

PAP 15 RECOMMENDATIONS TO SGIP ON BROADBAND PLC COEXISTENCE

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1 Introduction

Smart home appliances represent a major part of the Smart Grid vision aimed at increasing energy efficiency. To achieve this goal, home appliances need to communicate via home networks with other devices in the home as well as with entities and players in other Smart Grid domains. Power line communications (PLCs) is a technology used today in home networks that could also be used for appliance communications in Smart Grid applications.

The effective use of PLCs is impeded by the existence of multiple and non interoperable technologies currently under development in various standards development organizations (SDO). As these technologies do not interoperate, their operation in close proximity may cause harmful mutual interference when operating in the same band and at the same time. This interference may lead to severe performance degradation or even malfunctions in both Smart Grid and home networking applications. It is pointed out that this aspect goes beyond smart appliances and concerns any application that uses PLC.

There are today standardized protocols under standardization that limit the harmful interference caused by non-interoperable neighboring devices. These mechanisms are commonly referred to as coexistence mechanisms. The support for a coexistence mechanism is important to the underlying stability and usefulness of Smart Grid applications that use PLC. As one of the potential acceptable outcomes of PAP 15 is to achieve coexistence among multiple PLC technologies, a PAP 15 "Coexistence" subgroup was formed in January 2010. The purpose of this subgroup is to make a recommendation to SGIP on what coexistence mechanism(s) should be added to the list of Smart Grid standards.

This report contains such recommendation for the case of coexistence among Broadband PLC (BB-PLC) devices which operate in the High Frequency (HF) band, i.e. above 1.8 MHz. A second report concerning Narrowband PLC (NB-PLC) devices will be issued at a later time.

2 The BB-PLC Coexistence Standardization Problem

The IEEE 1901 Working Group established coexistence requirements and defined a mandatory coexistence mechanism called Inter-System Protocol (ISP) that allows coexistence between devices implementing either one of the two PHY/MACs defined in the IEEE 1901 Standard. The ISP coexistence mechanism defined in IEEE 1901 was then submitted to the ITU-T G.hn Working Group with the goal of extending IEEE 1901 coexistence to include ITU-T G.hn devices. Coexistence work was subsequently spun out of the G.hn project and another ITU-T project called G.cx was then created with the purpose of creating a BB-PLC coexistence recommendation based on ISP. The output of the G.cx project would then become the BB-PLC coexistence Recommendation ITU-T G.9972 which received final approval in June 2010.

Although the very same ISP coexistence mechanism ISP was submitted to both IEEE and ITU-T, the two different comment resolution phases followed by the two Working Groups caused a divergence of the ISP specifications in the IEEE and ITU-T drafts. This divergence basically resulted in an incompatibility between the ISP as specified in IEEE 1901 and as specified in ITU-T G.9972. This divergence had three root causes: 1) a different implementation of the same ISP mechanism and its requirements; 2) different solutions for identified problems in the original ISP; 3) the additional support in IEEE 1901 but not in ITU-T G.cx of coexistence with future classes of PLC services operating in the 2 to 4 MHz band (Low-Rate Wideband Services LRWBS).

At the time the PAP 15 was created, this divergence in the IEEE and ITU-T coexistence specifications had already occurred. Furthermore, the IEEE 1901 and ITU-T G.cx Working Groups were ending their comment resolution phases and were very close to final ratification thus requiring immediate remedial actions.

3 PAP 15 Remedial Actions for the BB-PLC Coexistence

As stated in the PAP 15 Task 1 Deliverable, a wide consensus was recorded on the need of coexistence in the High Frequency band and on the need to align ISP specifications in IEEE 1901 and ITU-T G.9972. Furthermore, PAP 15 also ascertained that the requirements at the basis of the ISP coexistence mechanism satisfied Smart Grid requirements. The BB-PLC coexistence requirements developed by the IEEE 1901 Working Group were examined in PAP-15 and cross checked against the OpenHAN specifications, an AHAM white paper on Home Appliance Industry's Principles & Requirements, and EPRI use cases. As reported in the PAP 15 Task 2 Deliverable, the group concluded that existing coexistence mechanisms whose requirements were developed in the IEEE 1901 were adequate for appliance communications in the home.

As the two SDOs were close to final ratification of the BB-PLC standards, PAP 15 took immediate action for the re-alignment of the two specifications. Under the oversight of the PAP 15 coexistence subgroup, a BB-PLC coexistence Focus Group was created in February 2010. The Focus Group was composed of members of both the IEEE and ITU-T Working Groups and its goal was to work towards identifying the sources of incompatibility and discuss remedial actions.

The Task Force gave regular updates to the PAP 15 group and their reports were also used as input for PAP 15 deliverables. Causes of incompatibility between the ISP as specified in IEEE and ITU were identified by the Focus Group and discussed in PAP 15. Technical contributions aiming at aligning the two specifications were successfully made by some PAP 15 members to IEEE 1901 and ITU-T G.9972.

All causes of incompatibility in the IEEE and ITU specifications of ISP have been eliminated as of June 2010 and before final approval of the IEEE 1901 standard and the ITU-T Recommendation G.9972. One notable difference between the two coexistence specifications is that IEEE 1901 also supports coexistence with LRWBS whereas ITU-T G.9972 does not; however, this difference does not affect the compatibility of the two BB-PLC coexistence recommendations with respect to the coexistence between IEEE 1901 compliant devices and ITU-T G.9960/9961 compliant devices that also implement ITU-T G.9972.

4 Final Result and Recommendation to SGIP

PAP 15 has achieved its goal of harmonizing the two BB-PLC coexistence implementations of ISP. As a result, PAP-15 has determined that IEEE 1901 compliant devices implementing either one of the two IEEE 1901 PHY/MACs can coexist with each other; likewise, ITU-T G.9960/9961 devices that implement ITU-T G.9972 can coexist with IEEE 1901 compliant devices implementing either one of the two IEEE 1901 PHY/MACs.

There is wide consensus in PAP-15 on the importance of BB-PLC coexistence as a means to ensuring that non-interoperable BB-PLC devices deployed in proximity do not interfere with each other causing performance degradation or service disruption to BB-PLC devices that support Smart Grid applications.

For the above reasons, PAP 15 makes the following recommendations to the SGIP:

1. Include the ISP-based BB-PLC coexistence standard ITU-T G.9972 in the list of standards recommended for the Smart Grid and add a remark that ITU-T G.9972 is compatible with the ISP defined in the IEEE 1901 Standard.
2. Add a remark to the already listed IEEE 1901 Standard that its specifications include as mandatory the ISP coexistence mechanism which is compatible with the one defined in Recommendation ITU-T G.9972.
3. Mandate that all BB-PLC technologies operating over power lines (either the ones currently listed in the list of recommended standards or the ones that may be added in the future) include in their implementation either Recommendation ITU-T G.9972 or ISP as specified in IEEE 1901, as appropriate.
4. In order to be compliant with this recommendation, IEEE 1901 compliant devices must implement and activate ISP (i.e., be always on), ITU-T G.9960/G.9961 compliant devices must be compliant with and activate ITU-T G.9972 (i.e., be always on), and any other BB-PLC technology must be compliant with and activate coexistence (i.e., be always on) as specified in ITU-T G.9972 or as in the ISP of IEEE 1901, as appropriate.

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