

Broadband Over Power Line Comes of Age

The last-mile solution may have been under our noses the whole time.

Michael Kennedy

Broadband over power-line carrier is emerging after a long gestation period as an important element of the solution to the last-mile problem. Within the last year, large-scale deployment of Internet access services using BPL (broadband over power line) have been achieved in Manheim, Germany; in Spain through the offerings of Endesa and Iberdrola — the country's leading electric utilities; and in Chile by Enersis — the large electric utility that offers services in Chile, Argentina, Brazil, Columbia and Peru. In the United States, the cities of Manassas, Va., and Cincinnati, Ohio, are the first to have fully operational commercial services. At least 20 additional market or technical trials are also underway including a number at very large utilities such as American Electric Power, Consolidated Edison, Duke Power, PEPCO, Progress Energy, PG&E and Southern Company.

BPL is an intuitively attractive approach to providing broadband services because its signals ride on the electric power distribution system that reaches every computer that is plugged into a power outlet. Furthermore, distribution automation applications including outage detection, meter reading and load management alone could easily support the business case for BPL deployment. BPL is also important to public policy initiatives such as the FCC's efforts to open up telecom markets. It provides the means for electric utilities to compete effectively in the broadband services market. Utility participation strengthens open market policies through the addition of a third facilities-based path to subscribers as well as through the economic and political might of the utility industry. Utilities, in addition, have no strong vested interest in the retail telecom market and are much more willing to pursue wholesale businesses than are telephone or cable companies.

Figure 1 shows the role played by BPL in delivering IP packets from the Internet core to end user devices. The electric power transmission system is made up of high- (greater than 40 KV), medium- (1 KV to 40 KV) and low-voltage (110 V or 220 V) transmission lines. Topologically, high-voltage lines are roughly analogous to the telephone company's interoffice facilities, while medium-voltage lines correspond to the feeder and distribution portions of the subscriber loop, and low-voltage lines

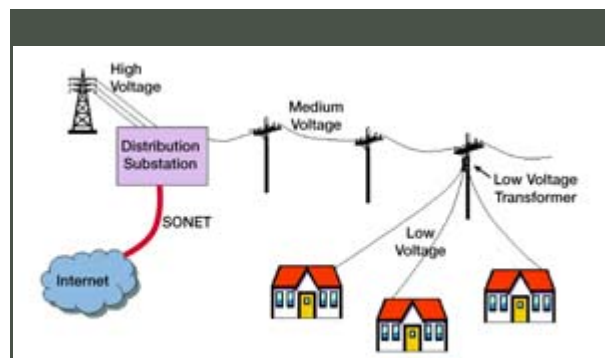


Fig. 1: BPL delivers IP packets from the Internet core to end user devices.

are much like the telco's drop wire from the street to the premises.

While the telco/power company analogy holds up fairly well, two exceptions should be noted. The distribution substations, where high voltage is transformed down to medium voltage, are placed closer to subscribers than are telco COs — the substations are more analogous to telco remote terminal units. Second, the low-voltage system extends to every power outlet — there is no inside wire interface point as there is in a telephone system. Consequently BPL is quite literally a last-mile solution. Backhaul connections from the distribution substation onto the Internet are made with standard telco optical fiber. The optical backhaul portion of the BPL system is typically closer to end users than are either telco or cable TV optical backhaul due to the number of substations. Consequently fewer subscribers share the available bandwidth of the BPL signal than is shared, for example, on the coaxial cable portion of an HFC system — typically 200 subscribers for BPL versus 1000 subscribers for HFC.

The shared BPL traffic is injected onto the medium-voltage transmission line by coupling radio-frequency energy using a spread spectrum modulation scheme ranging up to 120 MHz. One recent start-up vendor, Corridor Systems, however, uses a BPL system that operates between 2 GHz and 5 GHz. The low-voltage transformer, that in the United States typically serves five to six homes, represents the terminating point of the medium-voltage transmission line, and because the transformer is optimized for 60-Hz-electric power, it is a barrier to the BPL signal. This barrier is overcome in several ways.

Most BPL vendors, including Ambient, Current Technologies and Main.net, use couplers to divert the BPL signal around each transformer. Simple and inexpensive (\$30 to \$120) devices are plugged into power outlets and provide an Ethernet connection to the subscriber's computer or other Ethernet device. The HomePlug Alliance includes a wide-range of vendors offering a broad range of low-voltage BPL devices useful for on premises networking. Amperion, a BPL pioneer backed by American Electric Power and Cisco, solves the problem of getting beyond the low-voltage transformer by placing a Wi-Fi access point on the utility or light pole. This provides ubiquitous Wi-Fi coverage. Subscribers simply turn on their Wi-Fi-enabled equipment and sign up for service. Larger office buildings can be served through an outside antenna that could link to the internal wired LAN or WLAN solution.

Late Entrant

BPL was heavily promoted in the mid-nineties but until now it has not met those early pronouncements. Several obstacles proved more difficult to surmount than anticipated, especially in the United States. The first was the use of radio spectrum below 120 MHz, especially that below 30 MHz. Other uses for this spectrum include AM and FM radio broadcasting, public safety two-way communications, and shortwave broadcasters and amateur radio operators, who, through the ARRL (American Radio Relay League), are persuasive advocates for their use of this radio spectrum. The BPL signals tend to radiate from the injectors and repeaters spaced along the medium-voltage lines and even from the transmission lines themselves since they are designed to carry 60-Hz AC power not

MHz radio frequencies. Consequently, BPL systems must be operated at low power to avoid interference with the many licensed radio operators. This has required close repeater spacing and consequently increased cost.

The large number of couplers required to bypass low-voltage transformers has been a second source of high cost that has limited U.S. deployment as compared to Europe — five or six homes per transformer in the United States compared to 100 homes per transformer in Europe. Industry priorities also have retarded BPL development compared to cable modem or DSL. Cable MSOs spent nearly \$100 billion in the United States over the last decade modernizing their cable plants with HFC. Cable modem service has been heavily developed and promoted as a one means of capturing returns on this massive investment. Consequently, the DOCSIS 1 and 2 projects and the large-scale production of cable modems have yielded sophisticated, low-cost cable modem systems.

The telecom industry made a similar massive investment in DSL technology beginning in the mid-nineties in order to adapt its more than \$100-billion investment in twisted-pair copper cables to broadband. During the same period, the electric utility industry made a few cautious forays into wholesale communications services. It was badly burned in many cases and has yet to commit significant funds to BPL development. Consequently, BPL is now at the point on the technology price/performance progress curve that DSL and cable modems were in the mid-nineties.

BPL systems developers have addressed each of the barriers holding back development and are now poised to deliver price/performance superior to both DSL and cable modems. Figure 2 shows a capex analysis of BPL and DSL prepared by Arthur D. Little for one of its Latin American clients.

A family of three curves representing unit-cost points for 2004, 2005 and 2006 for each technology is shown as a function of residential subscriber Internet access service penetration. The year-to-year unit cost curves are tightly grouped for DSL reflecting its technical maturity while substantial gaps appear for BPL because it is still at the emerging technology point of the curve. The very large unit cost decrease shown for BPL between 2004 and 2005 reflects the role out of a new generation of chip technology that will take the shared bandwidth capacity from the current 20-Mbps range to more than 100 Mbps. The family of BPL unit cost curves slopes sharply downward with increasing subscriber penetration, because the cost of the signal injectors and repeaters are fixed regardless of the number of subscribers; unit cost decreases as the fixed cost is shared among more

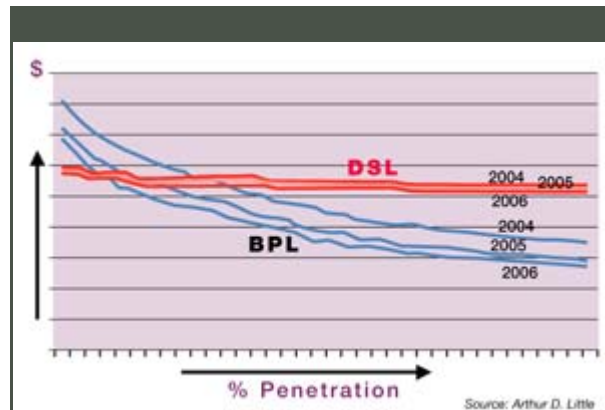


Fig. 2 A comparison of capital expenditures for BPL and DSL.

subscribers. In contrast, very little unit cost reduction is experienced with increasing DSL penetration since much of the capex is in the DSL line cards that are provisioned on a per-subscriber basis. The city of Manassas, Va., has been able to offer residential Internet access service with a symmetrical data rate of at least 300 kbps at \$26.95 a month as a consequence of this attractive cost structure.

Utility deployment of BPL-based Internet access services may signal the solution of the last-mile problem. BPL has the potential to provide high-performance broadband cost effectively without relying on either video service or telephony service bundles to cover high capital costs. It is especially attractive as a tool for providing open access to broadband since it does not depend on any incumbent provider's facilities; utilities prefer asset-based wholesale telecom business models to retail models; and utilities are the political and financial equals of incumbent telephone companies and cable operators. BPL-based access is also future proof — it actually uses more fiber than the HFC and DSL alternatives and, thus, provides an easy migration path to all-fiber (FTTP) solutions when they are needed. Despite the attractive business case for BPL, don't expect it to overtake DSL and cable modems quickly. Utilities tend to proceed only on the basis of carefully prepared business case studies. They remember the nuclear power building boom as well as the Internet bubble. However, their steady business-case-based development of BPL will spur the incumbent telephone companies to accelerate their broadband investments.

Michael Kennedy is co-founder and managing partner of Network Strategy Partners, LLC (mkennedy@nspllc.com).