

## Exploiting broadband over power lines

*Every continent in the world is about to deploy BPL. Can the United States afford to stay out of the game?*



*Executive brief*

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Broadband over power lines (BPL) and power line communications (PLC) are sets of equipment, software and management services that when overlaid on the electric grid provide users with communication means over existing “power lines” (cables transmitting electricity). In the U.S., the two terms are used to differentiate broadband versus narrowband communications. In other parts of the world, PLC is often used to mean the underlying communications technology and is used to represent both broadband and narrowband communications.

Utility companies have used their power lines for communications and control for more than 30 years. Applications have included automated meter reading and monitoring and control of grid operations. These applications require a very limited bandwidth, as the data transfer rates are small and communications speeds have been very slow.

In the early 1990s, several companies, mainly in Europe, began to research PLC technology and high bandwidth signals. Research continued throughout the 1990s as the technology matured and trials conducted. Commercial deployments are now actively taking place globally, and the United States is somewhat behind Europe in BPL deployment.

The new technologies operate in the 1-to-30 MHz range. The current technology delivers 45 Mbps and it is anticipated that the next generation will deliver 200 Mbps to the transformer. Capacity on the low-voltage network between individual homes is shared. Integrators are engineering their networks to provide 25 Mbps on average per home passed. Data transmission rates are symmetrical, so download and upload speeds are equivalent, unlike the asymmetrical digital subscriber line service.

### *The alternative broadband*

BPL technology offers an alternative means of providing high-speed Internet access, voice over Internet protocol (VoIP), video on demand (VOD) and other broadband services, using medium- and low-voltage lines to access homes and businesses. BPL’s technical feasibility has been demonstrated in more than a dozen field tests, and BPL as a business is being tested for the first time in Manassas, Va., and Cincinnati, where BPL networks are being assembled to reach thousands of customers.

IBM is working with a large provider in Texas to conduct a pilot of BPL technology in that utility’s territory. In addition, IBM is testing VoIP, VOD and “utility side applications” such as auto turn-on-turn-off, BPL-enabled AMR meters and others in its BPL lab. The City of Manassas Electric Department is making BPL available to the city’s 35,000 residents. In Cincinnati, Cinergy’s Current Broadband is creating a network that will extend to 260,000 customers. PPL Telcom is also deploying an “advanced market trial,” which is relatively large in scope, with a network that has passed about 16,000 homes, 1,200 of them already having subscribed as of September 2004.

As a means of high-speed Internet access, BPL has a number of appealing features, including transmission speeds that can be higher than cable and DSL. With BPL, both uplink and downlink speeds are equally fast, making it a better option when compared to the slower uplink speeds of cable and DSL.

BPL also offers electric utilities a high-value communications network that can enhance the power delivery system. BPL can help utilities with activities such as automated outage detection and restoration confirmation, remote capability to connect and disconnect electricity service and more efficient demand-side

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management programs via automated meter reading. One of the biggest benefits of BPL for utilities is in providing an intelligent grid.

BPL technology has received endorsements from Federal Energy Regulatory Commission Chairman Pat Wood and former Federal Communications Commission Chairman Michael Powell. Given that the technology can function through virtually any electrical outlet, BPL has the potential to provide a third alternative broadband option with ubiquitous service to all Americans at affordable rates. In fact, the FCC says that about 15 percent of all homes capable of getting high-speed Internet have chosen to buy the service.<sup>1</sup> That's about 6.2 million residences that have opted to pay \$40 a month, versus about \$20 for dial-up service. The FCC is also actively working to reduce any concerns between the HAM radio operators and utilities deploying BPL.

### *How does it work?*

In the BPL basic architecture, signals are injected into the electric grid from a head end on the medium- or low-voltage lines at a substation. To back haul the signal to the head end from the substation, fiber or wireless connections are used. The signals traverse the grid network over medium- and low-voltage lines to the home or business of the end user. Links between the medium- and low-voltage lines are facilitated by channeling signals either through the transformers or by bypassing the transformer via bridges.

In order to reach the end users, there are two alternatives that can be used. Vendors such as Amperion provide interconnect with end users via wireless connections at the transformer. It must be a WiFi (802.11b for now) connection at two points: at a service

injection point for medium voltage (12/23 kV) line, and at the customer drop. Repeaters and extractors along the line boost the signal and provide customer access via WiFi. Line-mounted extractors can be powered through induction (requires >70A line) and have an internal WiFi antenna. Pole-mounted and enclosure-mounted (for areas with underground wires) installations require a transformer and external antenna. One clever touch is an antenna hidden inside a light pole. The solution uses off-the-shelf WiFi equipment as CPE. Others, such as Mitsubishi, offer wire line connections, where users can plug a BPL modem into any electrical outlet. They then connect their PC to the BPL modem with an Ethernet or USB cable to finish the connection. The process is similar to that required by users to connect to a cable-based Internet service. BPL is able to transport data, voice and video at broadband speeds for end-user customer connections.

There are numerous BPL vendors in the marketplace, and the leading U.S. vendors in terms of installs are Amperion, Ambient, Current Technologies and Main.net (see Table 1).

In addition, Mitsubishi Electric has several installations in the U.S. and uses a bridging technology to bypass the transformer. It is the largest company in the BPL equipment market, with a global reach, and it bears watching as the market develops.

There is a wide range of energy companies in the U.S. that have shown interest in BPL or are currently using BPL on a trial basis. Cinergy is the first to go commercial. At least four other major U.S. utility companies have decided to go commercial in 2005. These utility companies represent close to 10 million potential BPL customers.



Table 1. Leading BPL vendors.<sup>2</sup>

<p><b>Amperion</b></p> <ul style="list-style-type: none"> <li>• Pairs medium-voltage connect power line technology with WiFi</li> <li>• Designed to serve multiple customers per transformer</li> <li>• Delivers data at WiFi speeds</li> <li>• Uses an injector, a repeater and an extractor. The devices clamp onto an electric line</li> <li>• High-speed access to homes within 600 feet of transformer</li> <li>• Has relationship with AEP and Cisco Systems, Inc.</li> </ul>	<p><b>Main.net</b></p> <ul style="list-style-type: none"> <li>• Goes through the transformer using OFDM (Orthogonal Frequency Division Multiplexing)</li> <li>• Provides standard data rate of 2.5 Mb/s at user level</li> <li>• Uses a highly efficient modem, specially designed to operate in noisy power line environments</li> <li>• Uses a concentration head end unit, RF repeating units at the transformers, in-home network termination devices</li> <li>• Technology is FCC Part 15 verified</li> <li>• They cite that they have customers in 40 countries using this solution on a commercial basis</li> </ul>
<p><b>Current Technologies</b></p> <ul style="list-style-type: none"> <li>• Bypasses transformer</li> <li>• Uses the following elements:             <ol style="list-style-type: none"> <li>1) CT backhaul point to connect traditional networks to the distribution network – uses coupler</li> <li>2) Coupler – interfaces the signal between the power line and the bridge or backhaul point</li> <li>3) Bridge – gateway between the medium- and low-voltage distribution network (handles security, routing of IP packets, admission control, service monitoring, modulation of signal over low voltage)</li> </ol> </li> <li>• Lists operating speeds at 2-6 Mbps today</li> <li>• Uses HomePlug standard</li> </ul>	<p><b>Ambient</b></p> <ul style="list-style-type: none"> <li>• Bypasses transformer</li> <li>• Network layer products: S-Node (at the substation), X-node (bypassing the transformer), R-node (repeater, strengthening the signal along the line), GW-node (gateway, connection to the home), U-node (user, a lower-cost GW option)</li> <li>• Physical layer components: (couplers) and the nodes will provide high-speed data access to customer premises via a standard electrical outlet</li> <li>• Lists relationships with Ameren, PPL, Telecom LLC, Southern Telecom and the city of Manassas, Va.</li> <li>• Lists operating speeds at 1.5-4 Mbps</li> <li>• Has relationship with Con Ed of NY, DS2 and Earthlink</li> </ul>

There are two sets of applications that are enabled through the use of BPL. They are “revenue-side” and “utility-side” applications. The basic revenue side applications are Internet service, VoIP services and video services. This is commonly called the “triple play.” There is a wide range of utility-side applications enabled through BPL. The utility companies that are using BPL on a trial basis are coming up with new applications all the time. Utility applications cover system monitoring and customer-facing applications such as AMR (automated meter reading), demand-side management, load shedding and others.

**BPL risks**

Managing risk is arguably one of the greatest challenges companies face in harnessing the rewards of new technologies such as BPL. Their ability to understand and manage operational, business and technical risks is crucial to protect brand image, develop customer confidence, increase market penetration and achieve long-term success.

Operationally, BPL is an overlay, not a grid element. There are no physical electrical path changes. The technology cannot disable the grid. Installation can be completed by contract personnel or by utility field crews, and crew availability can have an impact on deployment schedules.



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From a business perspective, implementing BPL is often seen as a foreign and risky concept to utility companies (those burned in the Internet bubble can attest to this). Expertise is required in broadband network deployment and management as well as ISP systems. These risks can be mitigated through the use of business partners with experience in deployment and operation of ISP operations.

Additionally, BPL will face competition from cable companies and Telcos. And they will join in because there have been numerous studies which indicate that there will be a market for BPL-based services.

Technically, BPL works well. Two key issues that need to be managed are interference and the lack of existing standards. These risks are mitigated through good network design, testing, deployment and management. Equipment must be FCC Part 15 certified to mitigate interference. Notching techniques can be used as well to help eliminate interference.

### ***BPL trials***

The PLCforum estimates that there are more than 80 PLC initiatives in more than 40 countries that have been launched by electric utilities.<sup>3</sup> They indicate that pilot sites, technological or commercial trials and deployments are numerous in Europe. The PLCforum highlights what they consider the most important European initiatives, as the ones developed by EDF ([www.edf.fr](http://www.edf.fr), France), EDP ([www.edp.pt](http://www.edp.pt), Portugal), EEF ([www.eef.ch](http://www.eef.ch), Switzerland), Endesa ([www.endesa.es](http://www.endesa.es), Spain), Iberdrola ([www.iberdrola.es](http://www.iberdrola.es), Spain), PPC ([www.ppcag.de](http://www.ppcag.de), Germany) and SSE ([www.scottish-southern.co.uk](http://www.scottish-southern.co.uk), Scotland).

In Africa, BPL is being used on a trial basis in Ghana and in South Africa. The City of Tshwane Metropolitan Municipality is leading the country forward with the deployment of BPL in South Africa.

### ***BPL associations***

In the U.S., the leading associations are the United Power Line Council and the Power Line Communications Association.

The UPLC is an alliance of electric utilities and technology companies working together to drive the development of broadband over power lines in a manner that helps utilities and their partners in North America. The UPLC's efforts are focused in three strategic areas: market awareness, regulatory and legislative advocacy, and technical operability.

The PLCA is a trade association representing the interests of electric utilities interested in offering power line communications. Associate membership in the PLCA is open to other parties who have an interest in PLC, such as equipment manufacturers. The PLCA held its first industry conference on Dec. 12-13, 2001. The founding membership of the PLCA includes electric utilities that collectively serve more than 9 million U.S. households and more than 27 million households globally.

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Worldwide, the PLCforum is the leading BPL association. The PLCforum is a leading international association that represents the interests of manufacturers, energy utilities and other organizations (universities, other PLC Associations, consultants, etc.) active in the field of access and in-home PLC technologies. The PLCforum was created at the start of 2000 and its membership stands at more than 60.

In Japan, there is the PLC-J, in South America, APTEL leads BPL efforts. In Europe, there is a local body called the PLC Utilities Alliance, involving several major utility companies, including; EDF (France), EDP (Portugal), EEF (Switzerland), EnBW (Germany), Endesa (Spain), ENEL (Italy), Iberdrola (Spain), and Unión Fenosa (Spain). This association represents more than 100 million potential users.

### ***BPL adoption***

The industry is adopting three basic models that vary based on the amount the utility wants to invest and the level of risk they are willing to accept.

At one end is the landlord model where the utility company basically rents their grid to an outside party (tenant) for a percentage of the profits this company can obtain. In this role, there is little investment required and low risk. Companies exploring the landlord model will usually want free use of the BPL infrastructure for internal utility use. The tenant will generally comply with this request as utility-side applications use little bandwidth.

At the other end of the spectrum is the developer model. In this model, the utility company fully funds all the capital needed to enable BPL. In this role, there is more risk but also more opportunity to generate revenue both from wholesale of the ISP and last mile access to offering utility-side applications. Companies interested in this model have often had some success with Internet offerings and are seen to have progressive management.

The third model, combining elements of both above models, is the joint venture model, whereby utilities and ISPs negotiate their partnerships based upon their capabilities, appetites for investment and responsibilities. Joint ventures often represent strategic decisions by the parties to refocus, to develop new capabilities and position their companies in new market spaces, and are often commitments over longer periods of time.

### ***Conclusion***

BPL is a technology that is maturing fast and is about to be deployed in 2005 by several leading U.S. utility companies. BPL has been implemented on every continent. Europe is the leader and significant deployments in Asia are expected in 2005. Any utility should seriously consider implementing BPL.

### ***About the author***

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## *Endnotes*

- <sup>1</sup> Inquiry Regarding Carrier Current Systems, including Broadband over Power Line Systems, Notice of Inquiry, 18 FCC Rcd 8498, Separate Statement of Chairman Michael K. Powell (2003); see also Broadband, National Journal's Technology Daily (Dec. 16, 2003).
- <sup>2</sup> IBM Business Consulting Services analysis. <http://www.ambientcorp.com>, <http://www.amperion.com>, <http://www.main.net>, <http://www.currenttechnologies.com>
- <sup>3</sup> PLC Forum, [http://www.plcforum.org/frame\\_plc.html](http://www.plcforum.org/frame_plc.html)

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