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| **Radiocommunication Study Groups** |  |
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| Received: 4 May 2011Subject: Power Line Telecommunications | **Document 6/334-EDocument 6A/531-E** |
| **5 May 2011** |
| **English only** |
| Rapporteur Group on Power Line Telecommunications (PLT) |
| Report on Developments on PLT sincethe fifth meeting of STUDY GROUP 6 |
| (Question ITU-R 221/1) |

# 1 Introduction

1.1 As a result of discussions on various liaison statements on PLT from other ITU-R Study Groups, and consideration of the activities on PLT in progress in the ITU-T, the last meeting of Study Group 6 (Geneva, 28-29 October 2010) noted the importance of this issue to Study Group 6 and its Working Parties. Study Group 6 therefore decided to establish a Rapporteur Group on PLT issues with the following terms of reference:

− To liaise between Study Group 6 and Study Group 1 (and its Working Parties) on all issues relating to PLT.

− To represent Study Group 6 at discussions on PLT in other Study Groups and at the relevant ITU-T Study Groups (for example, ITU-T SG 15).

− To report back to Study Group 6 and its Working Parties on this issue.

1.2 The rationale for ITU-T becoming involved with PLT was an appreciation that increasing use is being made of mains electrical wiring for the transmission of wideband data at rates of several hundred Mbit/s, coupled with the realisation that although power lines in the home were designed for delivering electricity safely and efficiently to power socket outlets and appliances they were neither designed nor engineered for communications purposes and certainly not for the transmission of wide bandwidth data. In particular, ITU-T has concerns with the unshielded and untwisted wires used for power transmission, which are subject to many types of strong interference[[1]](#footnote-1); many electrical devices are also sources of noise on the wire.

1.3 Because of the susceptibility of power line communication to incoming interference, advanced communications and noise mitigation technologies have been developed within Recommendation ITU-T G.9960. The G.9960 family of Recommendations includes:

− Recommendation ITU-T G.9960 (2010), Next generation home networking transceivers.

− Recommendation ITU-T G.9961 (2010), Data link layer (DLL) for unified high-speed wire-line based home networking transceivers.

− Recommendation ITU-T G.9970 (2009), Generic home network transport architecture.

− Recommendation ITU-T G.9972 (2010), Coexistence mechanism for wireline home networking transceivers.

1.4 The reciprocal case causing concern to ITU-R on PLT is that radiation from mains power wiring will take place and must be considered as a potential source of interference to radiocommunication services.

1.5 This Report summaries the developments on PLT in ITU-R and ITU-T since October 2010, with a view to identifying issues requiring further consideration, explanation or clarification during the continuing studies in ITU-R, ITU-T and in organizations outside ITU.

# 2 Recent developments on the Recommendation ITU-T G.9960 family

2.1 The current version of G.9960 deals with PLT operation up to 80 MHz. Earlier versions envisaged operation up 200 MHz. However, following representations from ITU-R about the increased potential for interference, any extension of G.9960 beyond 80 MHz will now only take place in cooperation with ITU-R.

2.2 Nevertheless, further work on PLT is continuing apace in ITU-T. A multiple-input/multiple-output (MIMO) extension to G.9960 is in progress with a view to completing the G.9960 MIMO extension in 2011. The MIMO extension only deals with communication over power lines whereas G.9960 also deals with in-home wideband communication using co-ax, telephone and ethernet cabling.

2.3 The major development in the MIMO standard is to allow use of PLT connectivity over live-neutral, live-ground and neutral-ground wire pairings in a 3-wire electricity distribution configuration. Previously G.9960 and studies on PLT in ITU-R only envisaged connectivity over the live-neutral wire pairing. Because a large part of the potential interference radiated from PLT systems results from unbalanced operation, the MIMO configuration will require additional studies. The advantage of the MIMO configuration for PLT is that throughput is shared over different paths. The disadvantage as regards compatibility with radiocommunication services is that 3-wire working may result in a greater potential for radiated interference, although this could be offset to an extent by being able to sustain reliable communication at lower injected power levels. Because of the great variation in how grounding is applied in buildings, and the additional complications when bi-phase and 3-phase internal wiring is involved, it would appear that PLT connectivity in the 3-wire MIMO mode may often owe more to capacitive or radiative coupling than to direct connection.

# 3 Recent developments on the Smart Grid project

3.1 A further development is the use of narrowband PLT for managing electricity use and distribution under the Smart Grid project, as described in the ITU [Technical Paper](http://www.itu.int/publ/T-TUT-HOME-2010/en) “*Applications of ITU-T G.9960, ITU-T G.9961 transceivers for Smart Grid applications: Advanced metering infrastructure, energy management in the home and electric vehicles”.* As noted therein, this is based on the philosophy that “*Wherever there’s a power socket there’s a data communications connection”*. It is envisaged that every electronic device or electrical appliance in the home will incorporate a PLT modem so that they can benefit from networking with other systems.

3.2 Within ITU, Recommendation ITU-T G.9955 is being developed for this purpose. Narrowband PLT modems are being considered under this standard that will operate in the frequency range 2-25 MHz with a throughput in the range 1-5 Mbit/s.

3.3 In addition to PLT, ITU-T SG 15 is now studying the use of narrowband wireless home networking for Smart Grid purposes and has provided ITU-R Working Party 1A and TSAG with the following information regarding progress on this initiative under Document [1A/138](http://www.itu.int/md/R07-SG01-C-0138/en):

 At the ITU-T Q.4/15 meeting held 14-25, February 2011, the Members of ITU-T Q.4/15 expressed interest in the development of a new Recommendation for narrowband wireless home networking transceivers which would complement the draft ITU-T G.9955 (ex G.hnem) Recommendation for narrowband home networking on in-home wires. This would address the physical layer and data link layer specifications for narrowband wireless transceivers for home networking, including the characteristics of radio signals for this purpose.

 Recognizing the ITU-R’s expertise in wireless systems, we request the ITU-R’s comment and advice on how to best collaborate on the development of a Recommendation on this topic.

3.4 However work on PLT applications for Smart Grid is also taking place in other standards organizations and these may involve use of frequencies in the LF and MF bands, as well as HF. Mr. Liebler, Chairman of the Working Party 1A Rapporteur Group on PLT, has advised his Group Members of the interest in Narrowband PLT (below 500 kHz), to be used for control and communication purposes in the “Smart Grid” project, that was evident during the IEEE International Symposium on Powerline Communications (ISPLC), Udine, Italy, 3-6 April 2011. ITU-R should therefore seek clarification on the ranges of frequencies under consideration for use in narrowband PLT applications for Smart Grid.

# 4 Recent developments in ITU-R

4.1 Working Party 1A completed work on Draft New Recommendation on ***“The impact of power line high data rate telecommunication systems on radiocommunication systems below 30 MHz”*** during its fifth meeting (Geneva**, 21-28 June 2010).** As noted in Document [6/319](http://www.itu.int/md/R07-WP6A-C-0465/en), this was subsequently approved by Study Group 1 as Recommendation [ITU-R SM.1879](http://www.itu.int/rec/R-REC-SM.1879-0-201101-I/en). Working Party 1A had already developed Report ITU-R SM.2158, *“Impact of power line telecommunication systems on radiocommunication systems operating in the LF, MF, HF and VHF bands below 8 MHz”*. In view of these developments, Working Party 6A provided a liaison statement to Working Party 1A, and others, on issues specific to the concerns of the broadcasting service on PLT (see Document [1A/320](http://www.itu.int/md/R07-WP1A-C-0320/en)). This was followed up by other service specific comments to Working Party 1A by Working Parties 5A, 5B & 5C (see Document [1A/324](http://www.itu.int/md/R07-WP1A-C-0324/en)). Work is continuing in Working Party 1A on the development of another Report on the impact of PLT, covering the frequency range 80‑470 MHz, and on extending Recommendation ITU-R SM.1879 so as to include the frequency range 80‑470 MHz.

4.2 Of particular interest among the revisions being considered by Working Party 1A are those on modelling the behaviour of mains wiring in respect of determining how much of the injected RF energy is radiated rather than being intercepted by the PLT modems. Annex 2 to Document [1A/311](http://www.itu.int/md/R07-WP1A-C-0311/en) considers changes to Section 2 of Report ITU-R SM.2158 for frequencies below 80 MHz. Also, Annex 1 of the Annex 1 to Document [1A/311](http://www.itu.int/md/R07-WP1A-C-0311/en) considers the situation for the VHF and UHF bands. These studies are all characterised by complex mathematical analyses. While accuracy is desirable when trying to understand how radiation takes place from the mains wiring, the complexity of the mathematical analyses tends to obscure the simple situation that, as noted by ITU-T (see 1.2 above), mains wiring does not present a well formed transmission line to the RF energy injected by PLT modems. Conservation of energy considerations mean that all deviations from a transmission line with constant impedance must result in that proportion of the injected RF energy which is not intercepted by the receiving PLT modems being lost into the environment through radiation or heating.

# 5 Cooperation between ITU-T and ITU-R

5.1 In order to foster cooperation between ITU-T and ITU-R on PLT, with the aim of developing an ITU solution on co-existence between PLT and radiocommunication services, all concerned parties in ITU agreed to the creation of the ITU-R [Working Party 1A Rapporteur Group (RG) on PLT](https://extranet.itu.int/rsg-meetings/sg1/wp1a/rg-plt/default.aspx). The first meeting of this group was held from 13 to 14 January 2011 at the Federal Network Agency, Mainz, Germany. A second meeting is scheduled to take place on 24 May 2011 in Geneva. In its 1st Report (Document [1A/334](http://www.itu.int/md/R07-WP1A-C-0334/en)), the RG provides proposals on how to continue the work of Working Party 1A on PLT. The results of these RG meetings will also serve to inform the ITU Forum on technical compatibility between PLT systems and radiocommunication services to be held on Geneva, 27 May 2011.

5.2 Annex 2 of the RG Report provides text for the development of a preliminary draft new Report ITU-R SM.[PLT + 80 MHz]. This was developed from Annex 1 to the Report of the fifth meeting of Working Party 1A (Document [1A/311](http://www.itu.int/md/R07-WP1A-C-0311/en)).

5.3 Annex 3 of the RG Report provides a Working Document towards a Draft Revision of Recommendation ITU-R SM.1879 for extending its range above 30 MHz. For frequencies below 30 MHz the previous recommended guidance is maintained on limiting the increase in the noise floor to 0.5 dB. For frequencies above 80 MHz the limit is reduced to 0.05 dB. An increase of 0.5 dB in the noise floor is equivalent to a T/T criterion of ~11% or an I/N ratio of –10 dB. Likewise, an increase 0.05 dB in the noise floor is equivalent to a T/T criterion of ~1.1% or an I/N ratio of –20 dB. This formulation is envisaged to apply in a wide range of circumstances, including the impact of PLT in the home environment to the amateur and broadcasting services. There are, as yet, no suggestions on how to cover the situation between 30 and 80 MHz.

5.4 The Working Party 1A RG also provided ITU-T SG 15 with a liaison statement (see Annex 4 to the RG Report) on progress, which includes comments on notching techniques. The liaison statement goes on to list a number of factors identified by ITU-R Working Parties 5A, 5B & 5C (Document [1A/324](http://www.itu.int/md/R07-WP1A-C-0324/en))) and Working Party 6A (Document [1A/320](http://www.itu.int/md/R07-WP1A-C-0320/en)) as requiring further study in assessing the impact of PLT, namely :

− seek clarification on how the characteristics of the Silicon Mask in respect of the conducted PSD relates directly to the radiation that may occur as a result of the conducted PLT transmission;

− undertake and evaluate measurements of interference to radiocommunication services above 80 MHz;

− undertake further study on assessment methodologies in order to provide information on how Recommendation ITU‑R SM.[PLT] can be implemented and to make a link with the background noise level which is reasonably representative of the service requirements of the various radiocommunication services;

− seek feedback on ITU contacts with EMC standards bodies, other fora outside ITU and individual manufacturers that are also working on broadband PLT apparatus;

− endeavour to influence those involved with PLT outside ITU on the need to cooperate in ensuring that the use of PLT apparatus will be compatible with use of the radio spectrum for radiocommunication and radiodetermination purposes, noting that proprietary systems are being advertised as operating up to several hundred MHz, i.e., well above the current ITU-T recommended effective limit of 80 MHz;

− study and develop methods for measuring, inferring or otherwise assessing the level and aggregation of radiation from PLT apparatus connected to internal and external electrical wiring in order to ensure that individual PLT devices will comply with limits set by national regulators.

5.5 In addition, the Working Party 1A Rapporteur Group requested further information from ITU-T Q.4/15 on the extension of the G.9960 family to include MIMO technology and Smart Grid applications.

5.6 However, it should be noted that standards groups outside ITU are also developing specifications for PLT equipment. Also, there are several proprietary standards in existence. Many of these seek to implement data rates of the order of GBit/s. Particular types of PLT modems have been observed to generate interference in the VHF and UHF bands. This has been confirmed by two studies on the impact of PLT on the broadcasting service that have already been included in the Working Document toward a Preliminary draft new Report ITU-R SM.[PLT + 80 MHz] - *Impact of power line telecommunication systems on radiocommunication systems operating in the VHF and UHF bands above 80 MHz* (see Annex1 to Document [1A/311](http://www.itu.int/md/R07-WP1A-C-0311/en)). Section A3.2.1 contains a study carried out by the Institut für Rundfunktechnik GmbH (IRT), originally submitted as Document [6A/360](http://www.itu.int/md/R07-WP6A-C-0360/en), and Section A3.2.2 contains a study carried out by Communications Research Centre (CRC, Canada), originally submitted as Document [6A/160](http://www.itu.int/md/R07-WP6A-C-0160/en). Further confirmation is provided by a recent study carried out by the BBC on the impact of PLT on domestic reception of FM and DAB broadcasting, which is now available as Document [6A/478](http://www.itu.int/md/R07-WP6A-C-0478/en).

# 6 Differences between assessing EMC compliance above and below 30 MHz

6.1 During the studies on PLT systems operating up to 30 MHz, one problem has been that the EMC standards in this range only relate to interference from conducted emissions whereas, as noted above at 1.4 and 5.3, it is the amount of RF energy that is radiated by the mains wiring carrying the PLT signals that is the real concern when assessing the impact of PLT on radiocommunication services. Further studies in ITU are now expected to concentrate on the use by PLT of frequencies above 30 MHz, where the recognized EMC limits apply directly to radiated emissions. This difference needs to be taken into account during further studies on the impact of PLT.

6.2 The liaison statement (Document [6A/486](http://www.itu.int/md/R07-WP6A-C-0486/en)) from the International Special Committee on radio Interference (CISPR) therefore comes at an opportune moment. CISPR is the body charged with protecting the RF spectrum from conducted and radiated disturbance from electrical and electronic equipment. It was also noted in the Chairman’s Report from the fifth Study Group 6 meeting that closer cooperation links would be desirable with CISPR. The IEC CISPR 22 standard, *“Information technology equipment – Radio disturbance characteristics – Limits and methods of measurement”*, has been taken as the operative reference in respect of PLT systems.

6.3 CISPR points out that limits for emissions from all types of equipment already exist in CISPR Generic and Product standards, and goes on to state that, as CISPR standards are technology neutral, these limits should be applied to all new and upcoming technologies in the scope of CISPR. CISPR also offers to provide further input to the ITU on this subject upon request.

6.4 The CISPR 22 limits apply to information technology equipment (ITE) in general. This includes data processing equipment, office machines, electronic business equipment and telecommunications equipment. The CISPR 22 standard sets limits on conducted and radiated emissions for two classes of equipment:

− Class A ITE: Not intended for domestic use.

− Class B ITE: Intended for domestic use.

6.5 Table 1 provides a summary of the CISPR 22 emission limits for Class A and Class B ITE:

TABLE 1

CISPR 22 edition 6 emission limits for Information Technology Equipment
(9 kHz bandwidth)

|  |  |  |
| --- | --- | --- |
| Frequencyrange | Conducted emissions (average) | Radiated emissions (quasi-peak, antenna at 10 metres) |
| Class A | Class B | Class A | Class B |
| 0.15-0.50 MHz | 66 dB(µV) | 56 to 46 dB(µV)\* | N/A | N/A |
| 0.50-5 MHz | 60 dB(µV) | 46 dB(µV) | N/A | N/A |
| 5-30 MHz | 60 dB(µV) | 50 dB(µV) | N/A | N/A |
| 30-230 MHz | N/A | N/A | 40 dB(µV/m) | 30 dB(µV/m) |
| 230-1 000 MHz | N/A | N/A | 47 dB(µV/m) | 37 dB(µV/m) |
| \* limit varies linearly. |

6.6 Note that there is a difference in how protection of the radio frequency spectrum is dealt with above and below 30 MHz. Below 30 MHz the dominant mechanism for potential interference is assumed to be via emissions conducted along common wiring connecting to other ITE or radiocommunications equipment. Above 30 MHz the predominant mode of interference is assumed to be via radiated emissions that are intercepted by other ITE or radiocommunications equipment.

6.7 In respect of the reception and generation of conducted or radiated emissions, the usual objective is to design ITE such that its operation will withstand incoming RF energy up to a certain level, and in the other direction to ensure that any RF energy produced by ITE equipment remains below certain acceptable levels. Where the generation of RF energy within ITE is concerned the requirement for EMC purposes is that the level of conducted and radiated RF energy remains low enough to protect the RF spectrum as a whole, not to protect individual radiocommunication services or systems. In principle, it should be possible to suppress RF energy leaking from electronic or electrical equipment to levels low enough levels to ensure compliance with EMC limits because the production of RF energy is incidental to the operation of the equipment. However, PLT systems depend on injecting RF energy along mains wiring at sufficient levels to overcome attenuation and sources of noise along the mains wiring.

6.8 PLT is, in fact, the first example of ITE that uses RF signals as the essential feature of its operation rather than producing some incidental RF energy as a side effect of its operation (such as with switch-mode power supplies in ITE, where filtering is employed to prevent RF energy being transferred to the mains wiring). The established standards and legislation surrounding EMC are based on the premise that designing ITE so as to keep the production and leaking of RF energy into the environment to the minimum level possible will not affect the operation of the equipment itself.

6.9 In contrast, PLT equipment operates by injecting RF energy into the mains wiring and cannot operate satisfactorily if the RF output level from a PLT modem is reduced to a level compliant with established EMC standards. In respect of conducted emissions below 30 MHz, the ITU-R response to the CISPR consultation on PLT **(**CISPR/I/301/CD), dated 11 June 2009, noted that:

 The present Committee Draft specifies two types of PLT devices. Difference between the two types is obviously the maximum PSD for the wanted PLT signal.

 For Type 1 PLT devices, information is found in Annex H Table H.3. The maximum PSD is indicated with  ‑55 dBm/Hz. At 100 Ohm termination this represents a wanted signal level of 95 dBµV (RBW = 10 kHz).

 For Type 2[[2]](#footnote-2) PLT devices such information is missing. Therefore CISPR should set the maximum PSD mask even for the Type 2 modem.

 The valid edition of CISPR 22 however controls, by means of the limits for the AC mains port, a maximum differential mode RF disturbance voltage level of 52 dBµV and 56 dBµV only, at the same 100 Ohm termination. It is hence quite obvious that operation and use of Type 1 PLT devices in in-house AC mains installations will cause the radiation to rise by 43 dB and 39 dB, in the frequency ranges 1.705 MHz to 5 MHz and 5 MHz to 30 MHz, respectively, compared to the situation where a PLT device would meet the limits presently specified in CISPR 22.

 For Type 2 PLT devices it is not possible to estimate this increase of the RFI potential in an exact manner.

6.10 This calculation[[3]](#footnote-3) showed that Type 1 PLT modems exceed CISPR 22 emission limits by around 40 dB. The spectrum mask for PLT devices contained in Recommendation ITU-T G.9960 uses the same PSD level of ‑55 dBm/Hz for frequencies below 30 MHz.

6.11 For frequencies above 30 MHz, CISPR 22 only sets limits on radiated emissions and the situation becomes less amenable to simple analysis. For example, it is not possible at frequencies greater than 30 MHz to make a similar simple calculation (as in 6.9 above) that relates directly to the output PSD of a PLT modem.

6.12 In order to assess whether the CISPR 22 limits on radiated emissions are adequate to protect the broadcasting service in Bands I, II, III, IV &V it is first necessary to know what exactly is being tested. A statement by a manufacturer under the allowed self-certification arrangements for EMC compliance for individual PLT modems in a box is of no value by itself. The issue when considering the case of radiated emission limits for PLT above 30 MHz is that the PLT system does not exist until 2 or more modems are connected to some wiring and switched on.

6.13 EMC testing standards for the simpler case of conducted emissions could also do with more precise elaboration, as witness comments by the Australian Communications and Media Authority (ACMA) – see: [http://www.acma.gov.au/WEB/STANDARD/pc=PC\_100896](http://www.acma.gov.au/WEB/STANDARD/pc%3DPC_100896). In considering EMC compliance for PLT modems, ACMA has expressed concerns that *“some confusion exists regarding EMC testing of BPL devices with some test houses conducting the ‘conducted emissions tests’ with the modulator in the device disabled or turned off”*. ACMA goes on to state that *“This is an incorrect practice and the devices must have this test conducted with the BPL signal turned on”*.

6.14 The situation with radiated emission limits above 30 MHz is obviously more complicated than when considering the case of conducted emissions below 30 MHz. A compliance test on radiated emissions from a single PLT modem without a representative external connection does not appear sufficient or correct. More than one modem will be needed in order to establish a network. Moreover, the radiated emissions will vary according to the length and topology of the electrical mains wiring to which the PLT modems are connected. The same is also true to an extent with conducted emissions that leak as radiation below 30 MHz, but at least the modem output PSD can be used to estimate directly how the level of disturbance voltage varies with the termination impedance of mains wiring and how that then compares with the limits.

6.15 While the situation with conducted emissions still involves many unpredictable factors, the situation when trying to assess the amount of energy radiated from PLT systems is very difficult to handle theoretically because the characteristics of each PLT system will be unique. In the real world environment, there will be endless combinations of modems and mains wiring layouts to consider.

6.16 With each and every PLT installation presenting different characteristics as far as radiated emissions are concerned, national administrations responsible for enforcing EMC standards and legislation will have to consider how a consistent standard can be applied for in home PLT systems operating above 30 MHz when each will behave differently according to the number of modems in use and the layout of the particular mains wiring to which the modems are connected. Moreover, the radiating length of mains wiring may extend to neighbouring houses or apartments, depending on national mains wiring practices.

6.17 Given that CISPR has offered to respond to queries from ITU-R, Working Party 6A could consider putting the following points to CISPR, through Working Party 1A and the Study Group 1/CISPR liaison arrangements, in order to seek clarification on the issues involved:

− Do EMC legislation and standards for radiated emissions relate to individual components of a practical system, the complete system, or both?

− In the case of EMC compliance testing for radiated emissions from a single PLT modem does the test require some wiring to be connected in order to simulate a practical arrangement?

− In the case of several modems being connected to a mains wiring, does the system as a whole have to comply with CISPR limits on radiated emissions? And, if so, who is responsible for ensuring compliance: the manufacturer, the supplier or the installer (noting that this may be an individual householder on a DIY basis) or all?

− Is it acceptable to carry out compliance testing or certify compliance under self‑certification arrangements with the PLT modulator tuned off?

− Does the electricity supply company/authority have any responsibilities regarding compliance with EMC radiated emission limits from parts of its network?

6.18 It may be that there is a void in EMC regulations and standards when a system is created from several parts concerning the identification of those responsible for certifying compliance and those responsible in the case of enforcement action.

# 7 EMC Coordination

7.1 Noting the above difficulties in trying to treat PLT as a EMC compliance matter it is instructive to consider Section 4.1 of the proposed text of Annex 2 to Document [1A/334](http://www.itu.int/md/R07-WP1A-C-0334/en), on a Preliminary Draft New Report ITU-R SM.[PLT + 80 MHz] on the *Impact of power line telecommunication systems on radiocommunication systems operating in the VHF and UHF bands above 80 MHz*. Thisintroduces the concept of EMC “coordination”.

7.2 Clarification on this term is necessary because its use and the consequential implications on “compatibility” are not consistent with how ITU-R approaches compatibility and coordination problems. Compatibility analyses in ITU-R start from the premise of trying to engineer out interference between radiocommunication systems, first at the top level by allocating distinct frequency bands to the various radiocommunications services as far as possible. Where frequency bands are shared between radiocommunication service compatibility requirements are established after carrying out the necessary studies. From these, it may be necessary to define a coordination mechanism in order to limit interference to acceptable levels.

7.3 The usual philosophy in defining EMC standards and protection requirements for Information Technology Equipment (ITE) is to ensure that other equipment in the vicinity will not be affected by RF interference conducted along common wiring or that is radiated; and likewise, that other electronic or electrical equipment does not interfere with the piece of ITE in question.

7.4 The term “EMC coordination” therefore seems inconsistent with established use in radiocommunications and EMC. Section 4.1 of the proposed text of Annex 2 to Document [1A/334](http://www.itu.int/md/R07-WP1A-C-0334/en), seems to present PLT equipment as ITE that for special reasons is excluded from normal EMC requirements. This would have serious implications on the present EMC regime. If one class of ITE with an acknowledged impact on the availability of the RF spectrum is allowed to exceed the established limits for conducted and radiated RF interference then it is difficult to see how the present EMC regime can be maintained for other electronic and electrical equipment. If adherence to EMC standards and legislation becomes optional, rather than prescriptive, then such a situation will impact adversely on efforts by industry to adhere to current EMC limits for the mutual benefit of all users of ITE and radiocommunication systems.

7.5 However, the term “coordination” does suggest another way of minimizing the impact of PLT on radiocommunication services. An alternative course of action could be to treat PLT as a user of RF spectrum and then to seek through ITU-T and ITU-R to ensure that all the compatibility issues are studied with a view to establishing compatible access to RF spectrum for PLT. This may include putting in place any necessary mechanisms for *coordinating* the use of PLT systems in the sense understood by ITU-R. The present efforts to seek an ITU solution for conditioning the use of PLT systems, as requested by the RAG and TSAG, could then include applying the normal spectrum engineering and frequency management techniques to PLT as an ITU recognized user of RF spectrum.

7.6 This alternative scenario would admit that PLT does make use of RF energy for the purpose of providing telecommunication services, with a view to seeing what opportunities exist for designating frequency bands for use by PLT that would not impact adversely on radiocommunication services – especially those used extensively by the general public in the home, i.e., the amateur and broadcasting services. In this way PLT equipment compliant with an agreed ITU standard would no longer be considered as ITE subject to EMC standards and legislation.

7.7 The mitigation techniques discussed in Section 4 could be recast in order to illustrate the compatibility issues involved, so as to inform the choice of potential frequency bands that could be used by PLT, but without needing to apply the current EMC standards. In effect PLT would be treated as a recognized user of the RF spectrum in an ITU mediated solution not, as now, as an incidental radiator of RF interference and an EMC problem.

7.8 There is a similarity with the special arrangements made for ISM equipment because, for both ISM and PLT equipment, the generation of RF energy is essential for the operation and use of the equipment. ISM equipment generates and uses RF energy for the purpose of exciting physical reactions at the molecular or atomic level (including burning and heating at the simplest). PLT equipment generates and transmits RF energy along electrical wiring in order to provide a communication path. Both are different from the usual EMC situation for ITE, where the production of RF energy is incidental or non-essential for the primary purpose of the equipment. In such cases, many measures can be taken to protect the RF spectrum through minimizing the generation and propagation of unintended or incidental RF disturbances without affecting the operation of the equipment in question.

7.9 The problem then is that PLT devices need to inject sufficient power into electrical wiring for meeting the intended communication objectives. This will vary according to the frequencies used, the length of communication path and the bandwidth. Broadband PLT, and in particular the 2nd generation modems envisaged in Recommendation ITU-T G.9960, are intended to provide sufficient bandwidth in homes for the distribution of high definition TV, together with the normal broadband internet requirements. The data throughput requirement for 2nd generation PLT may therefore be estimated at 200 Mbit/s or more, which with most efficient coding translates into an RF bandwidth requirement of 20-50 MHz. Recommendation ITU-T G.9960 currently sets an upper limit of 80 MHz for the PLT spectrum mask, although proprietary systems already on the market operate up to 300 MHz and produce spurious components into the GHz range (see Documents [6A/360](http://www.itu.int/md/R07-WP6A-C-0360/en) and [6A/388](http://www.itu.int/md/R07-WP6A-C-0388/en))

7.10 The G.9960 standard has a toolkit which allows national administrations and regulators to set the PLT spectrum mask according to national considerations and demands. In many countries the band 30-80 MHz range could be used for broadband PLT, with additional mitigation techniques where necessary, without an adverse impact on domestic reception. CENELEC is already considering such a solution under a study contract with the European Union. For narrow-band PLT (e.g., for Smart Grid applications) it may be possible to find designated frequencies, as for ISM, in the LF/MF/HF bands that avoid restricting the availability of the amateur and broadcasting services and avoid any interactions with safety related uses of radiocommunication and radiolocation for aeronautical and maritime purposes.

7.11 Considering that other standards organizations are developing their own PLT standards, it should be noted that time is limited for finding a solution within the ITU family that could be promoted as the definitive worldwide solution for all PLT applications. Now is the time for imaginative thinking on achieving an ITU solution.

# 8 Summary of further recommended actions

8.1 The following points have been identified as needing further consideration or clarification during further studies on PLT within ITU-R, ITU-T, CISPR and other relevant standards organizations:

− welcome the initiative of ITU-T SG 15 in studying the use of wireless technology within the Smart Grid project and seek more information on the frequencies being studied for narrow band PLT (paragraphs. 3.3 & 3.4);

− undertake further study in ITU-R on the relationship between the RF energy radiated from PLT wiring and the PLT modem output PSD, with a view to establishing a practical means of determining representative levels of radiated PLT emissions (paragraph. 4.2)

− endorse the issues identified by the Working Party 1A Rapporteur Group as requiring further study (paragraphs 5.4 to 5.6);

− request that the formal ITU-R response to the liaison statement from CISPR (Document [6A/486](http://www.itu.int/md/R07-WP6A-C-0486/en)), through the Study Group 1/CISPR liaison arrangements, includes clarification on the how radiated emission limits for frequencies above 30 MHz are applied and enforced (paragraphs 6.17 to 6.18);

− seek clarification from Working Party 1A and ITU-T SG 15 on the meaning of “EMC coordination” as to whether this implies relaxing EMC limits for certain types of ITE or envisages coordinated use of RF spectrum between ITU-R and ITU-T for radiocommunications and wired telecommunications (paragraphs 7.5 to 7.11).

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1. See section 5.1.2 of ITU-T Tutorial @ <http://www.itu.int/pub/T-TUT-HOME-2010/en>. [↑](#footnote-ref-1)
2. At the time of writing, CISPR studies Type 2 PLT devices have been suspended. [↑](#footnote-ref-2)
3. Values used in this calculation have been adjusted from those in Table 1 to reflect 10 kHz rather than 9 kHz bandwidth. [↑](#footnote-ref-3)