Broadband Over Power Lines

An Online Continuing Education Course for Engineers

Course Number: E-4037

Credit: 4 Hours / 4 PDH / 4 CPD

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Introduction

Despite the spread of broadband technology in the last few years, there are significant areas of the world that don't have access to high-speed Internet. When weighed against the relatively small number of customers Internet providers would gain, the incremental expenditures of building the necessary infrastructure to provide DSL or cable in many areas, especially rural, is too great. But if broadband could be served through power lines, there would be no need to build new infrastructure. Anywhere there is electricity, there could be broadband.

Technology to deliver high-speed data over the existing electric power delivery network is available and is used in some parts of the world. Broadband over Powerline (BPL) is positioned to offer an alternative means of providing high-speed internet access, Voice over Internet Protocol (VoIP), and other broadband services, using electric power lines to reach customers' homes and businesses. By combining the technological principles of radio, wireless networking, and modems, it is possible to send data over power lines and into homes at speeds up to 3 megabits per second (Mbps). By modifying the current power grids with specialized equipment, the BPL developers could partner with power companies and Internet service providers to bring broadband to everyone with access to electricity.

Broadband over powerlines (BPL) allows customers to get high-speed internet connections through their electrical outlets. Users can plug a power line modem into an electric socket anywhere in their home without requiring any special installation or wiring. Broadband over power lines (BPL) is the use of PLC technology to provide broadband Internet access through ordinary power lines. A computer would need only to plug a BPL modem into any outlet in an equipped building to have high-speed Internet access.

BPL may offer benefits over regular cable or DSL connections: the extensive infrastructure already available allows people in remote locations to access the Internet with relatively little equipment investment by the utility. Also, such ubiquitous availability would make it much easier to connect other electronics, such as televisions or sound systems.

Variations in the physical characteristics of the electricity network and the current lack of standards mean that provisioning of the service is far from being a standard, repeatable process. And, the amount of bandwidth a BPL system can provide compared to cable and wireless is somewhat of an unknown.

Deployment of BPL has illustrated a number of fundamental challenges, the primary one being that power lines are inherently a very noisy environment. The system must be designed to deal with these natural signaling disruptions and work around them.

Broadband over power lines has developed faster in Europe than in the United States due to a historical difference in power system design philosophies. Power distribution uses step-down transformers to reduce the voltage for use by customers. But BPL signals cannot readily pass through transformers, as their high inductance makes them act as low-pass filters, blocking high-frequency signals. So, repeaters must be attached to the transformers. In the U.S., it is common for a small transformer installed from a utility pole to service a single house or a small number of houses. In Europe, it is more common for a somewhat larger transformer to service 10 or 100 houses. For delivering power to customers, this difference in design makes little difference for power distribution. But for delivering BPL over the power grid in a typical U.S. city requires an order of magnitude more repeaters than in a comparable European city. On the other hand, since bandwidth to the transformer is limited, this can increase the speed at which each household can connect due to fewer people sharing the same line. One possible solution is to use BPL as the backhaul for wireless communications, for instance, by installing WiFi access points or cell phone base stations on utility poles, thus allowing end-users within a certain range to connect with the equipment they already have.

The second major issue is signal strength and operating frequency. The system is expected to use frequencies of 10 to 30 MHz, which has been used for many decades by amateur radio operators, as well as international shortwave broadcasters and a variety of communications systems. Power lines are unshielded and will act as antennas for the signals they carry and have the potential to interfere with shortwave radio communications.

In this course, we will look at the different technologies used to deliver broadband to the end-user, how BPL systems are actually designed and operated, the business model for BPL, and the regulatory hurdles that BPL most overcome to viable. Let's start with a look at the current status of broadband delivery in the U.S. today.

Chapter 1: Current Status of Broadband Delivery

Broadband access and services are delivered using a variety of technologies, network architectures, and transmission methods. The most significant broadband technologies include:

- Digital Subscriber Line (DSL)
- Fiber Technologies
- Coaxial Cable
- Wireless
- BPL (Broadband Over Power Lines)

The use of fast Internet connections has grown rapidly over the last few years. Currently, Coaxial Cable (Cable Modems) and Asymmetric Digital Subscriber Line (ADSL) dominate the industry. Table 1 shows a comparison of the various access technology options.

Table 1
Access Technology Options

Technology	Max Speeds	Remarks
Satellite	500 Kbps	Requires clear view to the south Weather can affect reception
BPL	5 Mbps	Same speed for Upload/Download Number of users affect speed
DSL	8 Mbps	Limited to within 18,000 ft of DSL central station equipment
Coaxial Cable	30 Mbps	Number of users affect speed
Fiber Optic Cable	1 Gbps	High costs to deploy

The following is a detailed description of each of the above-referenced access technologies.

Digital Subscriber Line (DSL)

DSL is a high-speed connection to the Internet that uses the same wires as a regular telephone line. A standard telephone installation in the United States consists of a pair of copper wires. This pair of copper wires has sufficient bandwidth for carrying both data and voice. Voice signals use only a fraction of the available capacity on the wires. DSL exploits this remaining capacity to carry information on the wire without affecting the line's ability to carry voice conversations.

Standard phone service limits the frequencies that the switches, telephones, and other equipment can carry. Human voices, speaking in normal conversational tones, can be carried in a frequency range of 400 to 3,400 Hertz. In most cases, the wires themselves have the potential to handle frequencies of up to several-million Hertz. Modern equipment that sends digital data can safely use much more of the telephone line's capacity, and DSL does just that.

Advantages of DSL

- Simultaneous Use - Phone lines can be used for voice calls and the Internet connection at the same time.
- A much higher speed when compared to a regular modem (up to 8 Mbps vs. 56 Kbps).
- Does not necessarily require new wiring. The existing phone line can be used.
- Providers generally include a modem as part of the installation.

Limitations of DSL

- The quality of the connection depends upon the proximity to the provider's central office, closer the better.
- Receiving data is faster than sending data over the Internet.
- DSL is not available everywhere.

There are several variations of DSL technology. Often the term "xDSL," where "x" is a variable, is used to discuss DSL in general. Listed below are descriptions of eight different versions of DSL.

1. Asymmetric DSL (ADSL)

It is called "asymmetric" because the download speed is greater than the upload speed. ADSL works this way because most Internet users look at, or download, much more information than they send or upload.

2. High bit-rate DSL (HDSL)
Providing transfer rates comparable to a T1 line HDSL receives and sends data at the same speed, but it requires two lines that are separate from a normal phone line.

3. ISDN DSL (ISDL)
Geared primarily toward existing users of Integrated Services Digital Network (ISDN), ISDL is slower than most other forms of DSL, operating at a fixed rate of 144 Kbps in both directions. The advantage for ISDL customers is that they can use their existing equipment, but the actual speed gain is typically only 16 Kbps (ISDN runs at 128 Kbps).

4. Multi-Rate Symmetric DSL (MSDSL)
This is Symmetric DSL that is capable of more than one transfer rate. The transfer rate is set by the service provider, typically based on the service (price) level.

5. Rate Adaptive DSL (RADSL)
This is a popular variation of ADSL that allows th speed of the connection depending on the length and

6. Symmetric DSL (SD
Like HDSL, this versio SDSL also requires a separate line from the pl sed by HDSL.

7. Very high bit-rate DSl
An extremely fast connec hort distance using standard copper phone wi

8. Voice-over DSL (VoDS
A type of IP Telephony, V into a single phone line that also includes data-

Table 2 is a summary of the