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BROADBAND IS POWER: INTERNET ACCESS THROUGH THE POWER LINE NETWORK

Digital communications over power lines is an old idea that dates back to the early 1920s, when the first patents were filed in this area. Since then, utility companies around the world have successfully used this technology for remote metering and control. These applications, however, require only very low bit rates.

More recently, there has been a growing interest in the possibility of exploiting the power grid to provide broadband Internet access to residential customers. The attractive feature of this idea is the presence of a vast infrastructure in place for power distribution, and the penetration of the service could be much higher than any other wired alternative. Access to the Internet is becoming as indispensable as access to electrical power. Since devices that access the Internet are normally plugged into an electrical outlet, the unification of these two networks seems a compelling option. Other broadband alternatives such as digital subscriber line (xDSL) and cable modems have only reached 10 percent of U.S. households, even though 60 percent of households are connected to the Internet. There is a tremendous opportunity for power line communications to bridge this gap. There is also growing interest in the prospects of reusing in-building power line cables to provide a broadband LAN within the home or office. The major advantage offered by power-line-based home networks is the availability of an existing infrastructure of wires and wall outlets, so new cable installation is averted.

Despite the enormous potential, there is some skepticism about the technology and its commercial viability. This is due to several technical problems and regulatory issues that still remain to be solved:

- The power line channel is a very harsh and noisy transmission medium and extremely difficult to model.
- The power line channel poses unique challenges to the modem designer, such as the choice of appropriate modulation, coding, and detection schemes.
- Regulatory issues naturally arise due to the unshielded nature of power line cables, which are both the source and target of electromagnetic interference.
- Other issues include the presence of a transformer, feeder segmentation, and, obviously, safety.

Although the many technical and regulatory issues cause some skepticism, there is today renewed interest in power line communications. In Europe and, to a lesser extent, in the United States, power utility companies are partnering with vendors to conduct field trials. Moreover, in the United States an industry consortium, HomePlug, has agreed on a specification for indoor power-line-based home-networking.

The purpose of this feature topic is to draw the attention of the communications community to this interesting and challenging area. It is symptomatic that most contributions on this topic are published in transactions on consumer electronics, power delivery, industry applications, and industrial electronics, whereas very few papers on power line communications have appeared in publications of the Communications Society, which usually fosters technical innovation in the area of communications systems. Moreover, the power line channel poses unique challenges in modem design, channel modeling, medium access, and many other aspects of communications architecture. Many of these challenges have only been partially addressed and solved to date. In fact, most efforts in this area have focused on channel modeling and the realization of working products; but with very few exceptions, a solid communications and information theoretic approach is still lacking. Our hope is that this feature topic will inspire basic theoretical work that will lay the foundation for a new generation of communications technology for power line data transmission.

We open the issue with an article by Gebhardt *et al.*, which contains an overview of the topology of the mains network, including both the medium and low voltage parts, and a discussion about the many regulatory issues involved in power line communications. The topic naturally leads to a comparative study of the mains in the United States, Europe, Japan, and some developing countries.

The second article, authored by Ezio Biglieri, tries to bridge the theoretical gap in the power line communications literature by analyzing several possible options in modulation and coding techniques suited to what the author refers to as a "horrible channel." The advantages and disadvantages of many modulation and coding schemes are put face to face with the unique challenges of the power line channel, pointing out new research directions

and solutions for the indoor and outdoor environments.

In the third article, by Dai and Poor, the authors propose advanced signal processing techniques based on multicarrier code-division multiple access and turbo multiuser detection to enable high-speed data communications over the low-voltage power distribution network.

Last but not least, we conclude this feature topic with two short articles that summarize the results of two ongoing field trials of power line communications. Since there are currently many ongoing field trials in the world, we felt it was important to shed light on some of their outcomes, and we chose to focus on two specific examples among the many possible, not for their particular merits compared to others but rather to allow us to provide details on the issues facing the deployment of a power line network. We chose one trial in the United States and one in Europe that we felt were sufficiently emblematic of power line field trials on these two continents. The first article, authored by Jee *et al.*, reports results obtained in a U.S. field trial in Westchester County, New York. The second article, by Liu *et al.*, provides the details of the results obtained from a European field trial carried out in Fribourg, Switzerland.

BIOGRAPHIES

STEFANO GALLI (sgalli@telcordia.com) received his M.S. (Laurea) and Ph.D. (Dottorato di Ricerca) degrees in electronic engineering from the University of Rome "La Sapienza" in 1994 and 1998, respectively. After completing his Ph.D., he continued as a teacher assistant in signal theory at the InfoCom Department of the University of Rome and, at the same time, began to work as a consultant for Italian telecommunications companies. In October 1998 he joined Bellcore (now Telcordia Technologies), Morristown, New Jersey, in the Broadband Access and Premises Internetworking Department where he is now a senior scientist. He has co-authored over 50 technical papers in peer-reviewed international journals and conferences. His main research efforts are devoted to the physical layer analysis of DSL technology, power line communications, and wireless communications.

ANNA SCAGLIONE (anna@ece.cornell.edu) joined the faculty of the School of Electrical and Computer Engineering at Cornell University in July 2001 as an assistant professor. Prior to her appointment at Cornell, she was an assistant professor with the Electrical and Computer Engineering Department of the University of New Mexico in 2000–2001, and a postdoctoral researcher at the University of Minnesota in 1999–2000. She received her Ph.D. and M.S. degrees in electrical engineering from the University of Rome "La Sapienza" in 1999 and 1996, respectively. Her research interests are in signal processing techniques for broadband transmission over frequency selective time-varying media and, more recently, in ad hoc sensor networks. With her co-authors she received the 2000 IEEE Signal Processing Transactions Best Paper Award for the paper "Redundant Filterbank Precoders and Equalizers Parts I and II." She has co-authored two book chapters, 17 journal papers, and about 50 conference papers. She also serves as Editor for *IEEE Transactions on Wireless Communications*, and has been a Technical Committee member for ICC '03 and Publicity Chair for SPAWC '03.

KLAUS DOSTERT [SM] (klaus.dostert@etec.uni-karlsruhe.de) received his Master's degree from RWTH Aachen, Germany, in 1976, and his doctoral degree from the University of Kaiserslautern in 1980. During the following years he worked as a post-doctoral fellow in the fields of RF communications, signal processing, and data transmission over power lines. In 1991 he completed his habilitation dissertation with the *venia legendi* for RF communications. In 1992 he became a full professor at the University of Karlsruhe. During the past 11 years his work has focused on all aspects of PLC, including channel emulation, system design, and EMC solutions. He has published more than 100 scientific papers and two books on power line communications. In 2000 he was invited as a guest lecturer by the Technical University of Vienna.