

Power-Line Broadband Comes of Age

The new IEEE Broadband over Power Line standard, which delivers 500 Mbps data rate over distances up to 1,500 meters, creates new synergies among power-line, fiber and wireless networks.

By Jean-Philippe Faure ■ *Progilon*

Real estate developers, urban planners and technology providers now have a greener, more robust, lower-cost option for installing broadband in building and last-mile data networks: the IEEE 1901 Broadband over Power Line (BPL) standard.

Ratified earlier this year by the Institute of Electrical and Electronics Engineers (IEEE), a leading international standards organization, the standard will be a key enabling technology for numerous applications, including smart energy, transportation and local-area networks. Because it is an internationally recognized standard, IEEE 1901 BPL will rationalize the world of power-line communications, which has until now been characterized by proprietary technologies and sluggish growth.

IEEE 1901 BPL delivers data rates of up to 500 Mbps over the same power lines that supply electricity to businesses, campuses, factories and homes. Two other important advantages over proprietary technologies are that IEEE 1901 BPL can communicate across utility grids and that it supports existing IP network protocols, including IPv6. Every electrical outlet is a potential networking node and – unlike wireless technologies – IEEE 1901 BPL is practically immune to interference and is unaffected by radio frequency barriers such as walls.

Because in-premises installation costs for BPL are low – basically the cost of a modem – the technology offers many synergies with fiber-to-the-premises networking technologies, for which



in-premises data distribution has always posed an economic challenge. For a recently ratified standard, IEEE 1901 BPL has already achieved a remarkably advanced implementation infrastructure, including testing and certification programs that are up and running as well as a rising wave of new products.

Because IEEE 1901 BPL has an extended range over disparate media and a 500 Mbps data rate, it is an ideal networking technology for utilities as they roll out their smart-grid programs. The primary aim of the smart grid is to reduce overall power consumption. It will do this by collecting granular information about power usage and other parameters from homes and businesses on the grid. Utilities can use high-bandwidth networks to collect and consolidate the data, analyze it and adjust loads accordingly.

FINALLY, A REAL BPL SOLUTION

Although distributing information over

power lines has been a promising technology for decades, the high-frequency noise generated in the power line presented significant challenges. The most important was that the noise reduced data bandwidth. Other issues included the disparity among power transmission network characteristics in different regions and the difficulty of passing information through the transformers used to step up or step down power voltages.

The IEEE 1901 working group successfully tackled all these challenges. Its success was due in large part to the development of sophisticated modulation techniques and algorithms and to the availability of high-performance integrated circuits that can execute in real time the standard's algorithms, which are based on orthogonal frequency-division multiplexing. More than 94 corporations, trade associations and universities contributed to the standard's development.

About the Author

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Using data modems that generate carrier signals of less than 100 MHz, products compliant with IEEE 1901 can transmit data of 500 Mbps over standard AC power lines operating at any voltage. This data rate is easily sufficient to carry video information and exceeds the data rates of most wireless networking technologies. In addition, IEEE 1901 BPL's transmission distances far exceed those of wireless. Devices compliant with the standard will have ranges of up to 1,500 meters. Repeaters can be installed to extend transmission range to kilometers for smart-grid applications.

In addition, issues of crosstalk between apartments in a multifamily building have been solved in IEEE 1901. Crosstalk causes neighbors' PLC systems' signals to overlap on the electric lines. One crosstalk issue, data privacy, has been fixed with robust data encryption. Another crosstalk issue, performance degradation due to signal collisions, has been fixed with power management that provides expected coverage while limiting leakage to neighboring systems and with MAC coordination between neighboring systems for avoiding collisions when home area networks still overlap.

The arrival of a robust, standardized BPL technology provides the opportunity to introduce a new, more capable, less expensive hybrid network architecture that leverages the advantages of fiber, power-line and wireless networking technologies. In particular, wireless networks can be used where they have always made the most sense – in the last few meters between the wireless node and an end-user device such as a PC, a TV or a cell phone. Fiber no longer has to be pulled through the walls of homes, businesses and schools but can be used to provide high-speed interconnection from the headend to the pedestal.

FAST OUT OF THE GATE

Achieving interoperability between equipment from different manufacturers is usually the greatest advantage of defining a technology as an internationally recognized standard. The IEEE 1901 BPL working group has included requirements that make interoperability even more accessible to product design-

ers and manufacturers. It has, for example, included a coexistence specification within the standard.

In November 2010, the HD-PLC Alliance, a trade association dedicated to promoting the use of BPL technology to transmit video, announced a program to certify products that comply with the IEEE 1901 PHY and MAC specifications. The certification tests include required PHY performance and compatibility tests with all HD-PLC (high-definition power-line communications) products. In addition, the program provides certification to the coexistence specification known as Inter-System Protocol (ISP) in IEEE 1901. Products certified as IEEE 1901 BPL-compliant by the HD-PLC Alliance will be used primarily for in-home distribution of entertainment media and PC connectivity.

GREENING THE SMART GRID

The IEEE 1901 BPL working group also took smart-grid technologies into consideration. Although power usage information from a single home or business may require little bandwidth, from the electric utilities' perspective the combined information flow becomes a torrent of real-time data that requires broadband connections such as IEEE 1901's 500 Mbps.

In addition, integrating the distributed power produced by microgeneration (small-scale wind, solar and hydro generators) presents significant challenges for the smart grid of the future – including accounting for local energy storage. IEEE 1901 BPL enables real-time management of two-way power flows for balancing generation and consumption.

Even further in the future, IEEE 1901 will prove its value as a green-enabling technology when electric vehicles become commonplace and service stations for them are set up around cities. Power distribution networks will have to be managed to handle the load of tens of thousands of vehicles charging their batteries. In addition, billing and credit card authorization information needs a secure network, and this security has been implemented in the IEEE 1901 BPL standard by the inclusion of advanced encryption and other technologies. **BBP**

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