid type D noise, television line frequency and harmonics should be avoided when modulating the signal

onto the channel- no signal information should be transmitted at these frequencies.

• Some kind of frequency diversity (for example frequency hopping) should be implemented to cope with interference at unknown frequencies

V. POWER LINE COMMUNICATIONS AND OFDM

The orthogonal frequency division multiplexing (OFDM) transmission divides the available broadband into many carriers each one being modulated by a low speed data stream, promises to be a suitable modulation technique for high capacity power line communications (PLC). OFDM data transmission is a promising modulation technique that eliminates a need for complex equalizer.

The basic idea behind OFDM transmission Scheme is to divide the available channel bandwidth into a number of sub channels, each one being nearly ideal.

A low-speed data stream modulates each subcarrier using QAM (Quadrature Amplitude Modulation) as sub channel modulation. The long symbol interval used in OFDM produces a much greater immunity to impulse noise and fast fades. The division of the available channel bandwidth into relatively narrow sub bands provides a transmission rate close to capacity. It is intuitively reasonable that the overall bit rate is maximized if a power division among the subcarriers and a selection of the number of bits per symbol (modulation level) for each subcarrier are chosen so that the bit error rates in all the sub channels are equal. The lower modulation level is assigned to lower SNR sub channel, whereas higher modulation level is assigned to high SNR sub channel. Optimum modulation level and power allocation per subcarriers in an adaptive OFDM system, according to channel conditions, provides the potential for a higher transmission rate. Channel state estimation is required for equalization, impulse response shortening of the effective channel and adaptive modulation level and power allocation in OFDM systems. The increasing demand for high-date-rate communications through the time-variant and frequency selective channel, as the power-line, makes blind channel identification very interesting since it does not require the transmission of a training sequence. The mitigation of the time-dispersive characteristic of frequency selective channel is achieved by inserting a cyclic prefix between OFDM blocks (symbols), as a guard interval, the length of which is longer then length of the channel impulse response in order to avoid inter-OFDM symbol interference. OFDM with cyclic prefix both inter symbol (ISI) and inter channel (ICI) interference and eliminates a need for complex equalizer. The insertion of the cyclic prefix to the OFDM signal induces its wide sense cyclostationarity that can be used for blind channel identification in OFDM systems [5]. The advances in digital signal processing are achieved by processing signals as cyclostationary [6, 7].

VI. CONCLUSION

PLC techniques, current devices and applications, as well as technical issues such as the challenges faced by PLC communications, an exploration of modern communications strategies suited to improving the performance of PLC systems.

REFERENCES

[1]. P. Sutterlin and W. Downey "A Power line communication tutorial challenges and technologies", Proc. IEEE 7th Int. Symp. on Power Line Comms. & its Appl., *ISPLC 2003.*

[2]. P. Mlynek, M. Koutny and J. Misurec. "OFDM model for power line communication". Proc. 4th Int. Conf. on Comm. & Info. Tech., *CIT10, Greece, Jul 2010.*

[3]. M. M. Rahman. S. P. Majumder. "Analysis of a Power Line Communication System Over a Non-white Additive Gaussian Noise Channel and Performance Improvement Using Diversity Reception". *Network and Communication Technologies.* Vol. 1.June 2012.

[4]. S. A. Bhatti, Q. Shan, I. A. Glover, R. Atkinson,P.J. Moore. "Impulsive noise modeling and prediction of its impact on the performance of WLAN receiver". *EUSIPCO. Aug. 2009.*

[5]. L. Wang, G. Deconinck, E Van Lil. "Performance analysis of Broadband Power line Communications under impulsive noise and crosstalk. *URSIBenelux.* .pp 1-3. Sep. 2012.

[6]. Sekhararao "Performance of coded Power line Communications,*NetworkandCommunicationTechnologies,2003*

[7]. B. Nikfar, A. J. Han Vinck. "Space Diversity in MIMO Power Line Channels with Independent Impulsive *Noise"ISPLC2012.*

[8]. L. Selander. Power Line Commucation Channel Properties. Department of Information Technology. *Ronneby, Sweden.1999.*

[9]. M. Zimmermann and K. Dostert, "A multipath model for the powerline channel," *IEEE Trans. on Comms.* vol., **50**, no. 4, pp. 553- 559. April 2002.

[10]. A. Hosseinpournajarkolaei, J. Lota and W. Hosney, "Challenges Facing The Design of Broadband Power Line Communication (BPLC) Systems," *in UPEC-Brunel University of London, London, 2012.*

[11]. K.S. Al Mawali. "Techniques for Broadband Power Line Communications: Impulsive Noise Mitigation and Adaptive Modulation." Degree of Doctor of Philosophy. School of Electrical and Computer Engineering. RMIT University. July 2011.