Before the
FEDERAL COMMUNICATIONS COMMISSION
Washington, D.C.

In the Matter of	)	
	)	
Inquiry Regarding Carrier Current Systems,	)	ET Docket No. 03-104
including Broadband over Power Line Systems	)	

COMMENTS OF ECHELON CORP. ON NOTICE OF INQUIRY

Echelon Corporation ("Echelon"), by its attorneys, respectfully submits these comments on the Commission's Notice of Inquiry ("Notice" or "NOI") in the above-captioned docket regarding revisions to Part 15 of the Commission's Rules for power line carrier ("PLC") communications, and specifically broadband over power line ("BPL") services.[1]

INTRODUCTION AND SUMMARY

Echelon is a leading supplier of products that network together everyday electrical devices of all types – appliances, motors, valves, sensors, etc. – creating "control networks" that function in much the same way as data networks (*i.e.,* LANs). Echelon invented the LONWORKS® control networking platform, an open standard that has been adopted by many United States and international standards-setting bodies, including the American National Standards Institute ("ANSI") and the Institute of Electrical and Electronics Engineers ("IEEE").[2] Roughly 30 million LONWORKS-compliant devices – including millions employing PLC technol-

[1] FCC 03-100 (released April 28, 2003), 68 Fed. Reg. 2182 (May 23, 2003). The Federal Register provides that comments on the NOI "are due on or before August 6, 2003, and reply comments are due on or before September 5, 2003."

[2] ANSI/EIA/CEA 709.1-B-2002 Control Network Specification; IEEE Rail Transit Vehicle Interface Standards Committee 1473-1999. The LONWORKS specification has also been standardized by such diverse bodies as the Association of American Railroads, the American Society of Heating Refrigeration and Air Conditioning Engineers, and the Semiconductor Equipment Manufacturing Institute. *See, e.g.,* AAR Wired ECP Brake Protocol Standard; ASHRAE SSPC 135 (BACnet); SEMI E54.6-0997 Standard For Sensor/Actuator Network Communications For LONWORKS.

ogy – have been shipped for use in hundreds of consumer,[3] business and industrial applications around the globe. Echelon has pioneered the design, manufacture and supply of power line carrier technology, and holds approximately 50 patents for narrow-band and spread spectrum transceivers, amplifiers, error correction and signal processing, coupling circuits and applications.

Echelon fully supports the Commission's goal of pursuing alternative technologies for spurring deployment of high-speed data and Internet access to American businesses and consumers. *Notice* ¶¶ 1, 9. At the same time, we agree with the NOI's suggestion that the "non-interference" principles governing unlicensed digital and RF devices under Part 15 should apply to BPL systems and technologies. *Notice* ¶¶ 2, 4-5. The current Part 15 regulations for use of unlicensed spectrum have fostered tremendous innovation in PLC applications; changes to Part 15 are not required for BPL and may inadvertently jeopardize the many PLC technologies and applications already operating today in the harsh environment of carrier current communications. Indeed, due to their propagation characteristics, BPL systems could create a substantial risk of harmful interference, justifying Commission consideration of special limitations on both radiated and conducted emissions levels for BPL under Part 15. The European Union ("EU") and its standards-setting entities have substantial experience with BPL that the Commission should take into consideration in evaluating the interference potential of BPL on existing non-BPL uses of the power line as a communications medium.

[3] For instance, many Echelon customers manufacture LONWORKS-compliant home automation products, under the ANSI/EIA/CEA 709.1-B-2002 standard, that use PLC communications for applications similar to those provided by the X.10 and CEBus specifications called out in the Commission's NOI. *Notice* ¶ 3 n.3.

DISCUSSION

I. A WIDE RANGE OF EXISTING PLC APPLICATIONS PROVIDING LOW-BANDWIDTH POWER LINE COMMUNICATIONS EXIST TODAY AND SHOULD BE PERMITTED TO OPERATE UNIMPEDED UNDER THE TRADITIONAL PART 15 FRAMEWORK

Non-BPL power line carrier devices for appliance control, lighting control, automated meter reading, valve/pump control, fault monitoring and general purpose automation applications (referred to hereafter as "non-BPL PLC systems") are in wide-scale use throughout North America and the rest of the world. Non-BPL PLC systems typically operate within the frequency range of 9kHz to 148kHz, the band covered under EN 50065-1, the European Standard adopted by CENELEC in 1991 for PLC home automation applications.[4] The design and operation of non-BPL PLC devices range from closed, proprietary implementations to open ANSI and IEEE standards, but all of these communication devices co-exist within current Part 15 rules. The existing Part 15 framework for low-speed, low-frequency power line carrier systems operating on a non-interference basis is well suited for this purpose, has proven efficacious, and should not be changed in its essential elements.

Outside of the use of a common media access method for co-existence defined, for instance, under EN 50065-1, dissimilar non-BPL PLC systems cannot interoperate. *See Notice* ¶ 17. Encouraging interoperability is a highly desirable goal and certain organizations, such as ANSI, have defined open standards for the purposes of fostering interoperability. ANSI/EIA 709.2, governing power line communications, for example, has been adopted by many product manufacturers worldwide for non-BPL PLC applications.

[4] CENELEC, the European Committee for Electrotechnical Standardization <http://www.cenelec.org>, is a non-profit technical organization comprised of the National Electrotechnical Committees of 23 European nations. European Standards (designated "EN") adopted by CENELEC are mandatory on EU member countries, which are obligated to implement them at the national level, thus giving EN standards the status of national standards, and by withdrawal of any conflicting national standards.

The most common modulation technique for a non BPL PLC system is bi-phase shift keying ("BPSK"). However, chip/chirp spread spectrum ("SS") modulation, amplitude shift keyed ("ASK") modulation, and frequency shift keying ("FSK") are also used. *Notice* ¶ 17. Sophisticated authentication mechanisms and message tagging are used to protect against spoofing and replay attacks. Since non-BPL PLC systems send event-related information and not data (no records or files), encryption is generally not as important as security against malicious and/or surreptitious message insertion or disruption. Under the European EN 50065-1 regulations, an access method has been implemented to allow dissimilar non-BPL PLC devices to share common bandwidth using an elegant media access procedure, and many manufacturers of non-BPL PLC systems utilize the EN 50065-1 scheme in North America for shared, non-interfering media access.

A number of applications envisioned in the *Notice* are already deployed on a wide-scale using non-BPL technology, and BPL cannot match these non-BPL applications with regard to engineering efficiency or cost. The suggestion that BPL fills an unanswered need for grid control, energy management, power outage notification or automated meter reading *(see Notice* ¶ 28) is called into question by the existence of low-speed, low-frequency power line carrier systems that have been fielded in extremely high volumes specifically for this these purposes. For instance, Enel selected a non-BPL technology for 27 million new automated electric meters in Italy, and Samsung decided on non-BPL PLC devices for its smart appliance initiative.[5] In contrast, it is likely that BPL is too expensive, and uses too much power, to be of significant value for these and similar control and telemetry applications.

[5] *See, e.g.,* Metering International, *AMR Is Becoming An International Technology,* Issue 2, 2002 <http://www.metering.com/archive/022/10_1.htm>; NewsFactor Network, *Samsung Installing Web-Connected Household Appliances in Korea* (Aug. 23, 2001) <http://www.newsfactor.com/perl/story/13039.html>.

The pervasiveness of non-BPL systems mandates that the Part 15 principles of *non-interference* – both with respect to the suppression of new sources of harmful interference and acceptance of existing sources of interference – and *non-exclusive use* should apply to BPL systems. Only by adhering to these principles can the FCC ensure that BPL devices and services are neither harmed by, nor cause harm to, non-BPL PLC devices operating under Part 15.

II. THE EUROPEAN EXPERIENCE SUGGESTS THERE ARE A NUMBER OF ENGINEERING AND TECHNICAL CHALLENGES FOR BPL TO OPERATE SUCCESSFULLY ON AN UNLICENSED, PART 15 BASIS

Under the European EN 50065-1 standard adopted by CENELEC, different PLC applications and services can share common power line bandwidth, without interference, by means of a defined media access procedure. Harmonization with EN 50065-1 has occurred in countries outside of Europe, most notably Japan, with the result that non-BPL systems that comply with EN 50065-1 can co-exist on the same power mains.

Non-BPL PLC systems rely on distribution transformers to act as band filters, effectively blocking non-BPL PLC signals and providing a reliable means to segment network traffic between or within neighborhoods. This has permitted non-BPL automated meter reading systems to operate effectively and reliably over very wide areas without mutual interference. Such a system is currently being fielded by the Italian utility, Enel, which as indicated previously has installed more than eight million new non-BPL PLC electricity meters (27 million to be installed by 2006) for automated meter reading and load control.

The substantial interference potential of BPL systems, wherein signals may be conducted through mains power cords and inadvertently inductively coupled within power supplies, presents a very different challenge that the popular and widely deployed non-BPL systems have not experienced. The Wide Area Networks (WANs) deployed by NorWeb, Ascom and others in the

United Kingdom and elsewhere in the EU for access BPL have performed poorly.[6] In August 2001, the first vote under ES 59013 to change the PL signaling regulations in Europe to accommodate BPL (by splitting the frequency spectrum to distinguish between last mile access bands and in-home bands) failed.[7] Follow-up activities by the governing CENELEC technical working group (WG10) further highlighted the issues with outdoor BPL systems due to the increased output power required for the BPL signals to traverse long distances, where such higher power signals were expected to cause interference with, or be susceptible to interference from, existing licensed devices operating in the target frequency range 1.6 MHz to 30 MHz. The work by CENELEC in this areas merits further investigation by the Commission.

The FCC should also examine the experience of the European Union with regard to the potential of PLC systems with respect to signal injection into ground. *Notice* ¶ 20. Signal injection into electrical ground should be prohibited as it is in Europe and other countries following CENELEC standards. Ground-coupled PLC signals have been shown to have a detrimental effect on the operating of residual current detectors (RCD)/ground fault interrupters (GFI), changing their operating characteristics and trip points. As a consequence, the RCD/GFI may fail to trigger in the event of a hazardous ground fault, say in a bathroom or kitchen, with potentially fatal results. Accordingly, the EU has banned Line-to-Ground and Neutral-to-Ground

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[6] *See, e.g.,* Silicon.com*, Peter Cochrane's Uncommon Sense: The Right Technology For The Right Job,* May 28, 2003 <http://www.silicon.com/opinion/164/1/4387.html>; The Register, *Siemens Pulls Plug On Net Over Power Cables Technology,* March 21, 2001 <http://www.theregister.co.uk/content/archive/17775.html>. "The [BPL] concept was all the rage in the late 1990s but then high-profile suppliers, such as Nortel/Norweb, Siemens and more recently RWE, pulled out of the market." The Register, *Broadband Over Power Lines Idea Alive And Well,* Sept. 20, 2002 <http://www.theregister.co.uk/content/archive/27221.html>. For instance, NorWeb's BPL test "was scrapped after being dogged by security issues: it had the potential to interfere with emergency services' radio and even suffered interference from street lights." IT Week, *Our Friends Electric Try Broadband Again,* Feb. 13, 2003 <http://www.itweek.co.uk/News/ 1138757>.

[7] ES 598013 is a CENELEC preliminary, draft standard for the co-existence of access and in-house use of PLC communications. *See* Technical Committee CENELEC TC 205*,* Powerline Telecommunications (PLT), Co-existence of Access/In-house Systems, PLT Phase 1 (April 2001) <http://www.autoid.org/2001_Documents/ regul_rapt/prES59013-2001.pdf>. The ICT Standards Board (ICTSB) maintains a listing of all European BPL standardization activities at <http://www.ictsb.org/Activities/PLC.htm>.

signal injection for in-home PLC systems. In the absence of a technical solution to this serious safety concern, the same restriction should be adopted in the United States.

III. THE COMMISSION SHOULD CONSIDER LIMITING THE EMISSIONS OF BPL SYSTEMS UNDER PART 15 DUE TO THE POTENTIAL FOR SUBSTANTIAL INTERFERENCE WITH EXISTING PLC APPLICATIONS

There are special interference characteristics of BPL that should be taken into consideration by the Commission. *Notice* ¶ 18. First, power mains are not conducive to high-speed, high-frequency signaling due to their basic construction, which makes them better antennas than data transmission lines. These characteristics of power mains afford the opportunity for every incandescent bulb filament and extension cord to serve as an unintentional radiating antenna. Since there is no proven or cost-effective means of filtering a high-frequency BPL system so that signals inside or outside one home or apartment do not affect an adjacent dwelling, noise from a competing, non-interoperable high-speed BPL in one home or apartment can interfere with the operation of both non-BPL and BPL devices in an adjacent home or apartment.

The special interference considerations arising from BPL require care with regard to effects of BPL systems on non-BPL systems. For example, non-BPL PLC systems rely on distribution transformers to act as band filters, effectively blocking non-BPL PLC signals and providing a reliable means to segment network traffic between or within neighborhoods. The addition to a transformer of a BPL band-pass filter that allows signals under 148 kHz to pass could be devastating to the non-BPL PLC industry because it might (a) disrupt existing installations that were otherwise fully functional prior to the installation of band-pass filters, and (b) require the redesign of system architectures that are already field-proven and robust. *See* Notice ¶ 20. The addition of band-pass filters would also injure BPL systems by allowing in-band noise and sig-

nals from non-interoperable BPL systems to extend into areas in which non-interoperable BPL systems are operating.

One of the unique aspects of PLC systems is that unintentional parasitic coupling effectively creates sneak-paths by which PLC signals jump from one electrical circuit to another. To date there has been no published research, nor commercially available products, for coupling around a medium-to-low voltage transformer without creating sneak-paths. Taken together with the lack of adequate filtering and segmentation techniques, this suggests strongly that BPL signals cannot be easily contained. For this reason, and due to the intended use of BPL systems in residential areas, all BPL systems should be treated as Class B devices and band-pass filters should not be permitted to be used to couple around transformers. *Notice* ¶ 20.

Additionally, there is a need to define frequency bands that must be avoided in order to prevent disruption of existing non-BPL PLC systems. Based on the >75dB sensitivity of many non-BPL receivers, "existing Part 15 rules for low speed carrier current systems" will be "adequate to protect authorized users of the spectrum who may be affected by new high-speed BPL technology" (*Notice* ¶ 20) *only* if disturbance limitations, such as those included in EN 50065-1, are implemented as a means to protect against known sources of harmful interference. Indeed, the nature of PLC signals permits them to inadvertently couple within electrical devices, and to inadvertently transmit using power mains and devices connected to the power mains as antennas. As a result, Part 15 should specify both radiated and conducted emissions levels for BPL systems.

CONCLUSION

The Commission's goal in this proceeding is to encourage BPL applications while simultaneously ensuing that BPL systems do not harm, and are not harmed by, existing Part 15 applications such as non-BPL PLC systems. There are a number of technical challenges and

concerns arising from BPL, in particular its potential for harmful interference with current PLC devices and applications, that merit examination in this proceeding. While the FCC should promote BPL as a possible alternative for spurring deployment of high-speed data and Internet access to American businesses and consumers, it should not do so at the risk of overriding millions of existing non-BPL PLC devices and services that have relied on the settled Part 15 non-interference framework to operate successfully in the United States.

Respectfully submitted,

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