Chapter 14
Exploiting Power Line for Communication Purpose:
Features and Prospects of Power Line Communication

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ABSTRACT

Power Line Communication (PLC) uses the available power line as a communication medium. The purpose of this chapter is to present the salient features, current trend and future scope of PLC with emphasis in the Indian context. Unlike other channels available, power lines are harsh media for data transfer and require efficient modeling and simulation techniques to propose and implement suitable mitigation schemes for achieving acceptable performance. Designed equipments have to adhere to strict mandates at the national and international levels to account for issues related to electromagnetic compatibility (EMC). In spite of this, PLC is expected to occupy an important place in the networking market in applications of smart grid and as a component of heterogeneous/hybrid communication system. The chapter is also backed by results from experiments carried on a typical power line in a test site with a presentation of noise, transfer characteristics, modeling and an estimate of the channel capacity.

INTRODUCTION

Power lines are readily available infrastructure that may be exploited for communication purposes. The idea started way back in the 1920's when two patents were issued to the American telephone and telegraph company (patent number 1,607,668 and 1,672,940) in the field of "Carrier Transmission over Power Circuits" involving communication over three- phase AC power wiring (Fetter, 1926). Consequently a rapidly growing field known as Power Line Communication (PLC) or Power Line Carrier Communication (PLCC) has emerged in the developed countries as well as in some developing ones.

The objective of this chapter is to review the work done on PLC based on available literature; present the salient features that are required for understanding the system and discuss some of the future prospects

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and expectations. The chapter starts with a note on the utilities benefitted from PLC. A description of the power line grid and a generic PLC system with the mandating standards is given. The associated problems and the characteristics that make it unique and different from others channels available are discussed using results from experiments carried out in a typical indoor power line. Next, modeling, simulation and mitigation methodologies that is indispensible for successful implementation has been presented. Issues relating to electromagnetic compatibility (EMC) and controversies that limit extensive usage have been discussed in brief. The current research and future prospects which is the driving force behind all research has been presented. In the end, the available scope in the Indian context has been discussed with an estimate of the channel capacity from experimental results.

POWER LINE COMMUNICATION UTILITIES

PLC is often heralded as the "third wire" technology offering applications in attractive modes. The ubiquity nature of power lines make it a suitable candidate for delivering new energy added values and telecommunication services of various natures. With large production, and decrease in cost, PLC aims to capture the last mile and last inch applications in areas of *access*, *in-house* and *control*. Access PLC provides communications to and among houses using either the overhead or underground electrical distribution lines. In-house devices enable resource sharing, offer easy integration of equipments within the home, provide internet sharing and even telephony. Utilities of control include automatic meter reading, real- time monitoring, voltage control and load management, scheduling and forecasting through smart grids that could improve reliability and safety to electrical customers.

THE POWER LINE GRID

The power line grid is the largest network connecting urban, sub-urban and rural places with nearly 100% electrification in some countries and even in some rural areas. Depending on voltage levels, the grids can be divided into high voltage (HV), medium voltage (MV), and low voltage (LV) lines as shown in Figure 1. Electricity is generated at the generating station and transmitted at HV $\left(\geq 120kV\right)$ over overhead lines to long distances for nationwide and even international transfers. In the distribution stage, the HV is first step down to MV $\left(1 \leq V \leq 30kV\right)$ via primary transformer substations (PTS) and distributed to towns, cities and industrial complexes through buried or overhead cables. Finally the MV is stepped down to LV $\left(V \leq 1kV\right)$ through a secondary transformer substation (STS) and distributed to the end users. Electricity usually enters a customer's premise through a *house access point* (HAP) followed by an electric meter and a distribution box. The grid structures vary from country to country in terms of length of the LV line, number of homes reached by each line, voltage levels and method of injection. These pose a problem in generalizing the construction of PLC system and have been discussed in later sections.