Advanced Grid Diagnostics Enabled by PLC for Sensing

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I. Introduction

Nowadays Power Line Communications (PLC) is an established and consolidated technology for communication in smart grids. Although there is always space for enhancements, the power line channel has been widely investigated and a considerable amount of scientific research has led the development of very performing communication solutions. For this reason, in the last years the research efforts about PLC have started moving from pure wired communications to other applications. One of these is using the power line modems (PLM) as network sensors. This means that PLM can not only be used for data transmission, but also to actively monitor the network and provide valuable information about its state and possible anomalies. Some recent papers [1], [2], [3], [4] have shown that continuously monitoring the power line channel response can be used to detect and localize a fault, but also to monitor the cable degradation. In particular, [1] focuses on single-ended measurements, i.e. measuring the echo channel response of a single modem. On the other side, [3], [4] focus on double-ended measurements, i.e. measuring the channel response between two communicating modems. Other techniques based either on single-ended or double-ended measurement have demonstrated that PLM can be used to identify and track the topology of a power line network [5], [6], [7], [8].

In this paper, we introduce the possibility of exploiting at the same time both single-ended and double-ended measurements for all the aforementioned diagnostic tasks. This possibility is given by the in-band full duplex (IBFD) technology, which has recently been introduced for PLC. With this technology, PLM modems can at the same time sense the echo response of the transmitted signal and measure the channel response of a signal coming from a far end [9]. The fusion of this double information enhances the diagnostic capability of each communicating node, merging both the advantages of single-ended and double-ended measurements. In fact, single-ended measurements allow good diagnostics of the network part that is close to the transmitting PLM over a radial area, while their efficacy decreases for diagnostic operations in distant network parts. Conversely, double-ended measurements provide the best results for diagnostics in or around the main path connecting the two modems involved, while their performance decreases elsewhere. With IBFD is hence possible not only to sense the electrical properties of a power line network in a radial area around the transmitting PLM, but also to enhance the sensing capability in one direction, based on the position of the second modem. Considering finally many PLM branched to the same network, the sensing capability can be enhanced in different directions at different times, increasing the self diagnostic capabilities of the network.

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