Comments on Consultation Paper on Broadband Over Power Line (BPL) Communications Systems, with Particular Reference to Radio Astronomy

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Summary of Position

From available technical information and results of modelling, it is not yet clear that the deployment of operational BPL systems will not raise compatibility problems with other users of the radio spectrum. Consequently, implementation of operational BPL systems in Canada should not proceed until compatibility issues with other users of the radio spectrum are addressed, or that clear processes for addressing them are identified and accepted by all concerned parties.

Critical Elements to be Addressed

Critical elements in the evaluation of new radio services[1] are:

1. Technical evaluation of systems.
2. Measurements of the levels, time-variability and spectrum of unwanted emissions produced by those systems when in normal and degraded operation.
3. Development of modelling tools for estimating the properties of unwanted emissions for more complex systems under more varied circumstances.
4. Studies of impact on other users of the spectrum.
5. Definition of unwanted emission targets that the BPL System operator should meet. Since BPL is not defined as a "service" in the ITU sense, these definitions might not be within the existing Radio Regulations.
6. Accepted methods by which compatibility issues would be addressed, both at the system and individual user level.

Comments

1. Technical Evaluations

Technical studies of test links have been carried out in Canada and elsewhere. However, these have been based upon much simpler networks that are envisaged in practice, and over relatively short timescales, which are in general insufficient for the assessment of the effects upon unwanted emissions of component degradation and damage either of the

[1] In this document the word "service" is not used in the ITU sense, but in the sense of a "service to customers".

BPL hardware, or more importantly, of insulator degradation, joint corrosion and other problems with the power line infrastructure being used. It is not clear that the diversity of equipment in existing power distribution systems was truly represented in the trials.

2. Measurements on BPL Systems

From the tests so far it is not clear what the impact will be upon radio astronomy, operations within which are based upon the use of equipment at its sensitivity limits, but measurements by radio amateurs indicate very strong interference that render operation impossible in at least some cases. It is clear from this that in some instances, enough radio-frequency energy can be emitted to cause problems for other users of the spectrum.

3. Modelling of Operational Systems

Extensive attempts have been made to develop modelling techniques for estimating the aggregate unwanted emissions from a complex BPL system, comprising multiple, complexly-connected links. These models are mainly based upon breaking the networks into elements each of which is driven with particular amplitudes and phases. The results are highly geometry specific, so it is not clear as yet what the error bars on such estimates would be. Considering the large potential impact on other spectrum users due to the signals emitted by the power lines, it is critical that this phase be satisfactorily completed before serious deployment be considered. One set of propagation estimates show BPL in the 15-30 MHz range being radiated, and through ionospheric reflection, being received thousands of kilometres away. It seems that simple inverse-square law calculations are not sufficient here, and that other propagation modes need to be included.

4. Impact on Other Spectrum Users

That significant levels of radiated power can be produced by BPL test systems is borne out by measurements made by radio amateurs. The impact upon radio amateurs could be very serious, particularly in suburban areas where radio amateurs have power poles within tens of metres of their homes. In general, radio telescopes are located far from suburban areas, moreover, whereas radio amateurs are affected by direct emission of the data signals in bands they are using.

Radio astronomy may be affected by both fundamental and harmonic emissions. In Region 2 the band 73-74.6 MHz is allocated to the radio astronomy service on a primary basis. It is possible that this band will be used by the prototype Large Adaptive Reflector radio telescope under development at the Dominion Radio Astrophysical Observatory, Penticton, British Columbia, and could be vulnerable to fundamental emissions from BPL. Other instruments are under development internationally for radio astronomical observations at low frequencies, such as the LOw Frequency Array Radiotelescope (LOFAR) and the Square Kilometer Array (SKA), in which Canadian astronomers are partners. Other radio astronomy bands could be vulnerable to harmonic emissions radiated by BPL systems. Since harmonic emissions by BPL systems will be a combination of the nature of the modulation and transmission process, together with additional harmonic generation in accidental non-linear elements such as dirty or cracked

insulators and corroded joints, it is not clear as yet as to the extent to which harmonic generation can be usefully modelled. There have been instances where cracked insulators have generated harmonics of the 60 Hz power service extending up to hundreds of MHz and rendering radio astronomical observations impossible at the radio observatory fed by that power line.

If ionospheric propagation is an additional, significant factor, it is not clear that BPL could be acceptably compatible with operations by other spectrum users, and it would be wiser not to proceed with the deployment of BPL systems.

If ionospheric propagation will not be a major problem, then there could be ways to address compatibility issues. For example, making sure BPL signals are excluded from all power lines within a protection radius (to be established) of radio astronomy facilities.

5. Definitions

The ITU Radio Regulations contain descriptions of the characteristics of spurious and out-of-band emissions, and the levels above which performance degradation would be caused to other users of the spectrum. There are also levels given for the thresholds of significant data loss in radio astronomical observations and the amounts of data loss that can be reasonably accepted. We need to agree on such levels for BPL systems or to decide that the levels in the Radio Regulations will be applied to BPL when compatibility issues are being addressed.

6. Application of Definitions

If BPL systems are broadly deployed, we will need clearly agreed processes whereby the definitions in Section 5 can be applied to real instances of compatibility problems. We cannot predict all the possibilities, so a very clear set of tools in this area will be needed.

Conclusion and Recommendation

At this point it is not clear that all the above points have been met, and so far some serious interference issues have been reported during the operation of test systems. On the basis of information available at this date, it is not clear that BPL systems can be implemented without major impact on other legitimate users of the radio spectrum. I propose that further work needs to be done to investigate the compatibility of BPL with the activities of legitimate users of the radio spectrum before Canada consider seriously their broad deployment. Since cross-border mobility is not an issue here, there is no need to follow any US course of action on BPL systems.