

INTERNET (BROADBAND) OVER ELECTRIC LINES

Abstract:

Broadband Over Power Lines - Is It for Real?

The use of power lines as a medium for communication services has been widely discussed for many years. Similar to the characteristics that led to the development of DSL (digital subscriber line), the use of surplus frequency space on power lines for communication is a simple concept that has been difficult to implement.

However, as the broadband gap between rural and more densely populated areas in the United States continues to widen, the idea of sending signals over power lines is gaining ground as a viable broadband option. Utility companies' interest in BPL (broadband over power lines) has increased as well because this technology provides a possible tool for improving overall power management.

In order to bring the high speed internet to areas where developing a traditional broadband infrastructure would be cost prohibitive, Broadband over power line technology can deliver broadband internet signals over the existing power lines that carry electricity. By using an entirely different frequency range, power lines can carry traditional AC power and data signals simultaneously.

Broadband connectivity as defined as an "always on" data connection that is able to support interactive services including internet access and has the capability of minimum download speed of 256 Kbps to an individual subscriber from the service provider.

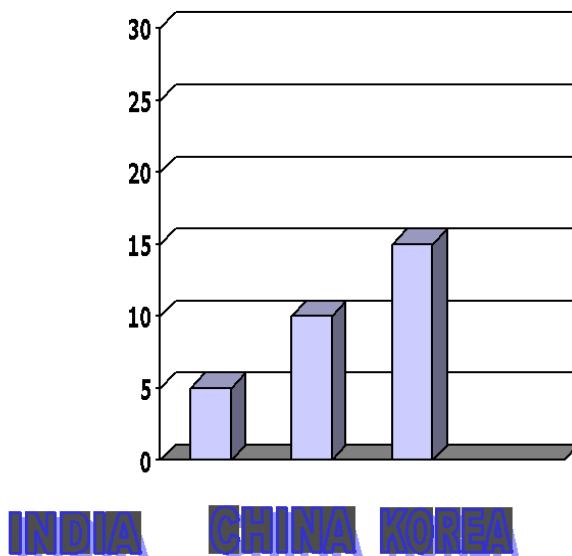
Despite the improvement in broadband technology in last few years, there are still huge parts of the world that don't have access to high-speed internet. Cost of laying cable and building the necessary infrastructure to provide broadband services is too high and that appears the major hindrance in the penetration of Broadband services typically in country like India.

Key Words: *Digital subscriber, broadband technology, AC power and data signals, High speed internet.*

Conclusion: As the time and technology advances, BPL seem to be very promising technology because the practical implementation problems are being addressed BPL is emerging as a viable third broadband wire into the home. BPLs impact on every day society will be so groundbreaking, that we can accept in a future. BPL is coming to more and more towns and cities. Careful design and operation of BPL system are essential for successful co-existing with nearby radio communications.

INTRODUCTION

The broadband penetration in India is very less as compared with other developing countries. As indicated in figure 1



BROAD BAND CONNECTIVITY FIGURE 1

In order to bring high-speed internet to areas where developing a traditional broadband infrastructure would be cost prohibitive, engineers have recently begun working on developing techniques for delivering broadband internet signals over the existing power lines that carry electricity. By using an entirely different frequency range, power lines can carry traditional AC power and data signals simultaneously. Although modifications to the current infrastructure are necessary to deliver the signals and minimize interference, the technology looks promising, as tests have yielded results comparable to other methods of broadband delivery.

With this, anywhere there is electricity there could be broadband. By slightly modifying the current power grid with specialized equipment, the Broadband power line developers could partner with power companies and internet Service providers, to bring broadband to everyone who has access to electricity. Because the utility companies have existing infrastructure in place to transmit BPL (Broadband power line) signals, they have a significant advantage over cable and DSL providers: whereas traditional broadband providers need to setup an entire infrastructure to tap into the market, utility companies need only to make slight modifications to the power supply grid to allow transmission. Yet, these slight modifications have proven to be very problematic. After its successful implementation, getting a broadband connection to home could be as easy as plugging a cord into an electrical outlet in the wall. The same power lines that deliver electricity to light rooms and refrigerators will transport messages, music, and video across cyberspace. To link up computers, music players, and TV set top boxes in a home network, people will no longer have to mess with a tangle of wires or WI-FI settings. Over the power lines, they'll have the convenience of plug-and-play.

Duke Power's BPL Service

- Interconnection with service provider partners at existing DukeNet facilities
- Use fiber optic network to transport out to neighborhood (FTTN)
- Coupler injects signal onto medium voltage distribution system. Signal is repeated as necessary
- At customer premise, transformer is bypassed and signal is injected on low voltage line
- Customer receives signal through outlets in home
- Special modem extracts signal and communicates via Ethernet to computer



ACTION FIGURE 2 : BPL IN

Such Ubiquitous availability would make it much easier for other electronics, such as television sets or sound systems, to hook up broadband internet service. It offers high- speed access to your home through the most unlikely path: a common electrical outlet. With broadband over power lines, or BPL, you can plug your computer into any electrical outlet in your home and instantly have access to high- speed internet. By combining the technological principles of radio, wireless networking, and modems, developers have created a way to send data over power lines and into homes at speeds between 500 kilobits to 3 megabits per second (equivalent to DSL and cable)

BPL is already being tested in several cities around the United States, the UK Brazil, and Hong Kong.

PRINCIPLES OF BPL

The principle behind BPL is very simple: Because electricity courses over just the low frequency portions of power lines, there's room for data to stream over higher frequencies. It uses an RF signal sent over medium- and low- voltage AC power lines to allow end users to connect to the internet. The RF signal is modulated with digital information that is converted by an interface in the home or small business into Ethernet- compatible data. That, however, will require significant upgrades of utility substations and power lines.

WORKING OF BPL:

In order to understand BPL it is important to understand existing working of power grid system. In addition to lines, power grids use generators, substations, transformers and other distributors that carry electricity from the power plant all the way to premises as shown in Figure 3. When power leaves the power plant, it hits a transmission substation and is then distributed to high voltage transmission lines. When transmitting broadband, these high voltage lines are the first obstacles.

The power following down high voltage lines is between 155,000 to 765,000volts. That amount of power is unsuitable for data transmission; it's too "noisy".

BPL by passes this problem by avoiding high voltage power lines all together. The system drops the data off of traditional fiber –optic lines down streams, onto the much more manageable 7200 volts of medium voltage power lines.

Once dropped on the medium voltage lines, the data can only travel so far before it degrades. To counter these, special devices are installed on the lines to act as repeaters. The repeaters taking the data and repeat it in a new transmission, amplifying it for the next leg of the journey.

The other major problem is the use of transformer by the power lines transmission to step up or step down the voltage. The problem with use of transformer is that our data signal carrying broadband signal is unable to travel across a transformer. There is a solution Couplers, which act as high pass filter, allow frequencies in the range of 2 to 50 MHz to pass through couplers must add to MV/LV lines so the internet signal can bypass the transformer and then "hop" back on the low voltage lines towards destination.

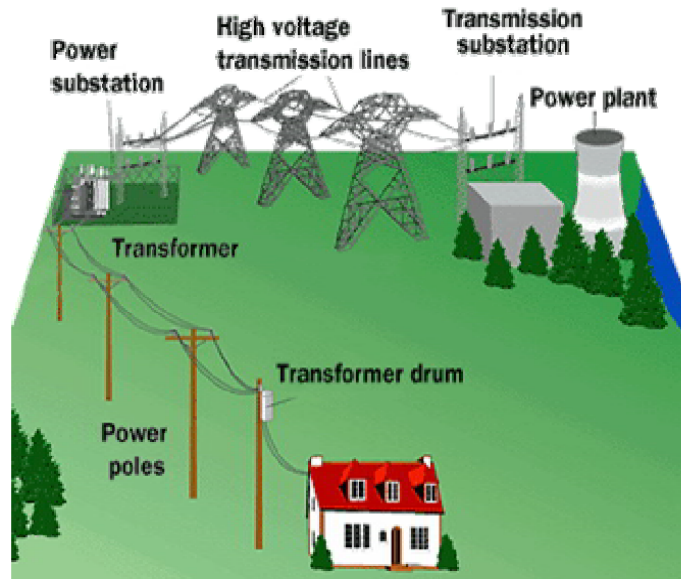


FIGURE 3 : POWER GRID SYSTEM

Now the next phase is to provide The Last Mile connection of broadband data over power lines. It is the final step that carries internet into the subscriber's home or office. There are two approaches to provide last-mile solutions for BPL. One is the used wire line link to carry the signal in with the electricity on the power line and the second is the put wireless links on the poles and send the data wirelessly into homes. As shown in figure 4 coupler and bridge is capable of both. The complete system is shown in figure 4 and 5.

The coupler and bridge can also manage symmetric data transmission to all the electrical outlets in the customer's home or office, support WiFi hot spots, handle data routing manage subscriber information , employ Dynamic Host Configuration protocol(DHCP-The protocol that allows the management and assignment of IP addresses on a network) and support security encryption of all transmissions

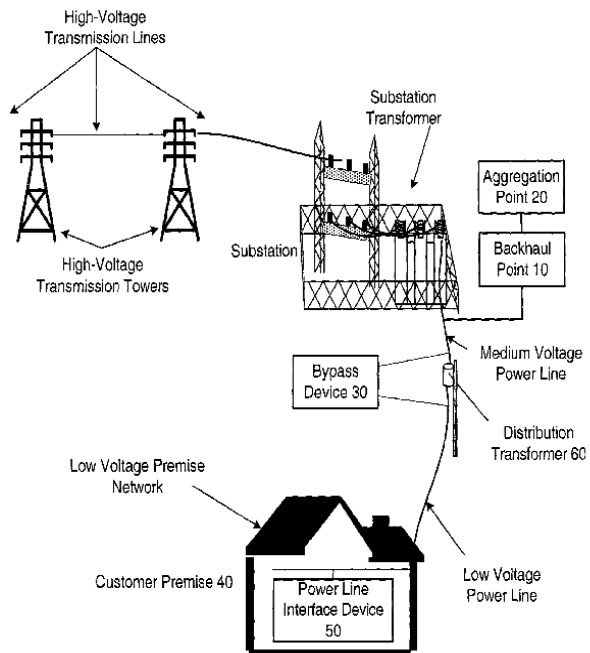


FIGURE 4 : BROADBAND OVER POWERLINES

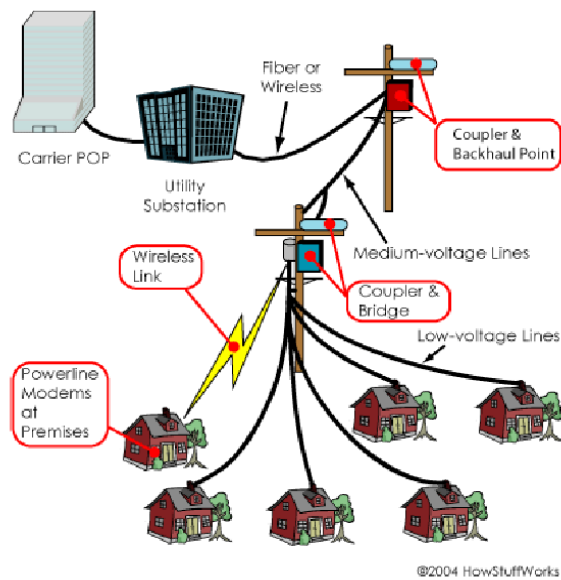


FIGURE 5 : DISTRIBUTION NETWORK

The signal is received by a power line modem. The BPL modem as shown figure 6 and figure 7 simply plugs into the wall and then into your computer. These modems are capable of transmitting the data with the speed comparable to DSL or cable modems. A BPL modem is plug and play and is roughly of the size of a common power adapter. It plugs into a common wall socket, and Ethernet cable running to your computer finishes the connection. Wireless versions are also available.



FIG 6 : BPL MODEM



FIGURE 7 : HOME PLUG MODEM

starts from the substation together and separates at the home premises.

POSSIBLE ADVANTAGES

Here is the list of possible advantages with the use of broadband over powerlines:

- ✚ Reduced cost of connectivity So, this is the complete story of the journey of broadband signal and the power signal that
- ✚ Improved energy management
- ✚ Remote metering
- ✚ Easy maintenance
- ✚ Home networking.

◆ REDUCED COST OF CONNECTIVITY

Broadband via electrical wires is certainly an encouraging idea since power lines serve nearly every home in the world with these homeowners can get a high speed connection—up to 3 megabytes per second – just by plugging a special modem into any outlet. That matches cable modem speeds and out paces most DSL offerings and without installing any extra media which certainly reduced the cost of connectivity to larger extent.

◆ IMPROVED ENERGY MANAGEMENT

After modifying an existing power grid to be capable of delivering DPL, not only can high space speed internet signal be transmitted, but also information about the status of the network. By placing the whole BPL system in action, the information about the status of the network and it can turn an electrical outlet into an internet connection data throughput rates can be remotely monitored by the utility company. In this way, the utility company will always know what is or is not working properly, without the need for field technicians to physically examine the site under questions. By injecting intelligence into the farthest reaches of

Parameters	Korea	China	India
No. of fixed telephone lines per 100 persons	51	18.0	3.9
No. of mobile phones per 100 persons	75	18.3	2.6
No. of Internet connections per 100 persons	26	2.5	0.4
No. of broadband connections per 100 persons	25	1.4	0.019
Charges per 100 kbps per months(US\$)	0.25	3.07	15.63

the power system, utilities can monitor their networks in ways never before possible. Currently, for example, power companies don't know about local outages until customers report them. With BPL systems watching the flow of data to individual homes, they can pinpoint the neighborhoods without light.

◆ **REMOTE METERING**

After successful installation of whole system companies become enable to remotely monitor the meter reading which would reduce the dependence of utility company on field technicians who would have to physically inspect the site under question.

◆ **EASY MAINTENANCE**

Whenever any user notices the slowing down the speed of the broadband connection and finds the problem of a cracked insulator on a pole next to his house, the user can immediately inform it to the service provider for rectification of the same. Otherwise, under normal circuit conditions, it would be very difficult for the service provider to locate every small insulator problem, which results easy maintenance

for the service provider.

◆ **DEMAND MANAGEMENT**

Demand management of energy is most interesting facility that will be possible with this dream technology. To encourage energy conservation, power companies would DATA

SHEET OF ICT INDICATORS AS ON 2004

FIG 8 like to charge customers more during peak demand and less at other times. To bill accordingly, they need to measure how much power a home consumes every minute of the day. The BPL will allow power companies to electronically monitor power systems and it becomes possible to check the usage according to time and charge according to that.

◆ **HOME NETWORKING**

By providing high-speed data transmission between all of the electrical pulses in a house, there is the potential to network all kinds of common appliances in a household. Imagine, if our alarm clock, light switch and coffee maker, computers, music players, and TV set top could talk each other via a high-speed connection without a tangle of wires or Wi-fi settings then our life style will be quite different and comfortable.

Scope for India

Even with tremendous growth in the information technology sector, overall ICT usage and penetration in India is still lagging behind the international averages. As indicated from fig8, the number of broadband connections per 100 persons in India is very less as compared to other developing countries. In order to get the respectable position in terms of broadband connectivity we must seriously consider BPL technology. It has a potential to prove as major contributor to achieve our aim of better connectivity, because with this technology we are able to deliver broadband Internet signals to rural and remote areas without any additional cost of infrastructure development.

➤ **Factors for BPL Success**

Most telcos and cable companies have chosen not to expand their networks to rural areas because of the high installation costs and reduced revenue potential.

Some BPL vendors are filling this void and beginning to find success by minimizing installation and operating costs while providing a high level of service comparable to that offered by existing broadband options.

To ensure future success, BPL vendors and service providers will need to do the following:

- **Minimize capital and operating expenditures by developing solutions that can transmit broadband signals over long distances with minimal line degradation and injection points.**

Most of the typical expenditures associated with installing broadband service are eliminated when using existing utility lines. However, BPL providers incur costs each time equipment is installed to boost and/or transmit the signal down the line.

The successful companies in this space have continually improved equipment such as couplers and regenerators that can pass on signals over long distances, thus lessening the interaction with line equipment.

Other vendors have developed solutions that bypass the medium-voltage lines altogether and send broadband signals wirelessly from the central office directly to the low-voltage lines and into the home. These solutions result in even lower maintenance costs and less grid disruption than the medium-voltage solutions.

- **Offer a suite of products and services that provide utility companies with "smart grid" metrics.**

For BPL to become successful, utility companies must see benefits outside the stream of revenue generated from the delivery of broadband communications to their consumers. "Smart grid" services can provide the added incentive for utility companies to embrace the integration of BPL on their networks.

- **Develop partnerships with service providers and utility companies to deliver broadband services to consumers.**

Most power companies do not have the experience or the capital funds to pursue a business model in which they provide both the back-end and the front-end broadband services to their customers. By outsourcing the retail broadband services like marketing and customer service to other firms, utility companies will still capture a portion of the broadband revenue without having to incur the financial and administrative burdens associated with retail service.

Problematic Aspects of BPL

Although PLC systems have been designed and tested on small markets of USA and Europe but many problems with the systems have halted the growth of BPL. Here are some of obstacles in the growth of BPL:

◆ RADIO INTERFERENCE

One obvious problem is that the wires that carry the signals were designed to transmit power signals at 50Hz, not broadband Internet signals in the megahertz range. Consequently, the unshielded cables transmitting the broadband signal will act as antennas interfering with other devices and picking up interference itself. Interference has been absorbed nearly one mile from the nearest BPL source. Unfortunately interference occurs in the same RF spectrum in which FM radio and wireless communication signal operated.

Consequently, the federal communication commission (FCC) of U.S.A realized the potentially enormous impact of BPL on American people and issued a change in the spectrum rules allowing BPL to operate safely in specific ranges of the RF spectrum. Modified spectrum states that all BPL devices must operate on an unlicensed basis and share the RF spectrum with licensed services. For the more these, devices must not interfere with licensed services and must accept all interference from such devices. With this rule change, BPL is considering an unlicensed service. BPL will be able to comply by determining what licensed services are in operations, such as radio services and at what frequencies they are broadcasting so as to avoid these frequency in addition certain "excluded frequency band" are define by the new ruled change , so BPL signals don't interfere with aeronautical and aircraft communication.

◆ **DIFFERNCIES IN THE ELECTRICAL DISTRIBUTION SYSTEMS**

In America and Europe there is differences implementation of PL. In America relatively few homes are connected to each transformer distributed. Where as European practice may have hundred of homes connected to each substation. Since the BPL signals do not propagated through the distribution transformers, extra equipment is needed in case of America. Due to these differences in electrical distribution there are problems in developing standards for BPL.

◆ **REQUIRE GOOD QUALITYOF LAST MHZ'S CONNECTIVITY**

In countries like India the last mile connectivity of power lines are very poor. We can often see naked power line cables and distribution of power to multiple houses from a single point. These practices will adversely affect the quality of broadband connection. So, in India there is a need of overhaul of last mile connectivity in electrical distribution system.