*Editorial*

# Power-Line Communications: Smart Grid, Transmission, and Propagation

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Power-line communication networks are gaining popularity in various service provisions such as in houses/offices, access networks, in ships, aircrafts, trains, vehicles, in industry systems control, and advanced metering infrastructure. This popularity is also striding towards smart grid implementations. However, the network structure affects the channel response which exhibits frequency selectivity and time variant behavior. These effects are due to different terminal loads connected to such systems, number of branches, and different branched line lengths. In addition, different types of cables and signal injection methods used (i.e., with respect to adjacent lines/grounds and the grounding systems implemented in different countries) for such systems render the propagation difficult. Furthermore, Electromagnetic Compatibility (EMC) issues and more especially Electromagnetic Interference (EMI) occurring at different frequencies of operations still need more investigation. Power-line communications have demonstrated the acceptance to support various applications such as HD Television (HDTV), Internet Protocol Television (IPTV), interactive gaming, whole-home audio, security monitoring, and Smart Grid management. These services have to be supported by the new home networks/access and be deployed and standardized worldwide.

This special issue was launched to gather state-of-the-art research contributions in the field of Power-line communications. It has attracted the submissions of many high-quality papers. After going through a conscientious peer-review process, six papers have been selected. These papers make an inspiring ensemble with a topic spectrum ranging from improved maximum likelihood detection of spread frequency shift keying (S-FSK) in PLC automatic meter reading (AMR), radiation mitigation for PLC, optimal receiver impedance design for SNR maximization in broadband PLC, PLC for Smart Grid applications, improvements of G3-PLC technology for Smart-Home/Building applications, and finally an overview of the HomePlug AV2 technology.

Specifically, in the paper entitled "*Improved maximum likelihood S-FSK receiver for PLC modem in AMR,*" Bali and Rebai present an optimized software implementation of a narrow band Power-line modem. The modem is a node in an automatic meter reading (AMR) system which is compliant to the IEC 61334-5-1 profile and operates in the CENELEC-A band. Because of the hostile communication channel, a new design approach is carried out for an S-FSK demodulator capable of providing lower bit error rate (BER) than standard specifications. The best compromise between efficiency and architecture complexity is investigated. Some implementation results are presented to show that a communication throughput of 9.6 kbps is reachable with the designed S-FSK modem.

In the paper entitled "*Radiation mitigation for Power-line communications using time reversal,*" Mescco et al. explain the use of the Time Reversal (TR) technique to mitigate radiated emissions from PLC systems. The method was probed

experimentally in real electrical networks with excellent results: in 40% of the observations, the electromagnetic interference generated by PLC transmission can be reduced by more than 3 dB, and this EMI mitigation factor may increase to more than 10 dB in particular configurations. The paper proposes also future research directions in the field of wired TR techniques at higher frequencies and on other media, such as Digital Subscriber Line twisted pairs. In addition, optimal protocols are suggested for development of practical implementation of TR in future standards.

In the paper entitled "*A study on the optimal receiver impedance for SNR maximization in broadband PLC*," Antoniali et al. present the design of the front-end receiver for broadband Power-line communications. The paper focuses on the design of the input impedance that maximizes the signal-to-noise ratio (SNR) at the receiver. The authors show that the amplitude, rather than the power, of the received signal is important for communication purposes. Furthermore, they analyse the receiver impedance impact on the amplitude of the noise term for which a novel model description is provided. Performance results are reported for real in-home grids that have been assessed with experimental measurements. The best attainable performance is studied when the optimal receiver impedance is used and it is shown that conventional power matching is suboptimal with respect to the proposed impedance design approach in terms of achievable information rate.

Two other papers deal with the topic of Smart Grid in various environments. In the paper entitled "*Power-line communications for Smart Grid applications*," Berger et al., surveys PLC technologies that are relevant in the context of Smart Grid. The specifications of G3-PLC, PRIME, HomePlug Green Phy, HomePlug AV2, as well as the standards IEEE 1901/1901.2, and ITU-T G.hn/G.hnem are discussed. Another paper entitled "*Enhancements of G3-PLC technology for Smart-Home/Building applications*," by Di Bert et al., consider the in-home/building scenario, for which a convergent network architecture is proposed to enhance the performance of the narrow band G3-PLC technology through its integration with an Ethernet-based network. The paper defines the protocols implemented by the network modules. Since Ethernet represents a convergent standard for many communication devices, by adding this functionality to G3-PLC, interconnectivity with other heterogeneous nodes can be offered. Furthermore, since the G3-PLC medium access control layer is based on a Carrier Sense Multiple Access (CSMA) scheme, its performance decreases when the number of network nodes contending for the channel increases. Therefore, the paper evaluates the network performance when an optimized time division multiple access scheme is adopted showing that performance improvements are reached.

In the paper entitled "*An overview of the HomePlug AV2 technology*," Yonge et al. provide an overview of the HomePlug AV2 system architecture and the key features at both the PHY and MAC layers. The paper presents the new techniques used at the PHY layer as multiple-input multiple-output transmission, beamforming and precoding, adaptation of the parameters, and power management for improved EMC.

Enhancements at the MAC layer are also discussed and they include the implementation of power saving modes, the usage of a short delimiter in the MAC frame, delayed acknowledgment, and the coexistence mechanisms with other PLC systems. The HomePlug AV2 performance is also assessed, through simulations reproducing real home scenarios.

We believe that the papers appearing in this special issue provide a good contribution and representation of significant research topics in the field of PLC.