

## **Power Line Communications for the Smart Grid**

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This tutorial covers recent advances in Power line communication (PLC) which is among the most interesting and important communication technology candidates for application in the Smart Grid since the grid is not only the information source but it also offers the infrastructure for the information delivery.

An overview of the various application scenarios of PLC (such as in-home, in-vehicle, and smart grids) and a summary about the evolution of PLC technology will be provided.

We will then discuss the important topics of channel and noise modeling and report up-to-date results about statistical channel modeling, MIMO channel modeling, and noise/disturbances modeling.

The main challenges of physical layer design for both narrow-band (NB-PLC) and broad-band PLC (BB-PLC) to encompass the presence of channel attenuation and frequency selectivity, interference, and various noise sources will be addressed. In particular, we will describe existing and emerging single carrier modulation approaches, filter bank modulation approaches (as OFDM, DWMT, FMT), and ultra wide band techniques. We will show that advanced modulation techniques, combined with coding and smart resource allocation algorithms are capable of granting robust performance and coexistence with other technologies.

We will then focus on the specific Smart Grid applications (as automatic meter management, grid monitoring, vehicle-to-grid communication, demand side management, home networking for energy management) and remark the similarity to those found in sensor and control networks. The role of PLC in HV, MV and LV networks will be discussed and in particular the relevant role of NB-PLC. MAC algorithms for sensing and control we will described as well as proposed relaying and cooperative schemes that grant range extension through the grid.

Finally, an overview of the main standards will be offered covering both NB-PLC and broad-band BB-PLC.

### **List of topics (A: Andrea, M: Masaaki)**

- Power line communication applications and evolution of PLC technology
- Channel modeling for narrow-band and broad-band communications, recent advances in statistical modeling and MIMO modeling.
- Noise modeling for broad-band and narrow-band PLC
- Physical layer techniques, single carrier modulation, filter bank modulation, coding and resource allocation algorithms.
- Smart Grid applications and the role of PLC.
- Narrow-band PLC and optimum modem algorithms design
- MAC protocols for sensing and control in the smart grid.
- Relaying and cooperative schemes.
- PLC standards.