POWERING THE BROADBAND MARKET IN 2005 AND BEYOND:

VIEWS ON THE EMERGENCE OF BROADBAND OVER POWER LINE TECHNOLOGY (BPL)

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EXECUTIVE SUMMARY

Broadband over power lines (BPL) has recently gained considerable attention in the media and from U.S. policymakers as a potential "third wire" in the broadband marketplace. A number of experts consider it capable of providing high-speed Internet access comparable to DSL and cable modem services. Today, electric utilities across the country are deploying the necessary technology to provide broadband and other advanced communications services, such as Voice over Internet Protocol (VoIP), via the power lines that connect to virtually every home and business. Many industry watchers and representatives now believe BPL can dramatically change the landscape of the broadband market, offering new forms of competition and delivering high-quality service to remote areas.

During the past two years, the commercial and media perspectives on BPL in the United States have evolved from categorizing the technology as "almost ready" to "really here." Europe and Asia have deployed the technology on a slightly greater scale. A range of questions still remain - What is the future of this technology? Is it a viable entrant into the broadband sphere? Can BPL generate profits and return on investment? Does the existing ubiquitous power line infrastructure provide a suitable platform for ensuring broadband access to all Americans? Have interference and other technical issues been addressed?

This New Millennium Research Council (NMRC) white paper seeks to further explore key issues surrounding this important industry and technology, focusing on BPL's prospects for success in providing widespread residential and commercial broadband services. The NMRC has compiled a comprehensive picture of the BPL industry to provide a basis for discussion among industry experts and watchers. This involved examining the history of the technology, the regulatory and technical issues that must be addressed, and potential services and benefits trumpeted by BPL proponents.

Is 2005 the year of BPL? There are a number of signs that suggest this could be the time the technology begins its emergence as a viable competitor in the broadband market. The NMRC offers this survey of the BPL environment to help both policymakers and industry experts gain a better understanding of this sector.

To illustrate technical advances and real world experiences, the NMRC chose two providers of BPL networks and services to profile in this report – COMTek and Ambient. These two companies are considered by industry followers to be among the leaders in the field, with deployments on a city-wide basis in Manassas, Virginia and a portion of New York City, respectively. The case studies examine the development of each company's involvement in BPL and the scale of each company's deployment.

Current research into the BPL industry indicates a belief among some experts that the industry may be primed for real growth in 2005 and beyond. Trials of BPL systems are increasing, with over 20 underway in 2004 and more equipment and service providers are seeking new customers. According to *Electric Utility Week*, approximately 250,000 homes in the United States had the opportunity to choose BPL services in 2004.[1] The technology is available in rural areas such as Everetts, North Carolina, suburban communities such as Manassas, Virginia, and in major cities, where buildings such as Trump Place in New York City have announced BPL deployments.[2]

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[1] Electric Utility Week, "BPL Still Thinly Deployed, But Advocates See Strong Reasons for Utilities to Choose It Soon," April 26, 2004.

[2] Katie Benner, "Internet In Your Electrical Outlet?" CNN Money, January 25, 2005. http://money.cnn.com/2005/01/19/technology/bpl/

The Federal Communications Commission's (FCC) October 2004 ruling on BPL, which established a nascent regulatory framework for the industry, was received as an important recognition of the technology as a possibly viable option for delivering broadband service. The recent visit by FCC Chairman Powell and FERC Chairman Wood to the COMTek BPL deployment in Manassas, Virginia highlighted the government's interest in promoting BPL and lent significant credibility to the burgeoning industry. Providing even greater exposure, President Bush lauded the technology in an April 2004 speech and called for additional work in creating effective standards so that BPL could be more widely deployed.[3]

Challenges still remain for an industry based on a transmission media which is designed to carry electricity, not data signals. Some technologists and industry analysts are still concerned with the potential interference from BPL systems that can negatively affect radio transmissions, particularly those of amateur radio operators. The FCC's 2004 order set out technical standards that limit the operation of BPL systems in certain frequencies and require BPL providers to "notch" out their signals (i.e., adjust them to reduce the radio frequency emissions) when an amateur radio user reports interference. Many industry leaders believe that such tactics will be sufficient to mitigate interference, but it is still a contentious issue.

BPL providers must also do more to demonstrate that there is a viable business case for this alternative broadband technology. Some BPL supporters caution that while the technology has been shown to be technically workable, economic questions remain about whether the electric utility companies can generate a profit.[4] Regarded by some as a perfect solution for America's perceived broadband "problems," BPL providers still must prove the technology can be reliable on a large scale.

This NMRC review of literature exploring the BPL landscape suggests that many experts and writers now believe that the industry is poised to gain further acceptance in near term. Given the significant increase in broadband subscription rates in the United States, and a growing belief among many businesses and consumers that broadband is a "must-have" commodity, industry experts see BPL as an "up and coming" competitor for new subscribers to high-speed services, especially in areas that have been traditionally underserved.

Methodology

The NMRC utilized both public and proprietary search tools to conduct research into BPL, culling information from news articles, technical reports, and other secondary sources. This report is not intended to serve as a compendium of new primary source research; rather it is a compilation of available information to spur further discussion and evaluation of the BPL industry.

Specifically, this paper is designed to generate thought-provoking responses, first and foremost from several BPL experts from academia and industry participating in the NMRC telenews event discussion on BPL. This report is not crafted as a position paper with regard to the future of BPL, but is designed as a reaction paper for others to review a synopsis of work performed to date on the topic.

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[3] President George W. Bush speech to the American Association of Community Colleges Annual Convention, April 26, 2004. http://www.plca.net/bushspeech.pdf

[4] Jennifer Mears, "Broadband Over Power Lines Gains Steam" PC World, August 23, 2004. www.pcworld.com.resource/printable/article/0,aid,117486,00.asp

BROADBAND OVER POWER LINE (BPL) TECHNOLOGY

Broadband over power line (BPL) is the transmission of high-speed communications services, including Internet access, over the existing electric infrastructure using adaptive technologies. The wires that carry electricity, either on poles above ground or through tunnels underground, possess the capacity to also serve as a conduit for data signals. These power lines are known as medium voltage, carrying between 1,000 and 32,000 volts of electricity and travel the distances between power substations and the customer's household or building. The power lines that connect to a household or other building from the utility pole are known as low voltage, transmitting 120/240/480 volts.

By bundling radio-frequency (RF) energy on the same line with the electric current that is already carried, data can be transmitted without the need for a separate line. Since the electric current, which is used to provide power to the end users, and RF energy signals carrying the data operate at different frequencies (with electric current traveling at lower frequencies and data at higher levels), the two don't interfere with each other. Electric companies have used a very low speed (56 Kbps) variation of this technology for years to monitor the performance of power grids.[5]

Technological advances in the past several years have enabled electric companies to place devices along existing wires and poles to provide broadband services. Known as Access BPL, the systems require a connection from the Internet backbone at a power substation, repeaters (in some cases) and couplers along the medium voltage power lines that transmit the data signals, and then a final converter that transfers the signal from the medium voltage to the low voltage lines that go into homes. Once inside the home, the signal can be accessed at any electrical outlet with a BPL modem.

From the fiber optic connection at the power substation, the broadband data can only travel a short distance before the signal quality degrades. Manufacturers have developed repeaters which are placed along the power lines and take the broadband data stream, regenerate the signal, and retransmit it. At selected transformers along the wires, which reduce the voltage in order to provide the standard amount of electricity to a home, a coupler is put in place which routes the data signal through or around the transformer.[6]

BPL does not replace the traditional telecom network. Rather, it serves as an access technology, using a different medium to transmit communications services. BPL still requires the initial connection to the Internet backbone. From there, it is a last-mile solution, either through direct connection to the home via the power lines or, as some companies have attempted, using Wi-Fi transmitters on the utility poles.[7]

Potential interference with amateur radio operations is a technical concern with BPL currently being addressed by both regulators and providers. BPL systems operate between 2 and 50 MHz, often in frequencies close to those used by Ham/shortwave radios and certain other licensed users. The power lines are not shielded in the same way copper wires and fiber optics are and the energy carried by radio frequencies along the lines can radiate out. The FCC's Part 15 rules specify emissions limits for devices operating in this spectrum.

In an October 2004 order (ET Docket No. 04-37), the FCC addressed this problem from a regulatory perspective, stating that it believes the potential for harmful interference from BPL technologies is low, and amendments to the Part 15 rules would overcome the difficulties. The FCC

[5] Robert Valdes, "How Broadband Over Powerlines Works" How Stuff Works, http://computer.howstuffworks.com/bpl.htm/printable
[6] Ibid.
[7] Ibid.

cited tests done by its own engineers, the National Telecommunications and Information Administration (NTIA), and others that indicated such interference was only detected within close proximity of approximately 150 meters from the power lines. The FCC concluded that the importance of promoting greater broadband deployment and competition outweighed the limited potential of interference from BPL.[8]

Some BPL companies have the capacity to "notch" out frequencies used by amateur radio, eliminating much of the interference problem. This technique involves altering BPL transmissions to reduce the emissions in a certain frequency band. In its order, the FCC specified that "notching" was a suitable remedy should interference occur. If a shortwave radio user indicates that a BPL system's operations are interfering with a licensed amateur radio transmission, the FCC will require the BPL provider to "notch" or reduce its emissions in that frequency by between 10 and 20 decibels. The FCC believes such reductions in "noise" will mitigate any interference problems for amateur radio. If the notching is unsuccessful, the FCC can then require the BPL provider to resolve the interference using other methods, or, in extreme cases, to cease operations in that specific area.[9]

History of the BPL Industry

The BPL industry of today grew from years of small uses of communications technologies by utilities for internal purposes and exciting laboratory tests that demonstrated the possibilities of BPL. Electric companies throughout the country began running fiber links between power substations in the 1990s, which allow BPL technologies to connect to the Internet backbone, although few deployments actually insert the signal at the substation. For some time, electric utilities have been transmitting very low speed communications signals over power lines for monitoring and control purposes.[10]

The creation of technologies capable of carrying Internet and other communications services along power lines to the end user was made feasible by the development of faster processors and microchips. For example, orthogonal frequency division multiplexing (OFDM) is a technique for separating data signals and then transmitting them over a wide swath of bandwidth.[11] A growing number of companies began developing the BPL equipment that now transmits high speed communications services from the traditional communications network

In 2003, the first concentrated efforts to deploy BPL technology commercially were announced. Previously, most work had been undertaken in the laboratory, with technologists working to determine if the technology could succeed at levels necessary to provide high-quality service to residential and commercial customers.[12]

Europe and Asia have utilized BPL since 1999, in much broader deployments than found in the United States. Spain and Portugal are home to what is considered the largest BPL deployment in the world. BPL has been more widely deployed abroad because many foreign nations use electric

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[8] *In the Matter of Amendment of Part 15 Regarding New Requirements and Measurement Guidelines for Access Broadband Over Power Line Systems,* Federal Communications Commission Report and Order, ET Docket No. 04-37, October 28, 2004. http://hraunfoss.fcc.gov/edocs_public/attachmatch/FCC-04-245A1.pdf

[9] Ibid.

[10] Rahul Tongia, "Promises and False Promises of PowerLine Carrier (PLC) Broadband Communications – a Techno-Economic Analysis" Carnegie Mellon University, 2003. Pg. 3.

[11] Electric Power Research Institute, "Broadband Over Powerline 2004: Technology and Prospects" November 2004. Pg. 4.

[12] Josh Long, "Shocking the System," *Phone Plus Magazine*, January 2004. www.phoneplusmag.com/articles/411feat06.html

systems based on the 240 volt standard and serve 200 to 250 households per transformer. In the United States, where electric networks are based on the 120 volt standard, transformers serve on average only 7.5 households. The economics were much more favorable on the 240 system in the early product development states, and now industry experts believe the manufacturers see a more economically viable case for the 120 volt systems prevalent in the U.S.

Perhaps the biggest boost to the BPL industry in the U.S. came in April 2004 when President George W. Bush announced, "There needs to be technical standards to make possible new broadband technologies, such as the use of high-speed communication directly over power lines. Power lines were for electricity; power lines can be used for broadband technology."[13]

Growth and Innovation

During 2004, more than 20 utility companies undertook some form of BPL trial or pilot program. To date, commercial BPL deployments have occurred in Syracuse, NY, Allentown, PA, Manassas, VA, Charlottesville, VA, and Cincinnati, OH. States with BPL trial experiments include Arizona, California, Michigan, Idaho, Florida, South Carolina, and Louisiana. Some of the companies conducting the trials expect that they can obtain 20% of the market share for broadband in their service areas within several years.[14]

According to a November 2004 Research and Markets report, 33% of new broadband customers and 13% of existing broadband users will choose BPL services by 2012.[15] In August 2004, Chartwell, a research firm that tracks the energy industry, found that 20% of all utilities were considering deploying broadband services in 2003, up from 6% in 2000.[16]

In addition to these analyst reports, experts at Penn State University recently announced that BPL technology can achieve transmission rates of one gigabyte per second (Gbps) per kilometer on a medium voltage power line. Under the Penn State model for BPL technology, that one gigabyte could be shared by numerous residential customers in a neighborhood, providing them with service speeds in the hundreds of megabytes.[17]

Trade associations such as the United Power Line Council (UPLC) and the Power Line Communications Association (PLCA) were established to cope with and further promote this expanding industry. In 2004, a consortium of companies, including high-tech retail companies, equipment manufacturers, and existing broadband providers, formed the HomePlug Alliance, whose mission is to create technical standards for the industry. Over fifty companies are current members of the alliance, including Cisco, Comcast, Radio Shack, Earthlink, a number of power companies, and BPL equipment providers.[18]

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[13] President George W. Bush speech to the American Association of Community Colleges Annual Convention, April 26, 2004. http://www.plca.net/bushspeech.pdf

[14] Karen George, "Are Consumer Broadband Over Powerline (BPL) Services Enough to Make the Business Case for Utilities?" Public Utilities Fortnightly, January 2005.

[15] Research and Markets, "The Market for Broadband Over Powerline," November 2004, www.researchandmarkets.com/reports/c10065

[16] Jennifer Mears, "Broadband Over Power Lines Gains Steam" *PC World*, August 23, 2004. www.pcworld.com.resource/printable/article/0,aid,117486,00.asp

[17] Penn State University Press Release, "Power Line Data Transmission Capacity: Bigger Than DSL or Cable," January 6, 2005. http://live.psu.edu/index.php?sec=vs&story=9603&pf=1

[18] Red Nova News, "Tech Companies Working to Deliver Services Via Home Wiring," January 24, 2005. www.rednova.com/news/displacy/?id=121382

HomePlug has created modems allowing consumers to create local area networks in their household, receiving the data signals from the electrical outlets in the wall and connecting to the consumer's computer.[19] The initial technical standard was not designed to work with BPL, but some manufacturers are now enjoying varying degrees of success in making the HomePlug modem compatible with BPL. The HomePlug Alliance is working on a specification called "HomePlug Access" that is designed specifically to interface with BPL networks.

***BPL CASE STUDY #1 – COMTek* (www.comtechnologies.com)**

COMTek (Communication Technologies, Inc.) is a Chantilly, Virginia based company that provides broadband services nationally using BPL technology. As a leader in the commercial deployment of BPL, COMTek offers network services to consumers, businesses, and electric utilities. COMTek was established in 1990 and provides a range of broadband services, including wireless and fiber optic solutions, to many commercial and government clients around the world, including Qwest, KDDI, Veristar, and the U.S. Department of State.

COMTek owns and operates the Manassas, Virginia broadband over power line network. This is the first city-wide BPL system in the United States. The city of Manassas awarded COMTek a ten-year franchise in July 2004 with the provision to provide BPL services via the city's electric system. Currently, COMTek service is offered to Manassas residents at $28.95 per month, while commercial offerings start at $39.95 per month. COMTek provides the BPL modem to customers free of charge. As transmissions speeds increase and BPL technology advances, COMTek plans to offer tiered services.

In addition to serving consumers and businesses, COMTek's offerings enable the Manassas public utility to identify service outages at both the transformer and customer levels, perform automated meter reading (AMR), deploy video surveillance systems for security purposes, and automate traffic signal functions throughout the city. For Manassas, one of the main goals of the BPL network was to develop a "transformer outage notification system," which would allow the utility to know if all their transformers are operating. For locating service outages, the BPL repeaters that are placed at intervals along the power lines are designed to signal an alarm at the utility's operation center, so if customers call to report a problem, the monitoring system can identity where the problem lies.[2] COMTek is developing integrated outage mapping systems that will be available in near the future.

Beyond owning and operating the network, COMTek acts as the Internet Service Provider (ISP), marketing the service to Manassas residents, signing up customers, and providing email and web hosting services. COMTek is responsible for costs related to the BPL equipment installed on the power lines and provides customer service and billing processes. The COMTek network devices are based on technology from a company called Main.Net.

Continued on next page

[1] Jennifer Mears, "Broadband Over Power Lines Gains Steam," *PC World*, August 23, 2004. www.pcworld.com/resource/printable/article/0,aid,117486,00.asp

[2] Electric Power Research Institute, "Broadband Over Powerline 2004: Technology and Prospects" November 2004. Pg. 16.

[19] Electric Power Research Institute, pg. 8.

The city of Manassas provides field technicians to install the couplers and repeaters and maintains the fiber connections that link the COMTek servers and routers to the COMTek infrastructure on the power lines. Under the franchise agreement, the city receives a portion of the revenues from residential and commercial subscriber fees as compensation for the labor and fiber optic resources they contribute.[3]

To address the question of interference with amateur radio operators, COMTek uses Main.net's ability to "notch" the transmissions. The BPL signals are not sent on frequencies that are used predominantly by short wave radio users.[5] COMTek can turn off any specific frequency where there might be interference. This is an innovative technique that overcomes a potentially major obstacle to widespread BPL success. Allen Todd, the recently retired Manassas director of utilities and a licensed Ham operator, has led the City's outreach program to the Ham radio community.

COMTek and Manassas have set a high standard for BPL deployment, according to many published reports. The project is categorized as ambitious and cost effective and the city and COMTek both state that the deployment is on schedule for completion in April 2005.

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[3] Thomas Hoffman, "Energy Execs Debate Future of Broadband Over Powerline," *ComputerWorld*, November 11, 2004. www.computerworld.com/printthis/2004/0,481497411,00.html

Benefits of BPL

Beyond offering consumers a potential new conduit for accessing broadband at homes and businesses, the electric utilities envisage a host of other useful applications made possible by BPL. First, BPL can serve as an interface between the utility and the consumer, offering information services to the end user. Examples include billing information, energy usage data, and warnings about possible system failures. Residential consumers can also utilize the services to make changes to their account.

Experts indicate that consumers are using BPL technology for all the same applications that are possible with other forms of broadband access. Streaming audio, video services when the speeds are sufficient, online gaming, and VoIP are just some of the features that BPL customers are enjoying.[20]

There is also the promise of "smart appliances" – refrigerators or other household objects such as washing machines and coffee makers that are connected to a network and can communicate when there is a need for maintenance or if the family is out of milk. While this type of innovation is currently considered "pie-in-the-sky," the advances in BPL technology could make this concept potentially more feasible, according to such equipment makers as General Electric, Maytag, and Whirlpool.[21]

For the electric utility, there are many possibilities for better monitoring and maintaining the power grid. Utility managers and experts envision an "intelligent electric grid" made possible by BPL. Some potential utility applications include:

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[20] Electric Power Research Institute, pg. 16.
[21] Matthew Herper, "Smart Kitchens a Long Way Off," *Forbes*, December 21, 2001. http://www.forbes.com/2001/12/21/1221networking.html

- Automated meter reading – customer usage can be monitored and billing completed without a visit to the home,
- Fault location and outage detection – BPL devices can alert the utility to possible failures in the power grid,
- Security and surveillance – the BPL network can provide video monitoring of substations and other utility buildings.[22]

Such industrial applications are cited by utilities as the prime motivation for entering the BPL market. The utility companies hope the intelligent grid will create huge cost savings, reduce energy consumption, and provide better allocation of resources to optimize efficiency. [23] These additional benefits showcase the unique qualities that make BPL an exciting prospect to many industry watchers. Experts suggest these opportunities are expected to further encourage investment by the electric utilities and increase BPL availability. As more consumers become aware of the technology and understand its qualities, experts predict interest levels should rise, along with subscriptions to the service.

BPL Hurdles and Question Marks

While BPL technology has witnessed marked growth in the number of trial deployments, questions remain as to its long term viability and the competitive economics of the industry. Selected media accounts and optimistic pronouncements suggest that BPL will radically change the broadband market, making high-speed Internet services ubiquitously available for comparatively low costs. While experts from the FCC and the industry cite the potential of the technology to expand broadband availability, many caution it is not yet the simple and immediate "magic" solution that some might hope.

A first order question is if providers can generate sufficient revenue and profits from the offering of BPL services. Differing business models have emerged in attempts to create profitable solutions. Some utilities sell access to their infrastructure to a third party provider, while others become the ISP themselves.[24] Owning the poles and the wires will help in terms of keeping deployment costs low for an electric utility, but the main challenge is still finding customers to buy the services.

According to experts, to attract these needed customers electric utilities will have to "sell" themselves in ways they have never before attempted. They will have to compete on price and quality with the existing broadband providers, in a market where the current players (DSL and cable) have a head start, a problem identified by the FCC's chief technologist during the FCC's investigation of BPL.[25] The BPL provider will also have to prove it is "better, cheaper, and faster" than other broadband alternatives.[26] This may be daunting and the necessary marketing may result in costs that are too high for utilities' business plans. In addition, the would-be BPL provider will likely require additional staff to provide high quality service to customers, further inflating costs.[27]

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[22] Ibid, pg. 16.
[23] George, 2005.
[24] Ibid, pg. 13.
[25] Joanna Glasner, "New Outlet for High Speed Access" *Wired Magazine*, February 18, 2004. http://wired.com/news/business/0,1367,62327,00.html?tw=wn_story_related
[26] Robert Shively, "Energy/Telecom Convergence That May Actually Make Sense," EnergyPulse.net, January 3, 2005. www.energypulse.net/centers/article/article_display.cfm?a_id=897
[27] Angel Cartegena, "Broadband Over Power Lines," RedNova News, April 2004, www.rednova.com/news/display/?id=48105

That said, BPL is often hailed by supporters as a potential solution for bringing broadband to rural America. FCC Chairman Powell stated, "It [BPL] really has the potential of being the great broadband hope for most of rural America."[28] While power line infrastructure is more readily available than current broadband technologies in some rural areas, there are still costs associated with providing BPL services to such areas. For example, one major cost factor involves the installation of the required multiple repeaters which allow BPL signals to be carried over long distances.[29] Also, the distance from the utility pole to the house can at times be measured in miles.

This is not to say that BPL is unworkable in rural areas. Certainly additional investment will be required, but there are options to consider. The Rural Utilities Service (RUS), a division of the U.S. Department of Agriculture, provides loans to rural broadband providers. Leaders from one of the BPL trade associations, the Power Line Communications Association, have worked with RUS officials to determine how these funds could be used for BPL.[30]

If BPL can overcome these obstacles, experts believe that the technology can fulfill its much-touted potential. As more trials are conducted, there will undoubtedly be additional information available about the appropriate business model and the ability of the technology to reach rural America effectively.[31] Many in the telecommunications industry agree that rural solutions will likely comprise multiple technologies, with BPL as a prominent contributor.

Regulatory Issues

As with any new technology, regulatory and legal issues have played and will continue to play an important role in determining BPL's success or failure. Broadband is an incredibly complex regulatory area with different rules for different technologies and legislative statutes from the pre-broadband era still governing the industry. In 2005, it is likely that Congress will revisit the Telecommunications Act of 1996 to specifically address broadband and Internet Protocol (IP) services.

To date, the most important regulatory proceeding on broadband over power lines was a 2004 report and order issued by the Federal Communications Commission (FCC). The order approved a set of operating rules for BPL systems to ensure that transmissions do not cause interference with other radio frequencies.

The interference "issue" centers on the radiation of signals from the power lines that affect the transmissions of amateur radio operators. Some tests have shown that the interference with radios occurs within 150 meters of the power lines.[32] The FCC sought to alleviate the problem by (1) excluding some frequencies from use by BPL providers, (2) creating a publicly available database of BPL providers to ensure information is readily available in the case of interference complaints, and (3) improving measurement requirements for BPL emissions.[33] If interference should occur, the FCC can require the BPL provider to alter its signal to reduce the interference or instruct the provider to shut down its operation until it can eliminate the problem.

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[28] Grant Gross, "Broadband Over Power Lines Gets a Boost," *PC World*, February 13, 2004. www.pcworld.com/resource/printable/article/0,aid,114793,00.asp
[29] Tongia, 17.
[30] *Electric Utility Week*, 2004.
[31] Electric Power Research Institute, pg. 17.
[32] Ibid, pg. 5.
[33] Federal Communications Press Release "FCC Adopts Rules for Broadband Over Power Lines to Increase Competition and Promote Broadband Service to All Americans," October 14, 2004. http://hraunfoss.fcc.gov/edocs_public/attachmatch/DOC-253125A1.pdf

An additional goal of the FCC in its BPL proceeding was to encourage intermodal competition in the broadband market. The FCC, in actions outside of the BPL sphere, has focused on increasing options for broadband customers to choose from different technologies. In its October 2004 BPL order, the FCC stated, "This new technology offers the potential to give rise to a major new medium for broadband service delivery. Services provided on Access BPL could offer high speed Internet and data communications that compete with, complement, or extend the broadband services provided on existing media."[34]

States also play an important role in governing BPL. Most regulation of the electric industry occurs at the state level. It remains unclear how a communications service offered over an electric network will be regulated by each of the 50 states. The National Association of Regulatory Utility Commissioners (NARUC) released a first set of BPL regulatory guidelines in February 2005. A number of important issues specifically controlled by the states include rights of way, pole access, and cross-subsidization of revenue.[35] Cross-subsidization, the use of revenue from services where a company has a monopoly (electricity) to fund services in a competitive market (broadband), could give power companies an unfair advantage in the broadband market.

The subject of pole attachments is also of continuing concern. Under current law, access to an electric utility' poles must be granted to any entity requesting it, if that utility has used the poles for any type of communications services whether provided by the utility or another company. Many utilities have avoided this regulation by not allowing communications services to be transmitted via their poles. Should they decide to offer BPL, the regulation would become an issue. The resulting additional administrative costs would have to be factored into any BPL business model.[36]

As states decide issues related to BPL, they may be at odds with federal mandates. This regulatory uncertainty could disrupt the industry's growth, according to Angel Cartegena, former chairman of the District of Columbia Public Service Commission.[37]

Virtually all the public reports and media coverage stress that it is vitally important to ensure a proper regulatory structure for BPL without overly burdening the emerging technology. While the interference question should not be overlooked, most experts outside of the amateur radio community believe the FCC has established a set of rules that will mitigate the problem. Continuing technological advances may hopefully further erode these concerns.

***BPL CASE STUDY #2 – Ambient* (www.ambientcorp.com)**

Ambient Corporation, based in Newton, Massachusetts, is a BPL company engaged in the design, development and marketing of equipment and technologies that enable broadband communications over low and media voltage power distribution lines. In cooperation with Consolidated Edison (Con Ed), Ambient has tested its technology in a portion of the greater New York City area.

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[34] *In the Matter of Amendment of Part 15Regarding New Requirements and Measurement Guidelines for Access Broadband Over Power Line Systems,* Federal Communications Commission Report and Order, ET Docket No. 04-37, October 28, 2004. http://hraunfoss.fcc.gov/edocs_public/attachmatch/FCC-04-245A1.pdf
[35] Electric Power Research Institute, pg. 9.
[36] Cartegena, 2004.
[37] Ibid.

Ambient was founded in 1996 and since 1999 has focused on BPL solutions. The technology deployed by Ambient includes couplers and repeaters that transfer the broadband transmission from the backhaul infrastructure to the power lines and ultimately to the consumer.

Ambient has developed a series of "nodes" that are installed at various points in the power line infrastructure. The Substation or "S" node is installed at power substations and connects to the backhaul Internet network; the Transformer "X" node is placed in transformers and can transfer data signals between medium and low voltage lines or serve as a repeater, carrying the signal along the medium voltage line; the Repeater or "R" node boosts the data signal over long distances but does not have the interface between medium and low voltage lines that the "X" node possesses; finally the Gateway "GW" node is the connection to the consumer, transmitting the communications signals from the low voltage line that runs from the pole to the building.

The Ambient collaboration with Con Ed involves two different deployments of power line communications technology. The first pilot program involved installing Ambient equipment that enables broadband transmissions over power lines in a Con Ed substation in Westchester County, NY. The limited deployment provided Internet access to two Con Ed employees who lived within one mile of the substation and to the Ossining, NY police department. Bandwidth speeds between 3.5 MBPS and 7 MBPS were available to the customer premises.[1]

During this trial, the BPL system indirectly allowed Con Ed to detect an impending service failure. One of the customers noticed the Internet access had slowed and contacted Con Ed. Workers discovered a cracked insulator on a nearby utility pole. The discovery of this problem averted a larger service interruption later on. Con Ed is now monitoring even slight deviations from normal conditions in order to spot potential problems.[2]

In the second program, Ambient installed equipment in a Con Ed tunnel that runs beneath Manhattan. These power lines carry Internet traffic and also allow Con Ed workers to make phone calls using Voice over Internet Protocol (VoIP) services.

Ambient plans to use the communications infrastructure in the future to provide many "intelligent network" tools to Con Ed. Workers will be able to read meters remotely, quickly identify locations where a power cable has failed or is in need of repair, and block power surges before they cause blackouts.[3]

Con Ed and Ambient may deploy the technology on a larger scale in residential areas, offering broadband and other communications services in a high-rise apartment building on the Upper West Side of Manhattan. This project will test the technology on underground wires that provide service to the building rather than the above ground wires that were employed in the Westchester County experiment.

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[1] Comments of Ambient Corporation to the Federal Communications Commission, *In the Matter of Amendment of Part 15 Regarding New Requirements and Measurement Guidelines for Access Broadband over Powerline Systems*, ET Docket No. 04-37, May 3, 2004.

[2] Catherine Yang, "Easy Broadband – And Smarter Power," Business Week Online, November 22, 2004.

[3] Ian Urbina, "Wiring Power Lines for Broadband Access," *New York Times*, October 21, 2004.

BPL Comparison to Existing Broadband Technology

The broadband industry is categorized by a number of different types of technologies (e.g., cable modem, DSL, fiber networks, and wireless) that provide a variety of capabilities and services to the end user, both businesses and residential consumers. Proponents believe the BPL technology compares favorably with these other types of services, offering similar and sometimes greater speeds and equivalent and sometimes lower prices.

The multiple forms of broadband access are provided over different types of network infrastructure. DSL is transmitted over existing copper networks with new equipment required in the telephone company central offices. Cable modem is a hybrid fiber-coax network which has required billions in investment from the cable industry to enable broadband. Fiber is seen as the "coming technology," offering extremely high speed services greater than all other broadband forms, including BPL, as well as the capacity for bundled voice, video, and data services. But deploying fiber to the home requires the building of an almost entirely new network which would cost billions.[38] Wireless networks, such as WiFi and WiMax, offer lower startup costs, but are limited in their service range and questions still exist about the security of these networks.[39]

Reports on BPL indicate the technology can offer symmetrical services with equivalent upload and download speeds.[40] This is a major difference from DSL and cable modems which provide faster download speeds, but slower uploads. DSL speeds range between 800 Kbps and 1.5 Mbps, while cable modems provide approximately 3 Mbps. BPL trials have shown similar speed capability and experts expect that next generation technology will allow up to 100 Mbps transmissions over the medium voltage wires which translates to between 10 and 30 Mbps available to the end user.[41]

The ability to plug a BPL modem into an electrical outlet also provides consumers with great flexibility. It is possible to deploy BPL in all rooms of a house as the service is not limited to only one plug.[42] A single BPL modem can also support multiple computers in a household via traditional routers and wireless access points. This ease of use has been cited by industry experts as potentially attractive to those customers who currently do not subscribe to broadband. It could also drive innovation by other broadband providers as their customers seek similar capabilities.

BPL Deployment

The expansion of BPL deployment according industry analysts from such market research firms as the Yankee Group will depend upon successful demonstrations of the technology on a large scale and a commitment from both industry players and regulators.[43] Current deployments showcase that the technology has the potential to be viable.

An important element in further deployment of BPL is the development of the so-called "triple play' – voice, video, and data – capability in order for the industry to be competitive with cable and

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[38] Verizon and SBC have both announced commitments to deploy fiber. Verizon stated it is investing $800 million in 2005 for fiber deployment and SBC has said the company plans to invest $4 billion in its Project Lightspeed by 2007.
[39] Jon Swatz, "Identity Thieves Can Lurk At Wi-Fi Spots," *USA Today*, February 7, 2005.
[40] Maryanne Murray Buechner, "Power Play," *Time*, May 3, 2004.
[41] Jim Barthold, "Broadband Over Power Lines," VON Magazine, January 2005. www.vonmag.com/issue/2005/jan/features/broadband_over_power_lines.htm
[42] Robert Luke, "A New Way to Plug Into the Internet," *Atlanta Journal Constitution*, January 4, 2005.
[43] Jennifer Mears, "Broadband Over Power Lines: Coming Soon?" PC World, June 2, 2003. http://www.pcworld.com/news/article/0,aid,110920,00.asp

DSL/fiber networks. VoIP, when digitized correctly, is possible over BPL networks.[44] Video services, however, remain problematic since they require higher speeds than the approximately 1-4 Mbps services currently available to the home with BPL. This issue also affects DSL and is one of the driving forces behind the move to fiber networks.

Customer acceptance remains an important issue for the BPL industry to address. Technology writers suggest that Americans tend to segment their services – voice service from the phone company, TV/video from the cable company, electricity from the power company. It appears that VoIP is starting to change this way of thinking since voice service is now available from many different types of providers and a growing acceptance and interest by Americans.[45]

Early broadband deployments often presented customers with a host of difficulties to surmount before they were able to access any services. Today's BPL technology in the home is considered "plug-and-play," because it requires little set-up effort from the end user. For systems delivering BPL via the low voltage lines directly into the home, the consumer merely has to plug the modem into an electrical socket. Electric utilities hope this simplicity will aid in gaining customer acceptance, potentially driving deployment and increasing subscription rates.

BPL Financial Costs

There are a number of costs involved in considering BPL models. Initially, there are the costs to BPL providers for the purchase and installation of the necessary BPL equipment along the electric infrastructure. Secondly, both residential and commercial customers must pay one-time upfront costs for hardware such as BPL modems and subsequent monthly fees for the services.

According to an April 2004 *Electric Utility Week* article, the cost to a utility to deploy a BPL network to one million customers is estimated to be approximately $100 million to $150 million, with the average cost per home passed between $100 and $150.[46] Other cost estimates per home passed expand the possible range to between $50 and $200. Experts from the industry have stated that installing repeaters, which carry and amplify the data signals along the medium voltage power lines, could cost between $1,000 and $5,000 per unit.[47] Fiber networks, heralded as the future of broadband, are also seeing costs decline, but still cost a minimum of $800 per home passed to deploy.[48]

Consumers in the various BPL deployments across the nation on average are paying $30 per month for BPL services.[49] For example, residential customers in Manassas, Virginia pay $26.95 per month while Cinergy customers in the Cincinnati, Ohio area pay between $29 and $39 per month. These prices are in line with average costs for DSL and cable modem services.[50] The up-front costs for in-home BPL hardware range between $30 and $300 depending on the type of BPL system deployed in the customer's community and whether the provider charges the customer for hardware.[51]

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[44] Barthold, 2005.
[45] Pew Internet and American Life & NMRC Data Memo, "27% of Online Americans Have Heard of VoIP Telephone Service; 4 Million Are Considering Getting It At Home," June 28, 2004, http://newmillenniumresearch.org/archive/voip_datamemo.pdf
[46] Electric Utility Week, 2004.
[47] Glasner, 2004.
[48] George, 2005.
[49] Michael Brush, "The Next Big Thing in Web Access: Power Lines," MSN Money, May 19, 2004. http://moneycentral.msn.com/content/P81685.asp
[50] Electric Power Research Institute, pg. 14.
[51] George, 2005.

CONCLUSIONS

Broadband over power line technology, once confined to the laboratories of technologists, is now viewed by many experts as a fast growing and potentially important player in the broadband market. Many technology experts point to 2005 as a time when BPL can achieve strong growth, demonstrate success in existing deployments, and expand into many parts of the country.

By injecting another competitor and type of technology into the broadband market, experts including the FCC chairman see a future in which BPL changes the dynamics of the way Americans obtain high-speed Internet access. A viable "third wire" to the home could contribute to faster innovation, more choices, and potentially lower prices. Policymakers are enamored with the possible contribution of BPL to the desired intermodal competition among different broadband technologies. Residents and utilities in areas currently without broadband access believe BPL could be the solution for their obtaining advanced communications services in the near term. Some do concede, however, that BPL is not a cure-all for the problems that hamper broadband deployment in rural and remote communities.

Consumers could benefit greatly from accelerated BPL deployment according to many published reports. The media coverage of existing field trials of BPL indicate the technology is delivering quality broadband services at affordable prices comparable to the rates of other broadband providers. Industry experts believe if BPL technology can deliver voice and video services comparable to cable modem and fiber networks, then the industry can provide the communications services consumers demand and become an economically competitive alternative.

Utilities are interested in BPL for the cost and time saving applications they envision deploying, including the "intelligent electric grid." They believe BPL can facilitate monitoring the electric network, improving security, preventing or quickly repairing outages, and providing more efficient services to customers. In much of the media coverage of BPL, electric utility leaders from around the country stress the importance of these innovations and the financial benefits that could result. The utilities are much more interested in augmenting their services with BPL technology than in becoming an ISP.

Many challenges remain for BPL, including mitigating interference and complying with the FCC's order, navigating state and federal regulations, and constructing viable business models to attract more customers and create more revenue. Experts feel that while the technology might be ready, electric utility companies and their partners still need to find ways to effectively compete in the broadband market. If regulators and policymakers create uncertainty with a variety of complex rules, it is possible that BPL rollout could be slowed, according to many accounts.

Although the BPL industry is still in its early stages, it has many supporters who envisage a future where power lines will be a strong and vibrant provider of broadband services. 2005 will be an interesting year for BPL as the industry strives to overcome its current limitations and move toward mainstream acceptance. Many interested parties, from policymakers to rural Americans who seek broadband access, are eagerly waiting to see if BPL can fulfill its promise in the near future.

REFERENCES

Comments of Ambient Corporation to the Federal Communications Commission, *In the Matter of Amendment of Part 15 Regarding New Requirements and Measurement Guidelines for Access Broadband over Powerline Systems,* ET Docket No. 04-37, May 3, 2004.

Jim Barthold, "Broadband Over Power Lines," VON Magazine, January 2005. www.vonmag.com/issue/2005/jan/features/broadband_over_power_lines.htm

Katie Benner, "Internet In Your Electrical Outlet?" CNN Money, January 25, 2005. http://money.cnn.com/2005/01/19/technology/bpl/

Maryanne Murray Buechner, "Power Play," *Time*, May 3, 2004.

Angel Cartegena, "Broadband Over Power Lines," RedNova News, April 2004, www.rednova.com/news/display/?id=48105

Michael Brush, "The Next Big Thing in Web Access: Power Lines," MSN Money, May 19, 2004. http://moneycentral.msn.com/content/P81685.asp

President George W. Bush speech to the American Association of Community Colleges Annual Convention, April 26, 2004. http://www.plca.net/bushspeech.pdf

Electric Power Research Institute, "Broadband Over Powerline 2004: Technology and Prospects" November 2004.

Electric Utility Week, "BPL Still Thinly Deployed, But Advocates See Strong Reasons for Utilities to Choose It Soon," April 26, 2004.

In the Matter of Amendment of Part 15Regarding New Requirements and Measurement Guidelines for Access Broadband Over Power Line Systems, Federal Communications Commission Report and Order, ET Docket No. 04-37, October 28, 2004. http://hraunfoss.fcc.gov/edocs_public/attachmatch/FCC-04-245A1.pdf

Karen George, "Are Consumer Broadband Over Powerline (BPL) Services Enough to Make the Business Case for Utilities?" Public Utilities Fortnightly, January 2005.

Joanna Glasner, "New Outlet for High Speed Access" *Wired Magazine*, February 18, 2004. http://wired.com/news/business/0,1367,62327,00.html?tw=wn_story_related

Grant Gross, "Broadband Over Power Lines Gets a Boost," PC World, February 13, 2004. www.pcworld.com/resource/printable/article/0,aid,114793,00.asp

Matthew Herper, "Smart Kitchens a Long Way Off," *Forbes*, December 21, 2001. http://www.forbes.com/2001/12/21/1221networking.html

Thomas Hoffman, "Energy Execs Debate Future of Broadband Over Powerline" ComputerWorld, November 11, 2004. www.computerworld.com/printthis/2004/0,481497411,00.html

Josh Long, "Shocking the System," *Phone Plus Magazine*, January 2004. www.phoneplusmag.com/articles/411feat06.html

Robert Luke, "A New Way to Plug Into the Internet," *Atlanta Journal Constitution*, January 4, 2005.

Jennifer Mears, "Broadband Over Power Lines Gains Steam" PC World, August 23, 2004. www.pcworld.com.resource/printable/article/0,aid,117486,00.asp

Penn State University Press Release, "Power Line Data Transmission Capacity: Bigger Than DSL or Cable," January 6, 2005. http://live.psu.edu/index.php?sec=vs&story=9603&pf=1

Pew Internet and American Life & NMRC Data Memo, "27% of Online Americans Have Heard of VoIP Telephone Service; 4 Million Are Considering Getting It At Home," June 28, 2004, http://newmillenniumresearch.org/archive/voip_datamemo.pdf

Red Nova News, "Tech Companies Working to Deliver Services Via Home Wiring," January 24, 2005. www.rednova.com/news/displacy/?id=121382

Research and Markets, "The Market for Broadband Over Powerline" November 2004, www.researchandmarkets.com/reports/c10065

Robert Shively, "Energy/Telecom Convergence That May Actually Make Sense," EnergyPulse.net, January 3, 2005. www.energypulse.net/centers/article/article_display.cfm?a_id=897

Jon Swatz, "Identity Thieves Can Lurk At Wi-Fi Spots," *USA Today*, February 7, 2005.

Rahul Tongia, "Promises and False Promises of PowerLine Carrier (PLC) Broadband Communications – a Techno-Economic Analysis" Carnegie Mellon University, 2003.

Ian Urbina, "Wiring Power Lines for Broadband Access," *New York Times*, October 21, 2004.

Robert Valdes, "How Broadband Over Powerlines Works" How Stuff Works, http://computer.howstuffworks.com/bpl.htm/printable

Catherine Yang, "Easy Broadband – And Smarter Power," Business Week Online, November 22, 2004.