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**Multiuser communications over frequency
selective wired channels and applications to the
powerline access network**

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Abstract

The low-voltage power distribution network is considered today as a serious candidate to provide residential customers with a high-speed access to communication services such as Internet. Outdoor Power-Line Communications (PLC) systems represent an alternative to the other classical 'last-mile solutions' such as ADSL, cable modems, or wireless access systems. The outdoor powerline channel is made of the interconnexion of various buried or aerial multiconductor cables, providing connectivity between the central PLC modem (installed at the medium-voltage/low-voltage transformer) and a number of remote PLC modems (installed at customer premises).

We developed an accurate powerline channel simulation tool based on the Multiconductor Transmission Line theory. This tool is able to predict the end-to-end channel responses on the basis of the multiconductor cable structure and the network topology. The obtained channel responses are strongly frequency-selective due to the cable losses and to the various reflections at cable derivations and unmatched terminations.

Then the issue of optimal resource allocation in a multiuser environment was addressed in the light of the Multiuser Information Theory. Simultaneously active users are in competition for the limited resources that are the power (constrained by electro-magnetic compatibility restrictions) and the bandwidth (in the range of 1 to 10 MHz for outdoor PLC). The concept of multiuser balanced capacity was introduced to characterize the optimal resource allocation providing the maximum data rates with fairness constraints among the subscribers.

The optimal PLC system was shown to require the shaping of the signal spectrum in the transmitters, and successive decoding in the receiver. A generic multiple access scheme based on Filter Banks (FB) was proposed, which offers the required spectral shaping with limited degrees of freedom. Classical multiple-access techniques (TDMA, CDMA, OFDMA) can be obtained by selecting the appropriate FB. The Minimum-Mean-Square-Error Decision-Feedback Joint Detector was shown to approach the performance of the optimal successive decoding receiver. Practical implementations were discussed and compared, with a special concern about complexity issues.

Finally, the robustness of the proposed system against channel estimation and timing synchronization errors was addressed. The problem of multiuser

timing synchronization was introduced, and practical multiuser timing error detectors were proposed.

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