|  |  |
| --- | --- |
| **Radiocommunication Study Groups** |  |
|  |  |
|  |  |
| Received: 9 April 2013  Subject: Radiated disturbances from PLT and wired telecommunication systems | **Document 6/116-E**  **Document 6A/247-E** |
| **11 April 2013** |
| **English only** |
| Study Group 6 Rapporteur on PLT Issues | |
| Report on Recent Developments Concerning PLT  and wired Telecommunication systems | |
| (Question ITU-R 221/1) | |

# 1 Developments during the January/February 2013 ITU-T Study Group 15 meeting

The January/February 2013 meeting of ITU-T Study Group 15 was the first of the new ITU-T study period and was mainly concerned with organizational issues and setting out the new work programme. PLT related issues are now handled in the Q4B/15 group, the G.fast project in the Q4A/15 group and Smart Grid issues in the Q15/15 group.

There were, however, some developments of interest to the broadcasting service concerning the use of the radio frequency spectrum by wired telecommunication systems.

## 1.1 Developments on PLT and Smart Grid

No changes were made on the spectrum related Recommendations G.9964, for broadband PLT, and G.9955 for narrowband PLT applications for Smart Grid. A number of improvements were made to the associated physical layer PLT Recommendations but without spectrum use implications. The July meeting of ITU-T Study Group 15 does, however, have the main ITU-T PLT Recommendations listed for further consideration.

As noted several times previously the main difficulty now is with other standards developing organizations (SDOs) promoting differing and conflicting standards for PLT devices. The latest example is the approval of the CENELEC EN50561-1 standard for PLT below 30 MHz. The standard passed the vote in CENELEC, but its approval for use under the EU’s EMC Directives is held up because of administrative hurdles within the EU Commission. If that matter is resolved then CENELEC will restart work on a standard for PLT above 30 MHz.

Although this line of work in CENELEC is has not led to the more serious difficulties reported in Document [6/62](http://www.itu.int/md/R12-SG06-C-0062/en) with the CENELEC PLT standard for Smart Grid, the ITU-T Secretariat continues to make approaches to both CENELEC and the Commission, hoping to achieve better coordination of these activities and to reduce any major technical divergences with Recommendation ITU‑T G.9964.

## 1.2 Developments of G.fast project

As also noted in the previous, Document [6/62](http://www.itu.int/md/R12-SG06-C-0062/en), the “G.fast” project is of interest to the broadcasting service because although it does not involve PLT it is a wired telecommunication system that is expected to use frequencies in bands allocated to the broadcasting service. That expectation has been confirmed during the last ITU-T Study Group 15 meeting.

The project promises to enable fibre-optic data speeds over “last-mile” copper connections from roadside fibre termination points into homes and buildings for onward connection to customers. G.fast and the specified CAD55 cable were originally expected to use frequencies in the 30‑80 MHz range and to operate up to a maximum range of 100 m. In response to a demand for data higher throughput over longer distances the G.fast spectrum mask will now cover Bands II and III. It is acknowledged (see the relevant Q4A/15 document at the Annex here) that notching and other techniques will have to be introduced in order to counter interference to FM and DAB broadcasting services. The coverage distance range will also increase to at least 250 m, meaning that more power may be needed.

The latest draft of the Recommendation G.fast also acknowledges that the characteristics of the various wiring types still needs to be studied, particularly for the higher frequencies up to perhaps 300 MHz. The multiple twisted pair CAD55 cable was previously expected to be used but previous submissions showed that cable performance becomes less predictable above the original design specification of 80 MHz.

Although the intention to study both general and dynamic notching is welcome as an acknowledgement of the need to protect broadcasting, the underlying philosophy is that parts of the FM band not locally in use should be freely available for other uses. This poses technical and regulatory questions. In particular, the problems with location based notching have been noted previously with PLT systems. However, there would be the advantage with G.fast that, unlike the situation with do-it-yourself PLT installations, G.fast installations are fixed and installed by competent network operators who should have access to up to date information on the local availability of broadcasting services. Nonetheless, the expectation that broadcasting spectrum can be used without any regulatory procedures sets a bad precedent that could be exploited by PLT systems not compliant with the Recommendation ITU-T G.9964 PLT spectrum mask.

The developments on the G.fast project have been communicated formally by ITU-T Study Group 15 to the Working Party 1A Rapporteur Group on *Coexistence of wired telecommunication with radiocommunication systems*, and it is clear that compatibility with the use of Band II and Band III by the broadcasting service must be considered. The spectrum use aspects of G.fast are expected to be finalized during 2013 and, overall, the G.fast project looks to be on course for meeting its target of consent by July 2013 and approval as an ITU-T Recommendation by March 2014.

With the higher operating frequency range now envisaged for the G.fast project, Working Party 6A/Study Group 6 should consider the potential for interference to reception of broadcasting in Bands II and III and pass any concerns on to Working Party 1A, which has responsibility in ITU‑R for addressing the coexistence of wired telecommunication systems with radiocommunication services. The main issue is how to manage spectrum demands from non‑radiocommunication services that, even if not causing harmful interference, nevertheless restrict the availability of spectrum for radiocommunication services in their allocated bands.

# 2 Review of documents submitted to WP 6A involving other wired telecommunication systems.

## 2.1 Document [6A/190](http://www.itu.int/md/R12-WP6A-C-0190/en) (ITU-T SG 5)

Document [6A/190](http://www.itu.int/md/R12-WP6A-C-0190/en) reports on work in ITU-T Study Group 5 concerning the draft new Recommendation K.mhn and a review of Recommendation K.60, which both deal with various aspects of immunity requirements and radiated disturbances involving both wired and wireless telecommunication systems. Of interest to the broadcasting community are implications for reception of broadcasting services and the use of Community Antenna TV (CATV) systems.

## 2.1.1 Recommendation [K.60](http://www.itu.int/rec/T-REC-K.60/en) – “Emission levels and test methods for wireline telecommunication networks to minimize electromagnetic disturbance of radio services (2008-02)”

ITU-T Study Group 5 reports that it intends to review the Recommendation K.60 in the context of its Questions 6[[1]](#footnote-1) and 8[[2]](#footnote-2), and has requested several ITU-R Working Parties to provide comments and relevant information before the next ITU-T Study Group 5 meeting, which is planned for November 2013.

The maintenance of K.60 is important because of the ubiquitous deployment of wired telecommunication systems providing broadband services, particularly for internet and television distribution. Transmissions are present on these networks at all times ('always-on') and there is a continuing trend to extend the transmission frequency range upwards in order to support increasing demands for bandwidth and throughput, much greater than for previous access systems. Hence, the risk of interference between wired telecommunication systems and between wired and wireless telecommunication systems, including those operating in radiocommunication services.

The stated purpose of Recommendation K.60 is to provide a measurement method and target levels to be used in case of interference with radio services. In addition, a methodology for resolving interference cases is provided, along with guidance on under what circumstances cases have to be forwarded to the national responsible body. The reference to ‘radio services’ resulted in correspondence between Study Group 6 and ITU-T Study Group 5 as to what exactly was intended. In Document [6/123](http://www.itu.int/md/R07-SG06-C-0123/en), ITU-T Study Group 5 explained that the target levels in K.60 are agreed for use with the procedure for resolving complaints about interference involving the operation of telecommunication systems. This intention is to share responsibility between network operators and the national Authority in resolving cases of interference – thus, K.60 is neither a compliance requirement nor a recommendation for protecting the radio spectrum. The final decision on settling an interference case is left to the relevant national Authorities.

However, because of continuing concerns[[3]](#footnote-3) that K.60 could still be misinterpreted as setting permissible limits for radio-frequency emissions without regard to RR **No. 15.12** , ITU-T Study Group 5 went on provide an amendment to Recommendation K.60, as noted in Document [6/164](http://www.itu.int/md/R07-SG06-C-0164/en), confirming that its purpose is to guard against conflict between telecommunication systems, not to imply that the Recommendation also serves to protect radiocommunication services.

The amendment to the scope of K.60[[4]](#footnote-4) reads:

*“The purpose of this Recommendation is to guide administrations when considering complaints of interference between telecommunication systems and is not intended to set compliance requirements or recommendations for protecting the radio spectrum.”*

The invitation to participate in the review of K.60 provides an opportunity to resolve and remove any remaining ambiguities surrounding its objectives and use. It would appear now that the main purpose of K.60 is to prevent radiated disturbances between wired telecommunication systems through defining a measurement method and target levels for radio frequency emissions from wired telecommunication systems, which are to be used in cases of interference. Note that K.60 covers radiated disturbances from a wide range of cabled networks, specifically including PLT by virtue of the text:

*“… all telecommunication networks using the low voltage (LV) AC mains network;”*

The target levels set in Table 1 to K.60 for radiated disturbances above 30 MHz are derived from CISPR 22[[5]](#footnote-5) limits on radiated disturbances but are, nevertheless, rather high when considered against the claim that they *“ do not, in most cases, exceed a level which could prevent radio communications receivers operated in the near vicinity from functioning as intended.”.* In most broadcasting bands the corresponding target levels would represent a good, usable field strength for a broadcast signal. This is confusing given the clarification that the primary purpose of K.60 is to ensure that any radiated emissions are low enough that no disturbance is caused to another wired telecommunication system. Moreover, the measurement distance of 3m used in Table 1 is larger than separations commonly found in the domestic environment where home networking systems and broadcasting service receivers operate in much closer proximity, often side by side. It follows then that the protection against interference occurring at the measurement point is far from good, since the signal-to-interference ratio would be permitted to lie in the vicinity of zero, or even negative, dB.

As the target date for comments Document [1A/271](http://www.itu.int/md/R07-WP1A-C-0271/en) is the next ITU-T Study Group 5 meeting in November 2013, there is still time to request Working Party 1A to provide a commentary on the EMC issues involved and to request Member States and Sector Members to provide contributions for detailed consideration of K.60 at the next Study Group 6 block meeting. A response could then be provided to ITU-T Study Group 5 that recognizes the particular circumstances of the broadcasting service.

Broadcasting coverage is planned on the basis that reception is available ubiquitously throughout the service area. This determines the maximum level of availability degradation that should not be exceeded if the consistency of broadcasting plans is to be maintained. The composition of tolerable interference from multiple sources should be apportioned according to whether the interference derives from emissions generated by systems of services that use the same frequency band on co‑primary basis or from radiations and emissions from sources without a corresponding frequency allocation in the Radio Regulations. For the apportionment of availability objectives, it is reasonable to set the sum of interference due to sources in the latter category, which would be indistinguishable from interference from wired telecommunication systems, at levels much smaller than the sum of interference from systems of services sharing the same frequency band on a primary basis, with a factor of around 1/10th being an accepted reasonable standard.

The principles of interference apportionment between sources of interference having a different allocation status is explained in the Annex to Recommendation ITU-R [F.1094-2](http://www.itu.int/rec/R-REC-F.1094-2-200709-I/en), and further by Working Party 5C in Documents [1A/271](http://www.itu.int/md/R07-WP1A-C-0271/en) and [1A/322](http://www.itu.int/md/R07-WP1A-C-0322/en) in giving its responses to Working Parting 1A on the EMC issues surrounding the operation of PLT and ISM equipment respectively.

## 2.1.2 Draft Recommendation [K.mhn](http://www.itu.int/md/T13-SG05-130129-TD-GEN-0074/en) – “Techniques to mitigate interference between radio devices and cable or equipment connected to wired broadband networks and cable television networks”

As reported previously, the ITU-T Study Group 5 draft Recommendation K.mhn is intended to provide guidance on solving interference problems caused by radio devices and cables or devices connected to wired broadband networks in the home. Interference from PLT systems is excluded from the scope of this text because ITU-T Study Group 5 is of the view that this may occur by different phenomena (such as induction between cables) than the normal EMC problems considered between wired and wireless broadband home networking systems or between different types of wired home networking systems.

The work on K.mhn is of interest to the broadcasting community because it involves interference mechanisms and mitigation techniques relevant to interactions between radiocommunication systems used in or nearby homes, wired broadband home networking systems (excluding PLT) or CATV distributing systems. Although CATV systems are not within the scope of Working Party 6A, the tuners used for direct off-air reception may suffer similar disturbances as the tuners connected to CATV systems from other home networking systems or radiocommunication systems used in the home environment. Because of this interest a contribution to the work on K.mhn was submitted on by Deutsche Welle (DW) on the impact of LTE signals on cable-TV reception. This [contribution](http://www.itu.int/md/T13-SG05-C-0077/en) summarized the results of measurements carried out in the beginning of the year 2009 at the IRT (Institut für Rundfunktechnik GmbH) and provided technical information concerning possible interference from the mobile service LTE-800 in the frequency range 790 MHz to 862 MHz into cable-TV receiving equipment. These measurements were performed in co‑operation with ANGA (Association of German Cable Operators).

Appendix 1 of the third draft of K.mhn includes a provisional reference to interference into a DVB set-top box from mobile phones, pending further consideration and clarifications. Broadcasting interests may wish consider how to improve on the treatment of this interference mechanism either through direct submissions into ITU-T Study Group 5 or by comments into Working Party 1A which has responsibility in ITU-R for addressing the coexistence of wired telecommunication systems with radiocommunication services.

## 2.2 Document [6A/194](http://www.itu.int/md/R12-WP6A-C-0194/en) (ITU-T SG9)

Document [6A/194](http://www.itu.int/md/R12-WP6A-C-0194/en) reports on work in ITU-T Study Group 9 concerning the draft new Recommendation ITU-T J.195.1 – *“Functional Requirements of high speed transmission over coaxial network connected with Fiber To The Building”*. This new draft incorporates further developments on the High performance Network over Coax (HiNoC) specification for high-speed data transmissions over coaxial cable networks, and will be supplemented by new Recommendation J.HiNoC covering the Media Access Control (MAC) physical layer specifications for HiNoC.

Primarily intended for distribution of HD and 4K TV signals around buildings, HiNoC supports 16 MHz bandwidth per channel, and is designed such that each channel can be deployed in any spectrum window below 1.2GHz, and can be allocated beside or between analogue TV, digital TV or data service channels without causing interference.

The interest to the broadcasting community is that as another means of providing CATV access there is a risk that interference mechanisms that may affect off-air TV reception may also impact on the integrity of the HiNoC transmissions, especially as the frequency range extends above that familiar to broadcasters. The claim that no interference will be caused to off-air TV reception also needs to be verified, especially as there is a history of the spectral power density injected into wired telecommunication systems, such as PLT and G.fast, increasing in order to satisfy further demands for throughput and circuit length. Further information should be requested on the HiNoC spectrum mask (physical layer), either directly or through Working Party 1A.

# 3 Recommended actions

This report has identified a number of areas of concern regarding the widespread use of frequencies in the bands allocated to the broadcasting service for wired telecommunication systems. Comments could be made directly to the ITU-T Study Groups concerned where Working Party 6A has received a liaison statement, but the developments in ITU-T Study Group 15 on the G.fast project were only sent to Working Party 1A.

The better course of action then would be to collate all comments on the issues raised in this report and send all to Working Party 1A, which has the prime responsibility within ITU-R to liaise with ITU-T and other SDOs on wired telecommunication systems that use radio frequencies in ways that may impact adversely on radiocommunication services.

The issues identified here where comments from Working Party 6A or Study Group 6 as a whole may be considered appropriate are:

1. Concerns over the extension of the G.fast spectrum mask by ITU-T Study Group 15 to cover Bands II and III.
2. The impending review of Recommendation K.60 by ITU-T Study Group 5.
3. Need to ensure that immunity considerations for CATV systems using DVB and set-top box tuners included within the ITU-T Study Group 5 draft Recommendation K.mhn are compatible with interference rejection considerations applicable to similar tuners used in off-air TV receivers.
4. Need to ensure that the High performance Network over Coax (HiNoC) specification being developed in ITU-T Study Group 9, under draft Recommendations J.195 and J.HiNoC, is compatible with channel use for off-air TV reception.

The review of Recommendation K.60 is the most pressing issue here because of the tight timescales set by ITU-T Study Group 5 and the evident confusion over whether it has, or should have, a role in protecting radiocommunication services from radio frequency disturbances radiated by any type of wired telecommunication system, including PLT.

Annex

**ITU - Telecommunication Standardization Sector** Temp Document 2013-01-Q4-064

STUDY GROUP 15 Original: English

Geneva, Switzerland, 28 Jan-1 Feb 2013

Question:  4A/15

SOURCE[[6]](#footnote-6): BT plc

TITLE: G.fast: On notching for G.fast

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**ABSTRACT**

This contribution addresses the requirement to be able to notch frequencies in the first alias band for a 4096 tone G.fast implementation. It considers requirements related to the VHF FM band II and DAB band III broadcast systems.

# 1 Discussion

In densely and relatively evenly populated counties like the UK the VHF FM band II, from 88 to 108 MHz, typically has a frequency re-use ratio of about 9. In countries where low power transmitters and the population are concentrated in relatively isolated cities far enough apart to prevent co-channel interference, the average frequency re-use ratio can be lower.

In the latter case it may be justified to notch the entire FM band. However in countries like the UK it should be practical to notch only the channels protected by the national/regional frequency re-use plan. This approach could release over 88% of the band for exploitation by G.fast. Even if a channel is vacated on each side of every active channel, around 66% of the band is available to G.fast.

It has been observed that some FM receivers have low immunity to image frequencies 21.4 MHz (10.7 MHz IF) from a wanted channel. It is usually the case that the Local Oscillator will be above the wanted channel. In this case the image will be above the half Nyquist rate for G.fast systems with 106 MHz bandwidth. In which case, it may be necessary to notch transmitted signals below 106 MHz, to avoid the alias tones aligning with the receiver image response.

It will be observed that the band of frequencies from 106 (105.984) MHz to 108 MHz lies in the first alias band of a system utilising a sampling frequency of 211.968 MHz. Without oversampling, the implementation of an anti-alias filter to reject signals just above the half Nyquist rate, without excessive loss just below, is not feasible.

EMC – Emissions

In areas where an FM signal is at the maximum extent of its coverage area is will be necessary to protect that FM channel from G.fast emissions. Should the FM channel in question be above 106 MHz it will be necessary to notch its image in the base-band below 106 MHz.

EMC – Ingress

Other sampling rates:

By a similar argument, frequencies just below 106 MHz may be made unusable close to a transmitter using a channel in the alias band. A full bandwidth system with sampling frequency of 423.936 MHz will not have this problem within the VHF FM band. However the DAB Radio band 174‑240 MHz raises similar issues, but the majority of the band is above the 211.968 MHz half Nyquist rate.

Another feature of DAB radio is that a single frequency can be used for all the transmissions of a single multiplex. This would suggest a low frequency re-use ratio - close to 1. However, the audience for radio is more local than this ideal. In the UK for instance the mix of national, regional and local broadcasting reduces spectral efficiency to produce a frequency re-use ratio in the order 3 to 4.

An intriguing solution using a non-binary factor DFT uses a sampling frequency of 317.952 MHz. The composition of radix 3 and radix 2048 DFT can be very efficient. The solution has the benefit of not splitting the VHF FM band, while the DAB radio band starts about 15 MHz above this half Nyquist rate so has some benefit from the anti-alias filter.

Management of notches

It is clear that given the potential need to manage notches in the alias-bands as well as the base—band it is necessary to both extend the band of supported notching frequencies and take into account the effects of different sampling frequencies.

Summary

It is proposed that G.fast shall provide a management facility to permit notching requirements to be defined up to 423.936 MHz, the transceiver creating such notches as required according to its sampling frequency and associated alias band structure.

We note that there as yet no agreement to define a way of setting notches from network management. Consequently we propose an agreement and issue created that this needs to be addressed.

Noting the benefits of using ¾ full rate sampling, for lower complexity than full rate, as well as handling of the DAB bands, we propose including the option in consideration of interoperability issues.

|  |  |  |  |
| --- | --- | --- | --- |
| 2.2.4 | Agree  28-Jan-13 | G.fast shall support spectrum notching analogous to that provided in VDSL2 taking into account the shorter symbol period and higher tone spacing frequency of G.fast. | This contribution |
| 2.2.3 | Agree  28-Jan-13 | G.fast shall be defined so that the full rate protocol can be applied at ½ the full rate sampling frequency, and the two versions coexist on the same DP to service CPE from different generations? | This contribution |
| 2.2.3.1 | Agree  28-Jan-13 | G.fast shall be defined so that the full rate protocol can be applied at ¾ and ½ the full rate sampling frequency, and the three versions coexist on the same DP to service CPE from different generations? | This contribution |

\_\_\_\_\_\_\_\_\_\_\_\_\_\_

1. Question [6/5](http://www.itu.int/en/ITU-T/studygroups/2013-2016/05/Pages/q6.aspx) – EMC issues arising from the convergence of IT and communication equipment. [↑](#footnote-ref-1)
2. Question [8/5](http://www.itu.int/en/ITU-T/studygroups/2013-2016/05/Pages/q8.aspx) – EMC issues in home networks. [↑](#footnote-ref-2)
3. See Document [6A/144](http://www.itu.int/md/R07-SG06-C-0144/en). [↑](#footnote-ref-3)
4. [Rec.ITU-T K.60 (2008)/Amd.1 (05/2009)](http://www.itu.int/rec/T-REC-K.60-200905-I!Amd1/en). [↑](#footnote-ref-4)
5. NB: CISPR 22 does not set levels for radiated disturbances below 30 MHz. [↑](#footnote-ref-5)
6. Contact: Les Humphrey T: +44 1473 606490

   BT plc E: [les.humphrey@bt.com](mailto:les.humphrey@bt.com) [↑](#footnote-ref-6)