6 July 2003

Reference: FCC Proceeding 03-104 (Notice of Inquiry on Broadband Powerline Communications)

To Whom It May Concern:

The following are comments I would like to make in response to NOI 03-104 and to point out some serious concerns I have with this technology.

Since joining Hewlett-Packard Company in 1989, I have been involved in test & measurement equipment and methods in all parts of the frequency spectrum up to microwave frequencies. HP is a recognized, respected name in this space and is the authority looked to for guidance on testing procedures, techniques, and error analyses. Presently, I am an application engineer for Agilent Technologies (formerly Hewlett-Packard Company), and as such I am on the 'front line' dealing with customers in the broadband, wireless, design, and test industries on a daily basis. Many of our customers have a vital interest in what happens with In-House and Access BPL.

I have several major concerns with regard to the implementation of testing procedure and regulation of access BPL. My concerns fall under three broad technical categories: 1/ Interference location; 2/ Interference mitigation; and 3/ Susceptibility. I have an additional concern with regard to the regulatory aspect of access BPL, but this is as an interested observer and not as a member of the legal profession.

1. Locating Interference

Without doubt, there are going to be numerous complaints of interference both by and to access BPL to/from a number of other services. In the NOI, FCC states:

> 1. Second, at frequencies below 30 MHz, where wavelengths exceed 10 meters, long stretches of electrical wiring can act as an antenna, permitting the RF energy to be radiated over the airwaves. Due to the low propagation loss at these frequencies, such radiated energy can cause interference to other services at considerable distances.

And, later:

> 2. Each of these authorized services in the spectrum must be protected from harmful interference.

It is going to be difficult to track down the source of such harmful interference. In Part 15 electromagnetic compliance (EMC) testing, a device under test is placed in the controlled environment of an anechoic RF chamber, and then great care is taken to isolate the source of electromagnetic interference (EMI) with special probes that are designed to respond to only the electric or magnetic fields in a highly directional manner. Access BPL has no such luxury. We are talking about the worst possible testing environment: out in the open, with power lines running in every direction, sometimes poorly-defined boundaries between the E and H fields (due to propagation and other factors), and the potential sources being as numerous as the number of residential and commercial dwellings in the area. At the frequencies and long wavelengths involved, directional probes or antennas are impractical, and certainly not feasible in a mobile testing installation,

which is going to be a necessary characteristic of the testing facility.

In EMC testing, the generation of EMI occurs when there is common-mode to differential mode conversion, that is, the differential response to a common-mode stimulus, while the susceptibility to EMI occurs largely because of differential to common-mode conversion. The efficiency with which an electronic system allows this conversion to occur depends on a number of factors, but is mostly affected by the characteristic impedance of the line and the symmetry of the circuit. These mixed-mode parameters are difficult to measure, but they will be orders of magnitude more difficult in the field where In-House and Access BPL are concerned because of the totally unknown nature of the power lines in a broadband, multicarrier, unshielded environment simply because the characteristics are not constant over frequency, and they *change with time* due to corrosion, swaying in the wind, load on the circuit, heating, the presence of tree limbs and metal objects in the vicinity of the power lines; and the system is anything but symmetrical from an RF standpoint. As an example, homeowner A's 220 V service drop simply does not present the same impedance (to signals up to 30 MHz) as homeowner B's.

The measurement problem is exacerbated inside the home, in In-House BPL, to largely the same degree. The number of electrical outlets in use, the types of appliances plugged into AC outlets, the length and routing of the wiring in the walls, the proximity of the wiring to metal objects, the presence of other emitters in the home such as alarm systems, all produce an environment as "seen" by the In-House BPL system that is different for every user. If there is one thing needed to make a good measurement, it is some kind of standard test bench for the device under test, which is the one thing In-House and Access BPL cannot provide.

(Digital subscriber lines (DSL) have not experienced these phenomena because of the much lower frequencies involved in that technology.)

To have any chance of lessening the harmful interference from In-House / Access BPL, one must be able to locate it. In an environment where the interference will seem to be coming from everywhere at once, trying to track down interference from both types of BPL could be an extremely frustrating exercise, if not an impossible one.

2. Mitigating Interference

The pressure to mitigate any interference caused by BPL will be tremendous. This pressure will come from broadcasters, military users, other users of the shortwave bands and from the BPL users themselves who will be subject to a wide variety of interference from emitters all over the high frequency (HF) spectrum.

It wouldn't be so bad if the devices interfered with by BPL were consumer electronic devices and other electronic appliances, but the overwhelming majority of susceptible devices in the HF region (from 2 through 30 MHz) are very sensitive receivers! This is the worst possible scenario, because receivers by definition are designed to have the lowest internal noise so that they can hear the most faint of signals. The situation is akin to sneezing in a library; the noise level by definition is low, so the sneeze is heard everywhere by everyone. Simply put, the smallest amount of harmful leakage from the BPL system will be noticed immediately by a receiver somewhere which is dependent on having the lowest noise floor possible. In many cases, the receiver will be right under or next-door to the offending BPL system. In some cases, it will be in

the same building.

To get an idea of the interference potential, take a portable transistor radio into a house with an alarm system that continuously polls the windows and doors, and tune into a weak AM station. The alarm system operates at frequencies many order of magnitude less than the proposed BPL system. There is no part of the house where the interference is lessened; it seems to be everywhere. Have crude intial tests like this one been performed in an In-House/Access BPL environment? It is unconscionable that simple tests like this have eluded interested parties up until this point. In this respect, the man-in-the-street has a better handle on the nuisance that BPL will become.

Imagine a broadcaster who has just invested millions of dollars upgrading his transmitter to provide for better coverage for his listeners, only to find that a large number of the listeners are experiencing interference from BPL. Or, in another nightmare scenario, homeland security being compromised because of the new BPL installation down the street.

Whatever the modulation scheme adopted for the BPL standards, the BPL signal will have a wide bandwidth and a spectrum that is noise-like. In Agilent Technologies' Application Note 1303, *Spectrum Analyzer Measurements and Noise*, (http://cp.literature.agilent.com/litweb/pdf/5966-4008E.pdf), digital communications are compared to noise and in fact are found to be quite noise-like, so much so that the same techniques for measuring noise can be applied to measurements on digital communications. Thus, EMI generated by BPL will appear not as a discrete signal, but as a general increase in the noise floor.

To sustain the data rates cited in the FCC's NOI, BPL will have to employ a multicarrier scheme, perhaps orthogonal frequency division multiplexing (OFDM) or a variant thereof, and it will change as time goes on because it will have to react to interference that it hears in an effort to adapt to it. To anyone who has had to make measurements of an OFDM signal, the techniques are very much like measuring noise, because the signal exhibits noise-like characteristics. Yet, because of it's time variance, it will elude noise reduction techniques at the receiver and result in a generally poorer receiving environment.

To what level will we be able to pinpoint a BPL source of harmful interference? Perhaps, under the best of conditions, no more precisely than to a specific residence. At that point, who assumes responsibility? The homeowner? Most homeowners will be ill-equipped to understand the mechanism of interference, much less deal with mitigation. The ISP? The In-House or Access BPL equipment manufacturer? The electric utility? At the risk of sounding a cynical note, not any of these types of parties has up until now demonstrated a willingness to cooperate to mitigate interference, and past behavior is an indicator of future behavior. The potential for finger-pointing is enormous. The loser is the individual consumer.

3. Susceptibility of BPL to interference from external sources

The party least prepared to deal with interference is the BPL user himself. Yet, in many ways, the user, in his or her own home, will be the most susceptible to interference.

It is impossible to list all of the possible sources of potential interference to BPL in the HF spectrum. They are well-known. But the following little-noticed news item appeared on http://www.arrl.org/arrlletter/03/0516/ , the 16 May 2003 edition of the *ARRL Letter*, a weekly internet newsletter about radio, which read in part:

> The FCC bowed to power company concerns and declined to grant amateurs an expected sliver-band allocation at 136 kHz "at this time."
>
> The FCC, however, found itself more persuaded by arguments from electrical utilities and other commenters that amateur operation at 136 kHz might interfere with power line communications (PLC) used by electrical utilities to control the power grid.
>
> The FCC said a new amateur LF allocation is not justified "when balanced against the greater public interest of an interference-free power grid." The FCC said amateurs wishing to experiment with LF could apply for experimental licenses or operate under existing Part 15 rules. "We will not jeopardize the reliability of electrical service to the public," the FCC concluded.

The relevancy of this seemingly insignificant news item is huge. **If low power transmissions at 136 kHz (a much lower frequency than even the proposed BPL operating spectrum) have the potential of interfering with power line communications (of which BPL is a type), then 1/ what will be the disruption to BPL from much, much higher effective radiated power (ERP) transmissions from broadcasters, civil service, military and amateur services; and 2/ from antenna theory, the interference potential has to be regarded as reciprocal, supporting the argument that BPL represents a serious potential for harmful interference to other services.**

I fear that the uncertainty that presently surrounds BPL—in it's implementation, testing, and interference mitigation—will blossom into full-blown legal action on the part of all parties involved. The example of the broadcaster whose coverage area is seriously compromised by BPL is one example of potential litigious activity that one can see looming on the horizon, should BPL be given the go-ahead. Throwing the fate of BPL into the judicial system is not the solution to the present uncertainty! If an idea is a bad one, then what is needed is to come up with a better one.

At this moment, the FCC wants to do what is best for the public. In-House and Access BPL are seen as services that will improve and facilitate the public's use of the World Wide Web. In order to use these new services, the public will have to invest in new equipment and services, and in the interest of full disclosure, the public has the right to know all of the facts about the potential to and by BPL to/from other services, before they make the decision to proceed. We all want to guarantee an "interference-free power grid", but if this is not possible because of the laws of physics, then we cannot blindly embrace a technology that is doomed from the onset.

Al Lorona
Arcadia, CA