RIVIER COLLEGE

CS553: INTRODUCTION TO NETWORKING TECHNOLOGIES

AN OVERVIEW OF BROADBAND OVER POWER LINE (BPL)

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Abstract

A new technology is being standardized as an alternative to Cable or DSL to deliver the 'final mile' of broadband internet access to subscribers throughout the world. This technology requires no new cabling or infrastructure, instead leveraging the long established power grid provided by Electrical Companies. This paper introduces the reader to Broadband over Power Lines (BPL) technology, discusses the major concern with technology, and looks at its potential for the future.

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Overview of BPL

Broadband over Power Lines (BPL) is a term used to describe the use of existing electrical lines to provide the medium for a high speed communications network. BPL, also known as Power Line Communications (PLC) is achieved by superimposing the voice or data signals onto the line carrier signal using Orthogonal Frequency Division Multiplexing.

There are two main categories of BPL: in-house and access. In-house BPL is broadband access within a building or structure using the electric lines of the structure to provide the network infrastructure. HomePlug (Homeplug, 2005) is an alliance of several vendors of in-house BPL products which has authored a standard for device compliance. Products conforming to the HomePlug standard have been commercially available since 2002. For example, LinkSys offers the PLEBR10, an adapter which connects an existing router (which accepts the in-coming broadband from Cable or DSL) to the electric lines of the house. Other computers in the building can then connect to the network simply by attaching their computer's network card to an adapter (LinkSys PLUSB10) plugged into a wall outlet.

Access BPL is the use of the electrical transmission lines to deliver broadband to the home. Access BPL is considered a viable alternative to Cable or DSL to provide the 'final mile' of broadband to end users. A BPL coupler placed at the pole converts the transmission medium from fiber (originating at the substation) to medium voltage power lines. Broadband signals traverse the medium voltage power lines, bypassing transformers, with repeaters placed every mile along the transmission path. At the final pole, a BPL wireless device can deliver the broadband to home-installed BPL wireless receivers, or, the signal can be sent to the individual homes via the low-voltage electrical lines and made available through any BPL wired receiver.

Figure 1 below shows a typical Access BPL installation. Note that Fiber carries the internet to the Power line router, which applies the data signals to the medium voltage lines using ODFM. A gateway converts the signal from the medium to low-voltage lines which connect to the buildings electrical supply.

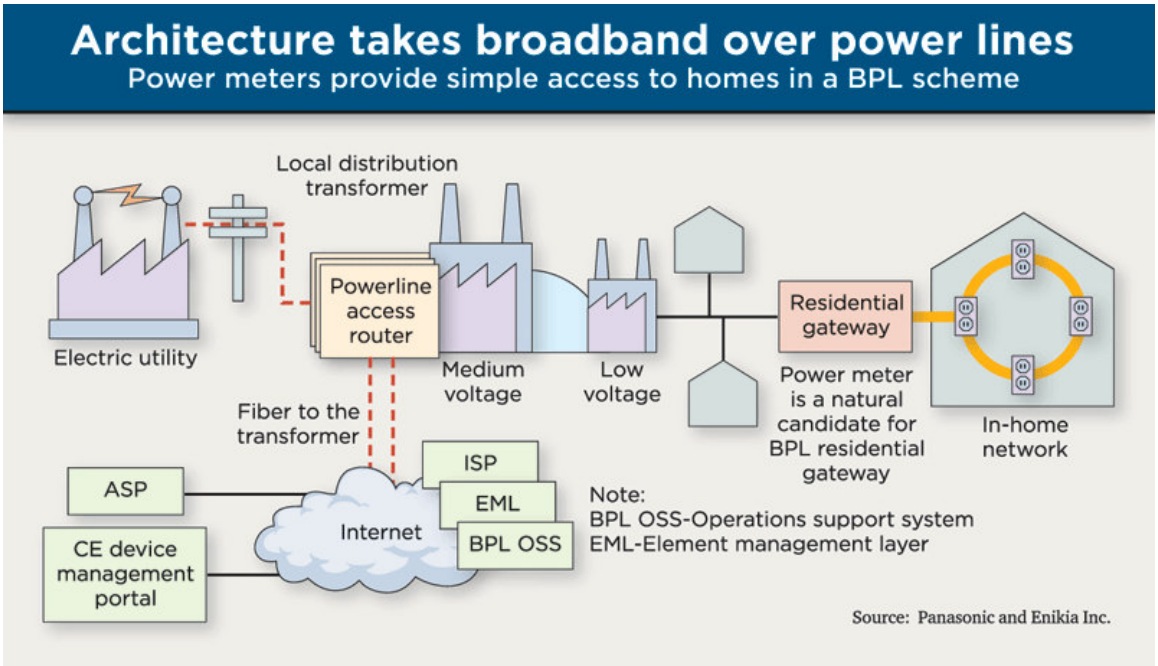

Figure 1: Access BPL Architecture

History of Communications over Electric Lines

Using electrical lines for communication is not new. Traditionally, the term "power-line carrier", has been used to refer to the use of electrical lines as a medium for communications. Electric companies have deployed technologies such as SCADA (Supervisory Control and Data Acquisition) over power-lines to perform simple command/control functions at remote locations, such as substations, using the electric transmissions lines as the conduit (Wikipedia, 2005). Electric company linesmen have also used the transmission lines by tapping the wire with specialized radios for communicating with each other along through the line.

On a smaller scale, in-home intercom systems have been available for many years that use the electric lines of the building to deliver audio data over the buildings electrical lines.

These historical uses of power-line communication typically operated at low frequencies, generally below 600 kHz (OSHA, 2005). Modulation techniques vary for traditional PLC, from FM to Wideband.

BPL Arrives on the Scene

BPL emerged in the 1990s as a means of leveraging the pervasiveness of the power grid to deliver high speed broadband communications. In order to achieve high bandwidth levels, BPL operates at higher frequencies than traditional power line communications, typically in the range between 2 and 80 MHz. The modulation technique of choice for BPL is Orthogonal Frequency Division Multiplexing. According to Jim Mollenkopf of Current Technologies, a leading supplier of BPL components, OFDM is superior to Spread Spectrum or Narrowband for spectral efficiency, robustness against channel distortions, and the ability to adapt to channel changes (Mollenkopf, 2004).

The Federal Communications Commission (FCC) sees Broadband over Power Lines as a means to deliver high speed broadband access to rural/remote portions of the country where it is presently cost prohibitive for Cable and DSL providers to develop an infrastructure of services. In the Telecommunications Act of 1996 (FCC, 1996) section 706 "Advanced Telecommunications Incentives", the Act indicates the FCC "shall encourage the deployment on a reasonable and timely basis of advanced telecommunications capability to all Americans". The FCC has provided four update reports to the Act, the second of which (FCC, 2000), identified Americans living in rural regions as being 'at risk' for obtaining high speed internet access based on existing market forces. In April 2003, the FCC issued a "Notice of Inquiry" (FCC, 2003) on BPL, seeking information on the technology. In the fourth update report (FCC, 2004) the FCC indicated "the technology has the potential to take advantage of the large-scale deployed infrastructure of the power grid to provide broadband services to some customers not yet served by DSL or cable modem services".

Recognizing the potential of BPL, the IEEE, in July 2004, began work on P1675 “Standard for Broadband over Power Line Hardware”. In the IEEE announcement of P1675 (IEEE, July 2004], they indicate the standard “will give electric utilities a comprehensive standard for installing the required hardware on distribution lines, both underground and overhead” and “will include installation requirements for the protection of those who work on BPL equipment and to ensure such systems do not place the public at risk”. In July 2005, IEEE started the P1901 “Standard for Broadband over Power Line Networks: Medium Access Control and Physical Layer Specification” (IEEE, July 2005). The standard strives to “create a

balanced and efficient BPL channel that has the bandwidth and quality of service needed by all users". IEEE is targeting both Access BPL and in-house BPL with P1901.

The Power Line Communications Association (PLCA) and PowerLine Council (UPLC) submitted a report to the FCC in March 2003 (PLCA/UPLC, 2003) summarizing the state of BPL. The report cites existing trials of BPL and states "Early results have been very encouraging. Participating households are reporting a high degree of satisfaction with the service". The report also requests prompt action by the FCC to define the emission rules for BPL devices.

Concerns with BPL

While the benefits are numerous to BPL deployment, there are concerns, primarily with Radio Frequency Interference (RFI). The American Radio Relay League (ARRL) has been one of most vocal opponents to the deployment of BPL, citing concerns with spectrum interference of existing licensed services, including ham radio operators and emergency services.

Gary Box, representing the ARRL, published an extensive analysis of their RFI concerns in (Box, 2005). In the report, Mr. Box cites three active BPL trials where interference was detected and reported through the prescribed channels. Each of the three trials resulted in aborted trials, though not all were overtly terminated for interference reasons.

The FCC, recognizing the concern with RFI, released an update to their Compliance Rules (FCC Rules, 2005) in September 2005, which includes a section on Access BPL (see Subpart G). In the document, the FCC takes several steps toward mitigating interference issues, including:

1. Requiring Access BPL deployments to be registered with a central repository
2. Access BPL systems must be able to remote adjust power and adjust operating frequencies in the event that a licensed service is interfered with as a result of BPL interference.
3. Providing a notification scenario for users of licensed services to report interference problems.

Future of BPL

While in-home BPL is already on the scene with commercial products readily available, proliferation of Access BPL faces more formidable challenge. RFI concerns are legitimate and specific cases have been documented. Standardization by the IEEE for device compliance is critical to avoiding the proliferation of proprietary solutions. Companies manufacturing BPL devices will have to ensure their products meet the revised standards set forth by the FCC, which will increase the cost of the deployment.

The electric companies are eager to pursue BPL, envisioning increased services and reduced operating costs as a result of the deployment (Forbes, 2005). Cable and DSL providers will be watching the emerging competition closely and, along with the ARRL, will be eager to ensure the BPL installations are meeting the requirements of the FCC.

BPL companies such as Current Technologies Group will continue working with the electricity providers in more trials around the country while continuing to work through issues with RFI. At the same time, the ARRL will continue to monitor and report occurrences of RFI to defend licensed services.

Summary

With the firm backing of the FCC, BPL is likely to realize a significant rollout throughout the United States. The success of the rollout depends largely on the ability of the electric companies and the BPL component developers to meet the FCC rules set forth for BPL devices. If they fail to do so, the ARRL will become even more vocal and active in their opposition to the technology.

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