Power Line Carrier Communications and its Interest in the Current Power Grid Scenario

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Abstract. During the last years PLC technologies have been widely developed mainly due to new modulation techniques used for wireless telecommunication systems that can also be applied to PLC systems. The current state of the art of PLC communications is presents many possibilities and opportunities for the utilities.

Besides the Distributed Energy Resources integration to the distribution grid is

The aim of this paper is to make a review of the existing PLC technologies as well as the analysis of an interesting range of electric applications of PLC.

Key words

Power Line Carrier (PLC), Smart Grid, Active Network, Distributed Energy Resources (DER).

1. Introduction

Power Line Carrier communication systems consist of a high frequency signal injection over the electrical power lines. This kind of technology has been used since the 1950 decade in order to provide signalling and ripple control in High Voltage lines, at transmission level.

In the last years the interest for this technology has suffered a revival because the impressing increase of the mobile telecommunications has brought a big development in transmission technologies for this kind of communications. In particular, new modulation technologies used for wireless communication are especially suitable for PLC communication and make massive data transmissions possible.

Besides, the opening of the market, the need to integrate Distributed Energy Resources (DER) and the increase of the power supply demand create a new scenario in which the approach of the energy distribution system has to change.

In such a scenario, the distribution system needs to be automated in order to give a satisfactory response to the problems that will eventually appear. The actual automation ratio of the Spanish distribution system is of approximately a 2% or 3% and the prevision is that it should increase to more than a 50% in the following years.

Currently PLC communications can be broadband as well as narrowband and both cases present successful transmissions.

In the case of Narrowband PLC there are the CENELEC standards EN50065 and EN50065-1, for signals between 3 kHz and 148 kHz over low voltage public and/or private grids. For Broadband PLC, European Commission funded OPERA IST and Opera 2 projects are working towards the standard development currently. In this case the used signals range from 1MHz to 34MHz with a bandwidth between 10 and 30MHz and a bit rate of 200mbps. The results of the both above mentioned projects will feed the ETSI Broadband Powerline Telecommunications standard.

Thus, it would be possible to think of an automated distribution scenario with PLC used as a communication link used for multiple applications.

2. PLC Network: Structure and Topology

PLC networks have a parallel structure to the electricity network and thus show several similarities with this In this point an analysis of the typical PLC structure and the usual topologies of such a grid will be done.

A. Structure

A PLC network is divided in two main parts. On the one hand there will be a PLC network parallel to the medium voltage grid and on the other a PLC network parallel to the low voltage grid. The border and end components of the network are shown in Fig 2.

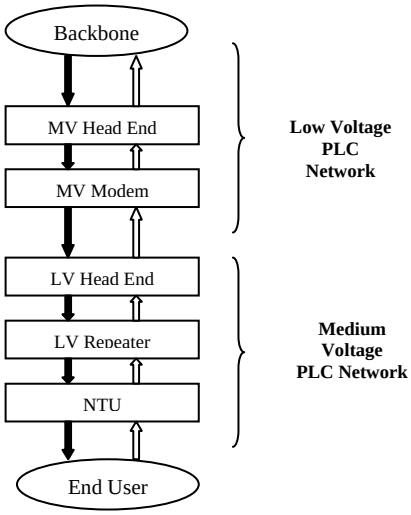

Fig. 2. PLC Network Structure

Medium Voltage Head End: It enables the communication between the Backbone or the main communications network and the PLC network.

Medium Voltage Modem: it is the interface between a Medium Voltage PLC Network and a Low Voltage PLC network on the Medium Voltage side.

Low Voltage Head End: It represents the end of the Low Voltage PLC network and is a gateway to the Medium Voltage network which can be PLC or otherwise. It is normally placed on the distribution transformer which acts as a natural low pass filter for the high frequency signal injected in the network.

Low Voltage Repeater: In case of lines of significant distances between the Head End and the Network Termination Unit it will be necessary to place Repeater Units along the line in order not to lose the high frequency signal.

Network Termination Unit (NTU): It is the interface between the client equipment and the low voltage PLC network. It is normally placed at the client premises.

B. Topology

The PLC Network topology depends strongly on the distribution grid topology and is similar to it. Thus, it can be meshed or radial and generally the MV Head and LV Head end are placed at substation and transformation centre levels respectively.

3. PLC Modulation and Transmission

A.Modulation

Three are the most used modulation techniques by PLC equipment providers. DS2 uses Orthogonal Frequency Division Multiplexing (OFDM), and it has been chosen by Opera so very probably it will be the European standard. ASCOM uses Gaussian Minimum Shift Keying (GMSK) and Main.net used to use Direct Sequence Spread Spectrum, which is a modulation technique based on CDMA. This three modulation techniques are noise resilient and make satisfactory bandwidth management.

B. Transmission Problems

The parameters that affect the PLC transmission and thus have to be considered are: attenuation, noise, noise to signal relation, crosstalk and delay spread.

4. PLC applications and interest

As we mentioned in the introduction, the interest of PLC communications is growing, due to the current circumstances. The active grid or intelligence grid concept will define the network of the future and needs of a parallel communication system in order to give a successful response to its problems. Possible PLC applications can be made in industrial automation, telecommunication services and electrical utility related services such as ripple control, demand side management, transformation centre's telecontrol, fraud detection, Distributed generation integration, system protection and fault detection.

5. Conclusion

The electric power grid is about to face an important renewal in which the information and communication technologies are of vital importance. Thus, it is important to have a solid communication infrastructure. Currently, PLC networks provide a proprietary solution and enough reliability and quality conditions.

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