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RADIO SPECTRUM POLICY GROUP

Report

on Furthering Interference Management through exchange of regulatory best practices concerning regulation and/or standardisation

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1 INTRODUCTION

Subject and relation with other work

Interference management is a key challenge facing Member States' Administrations. Together with efficient frequency management and management of radio equipment, efficient interference management can allow the spectrum to be fully exploited by allowing the co-existence of existing and planned radiocommunications services. In addition to the basic principles and approaches of the EC, ITU and CEPT and noting the RSPG Opinion on "Streamlining the regulatory environment for the use of spectrum"[1], Member States' Administrations have also developed specific national approaches to managing interference which meet their particular circumstances and the expectations of stakeholders.

From a European perspective, an exchange of national best practices concerning regulation and/or standardisation may help to support further efficient interference management. This exchange of best practices could support the policy objective in Article 3 k (as concretised in Article 4 par. 3 of the Radio Spectrum Policy Programme (RSPP)). This objective refers to the benefit of fostering development and harmonisation of standards for radio equipment terminals, as well as for other electrical and electronic equipment and networks in response to Commission standardisation mandates.

In order to focus on the priorities of the Radio Spectrum Policy Programme[2], Member States and the Commission shall cooperate to support and achieve inter alia the policy objective of its Article 3 k):

"avoid harmful interference or disturbance by other radio or non-radio devices, inter alia, by facilitating the development of standards which contribute to the efficient use of spectrum, and by increasing immunity of receivers to interference, taking particular account of the cumulative impact of the increasing volumes and density of radio devices and applications;"

In addition to spectrum regulation, Harmonised Standards under Directive 1999/5/EC are an important tool to achieve efficient use of spectrum and should take account of the

[1] RSPG 08-246, http://rspg.groups.eu.int/_documents/documents/meeting/rspg17/rspg08246_finalopinion_streamlining.pdf

[2] The Radio Spectrum Policy Programme is published in the Official Journal on 21 March 2012: http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2012:081:0007:0017:EN:PDF

planned spectrum sharing scenarios to avoid harmful interference between radiocommunications services. European Electromagnetic Compatibility (EMC) standards under Directive 2004/108/EC should also limit electromagnetic disturbance to spectrum use from non-radio electrical and electronic equipment and networks and ensure that equipment has a level of immunity to the electromagnetic disturbance to be expected in its intended use which allows it to operate without unacceptable degradation.

The cumulative impact of the increasing volume and density of electrical devices which produce radiation in the radio spectrum, densification of spectrum usage by various applications, mobile and nomadic usage as well as wireless devices and applications combined with the diversity of spectrum use by commercial and governmental entities present a challenge to current approaches to interference management. These should therefore be examined and reassessed together with receiver characteristics and more sophisticated interference avoidance mechanisms.

Article 4 par. 3 of the Radio Spectrum Policy Programme states:

"Member States and the Commission shall cooperate to foster the development and harmonisation of standards for radio equipment and telecommunications terminals as well as for electric and electronic equipment and networks based, where necessary, upon standardisation mandates from the Commission to the relevant standardisation bodies. Special attention shall also be given to standards for equipment to be used by disabled people."

In 2008 the RSPG Opinion on "Streamlining the regulatory environment for the use of spectrum" proposed solutions and recommendations to ensure consistency between various regulations affecting spectrum and to improve the co-operation between bodies involved in spectrum policies, in order to facilitate making spectrum available for new applications and to improve the efficient use of radio spectrum in conjunction with the avoidance of harmful interference.

Scope of the Report

This Report addresses the issue of interference management through an exchange of regulatory and technical best practices. The report identifies approaches how to take advantage of the characteristics and capabilities of the most advanced digital technologies and filtering techniques, including receivers, and how these advances are reflected in the best practices concerning regulation and standardisation in order to foster a more efficient use of spectrum. In particular, the report provides a common understanding on the solutions found at national level to address interference issues and on the specific role that could be played by improved standards in helping devices deployed in the future to avoid interference and, thereby, to improve spectrum efficiency.

The Report mainly focuses on:

- Identification of the basic principles and approaches of efficient Interference Management as well as Member States' best practices in managing interference taking into account increasingly flexible conditions of use in spectrum rights;
- Examination through the analysis of best practices, what role EU spectrum policy and specifically the R&TTE and EMC Directives, could play for improved receiver standards;
- Ways to improve receiver standards within the current ETSI, CENELEC and EU processes as well as to indicate how the European institutions could facilitate such a breakthrough;

This Report has been drafted further to the publication of the European Commission proposals for a Radio Equipment Directive (RED) in October 2012 which is under negotiations at the Council and the European Parliament at the time of writing.

2 DEFINITIONS

For the purpose of this Report, in particular under a radio spectrum policy perspective, RSPG took in due consideration the definitions regarding different kinds of interference as given in the Radio Regulations of the ITU, RR 1-17, Section VII of chapter 1, articles 1.166 to 1.169 (see Annex 1).

The definitions of the ITU are used for purposes of radio regulations by its members and should also be used in the light of furthering interference management on a European level.

Additional definitions regarding receivers are contained in Annex 2.

3 DESCRIPTION OF INTERFERENCE MANAGEMENT

An efficient use of spectrum requires a combination of ex-ante and ex-post approaches of interference management in a well balanced order (see section 4 hereafter which highlights that the main goal is to prevent interference and to avoid harmful interference in the "ex-ante interference management"). Evaluation, justification and documentation of interference are also essential parts of interference management.

Through ex-ante interference management harmful interference should be prevented from occurring whereas through an ex-post interference management harmful interference, when it occurs, should be eliminated. Very often remaining interference cases are solved by an ex-post manner with practical solutions on a case-by-case basis (e.g. the application of extra filters, the increase of the desired signals or a reduction of the unwanted signals by a decrease of the field strength). This approach may be appropriate but it may not sufficient in every case, e.g. regarding the introduction of RLAN in the 5 GHz band (see Annex 4).

In the scope of this Report, ex-post interference management is understood as the case where all kinds of EMC and Radio spectrum impairments have to be analysed and improved where appropriate and where solutions could be implemented at national level.

Furthermore, interference management may apply on different levels, either through appropriate restrictions at technical/administrative level in the authorisation/individual rights of use or through the design of the hardware or software taking into account sharing and spectrum usage conditions. Often these principles are applied in combination with each other.

The RSPG identified the following Interference Management principles:

- Self co-ordination between radio equipment users, often applied for in-band purposes taking into account the spectrum regulation in force

  Examples are found in frequency bands for PMSE, mainly under general authorisation where the use is coordinated within a local area between the users themselves. Another example of self co-ordination by the end-users is the use of PMR446 equipment. The users are able to choose between several channels and therefore have the ability to avoid co-channel interference from other users operating in the same location.

- Design/technology (self-co-ordination by the equipment itself)

  In this case, the performance of radio equipment will support the management of interference (e.g. auto power up or down in terminals, equipment may perform better than the standards, listen before talk, cognitive radio). Improvement of receiver parameters may be done on a voluntary basis to ensure better functioning of the radio equipment.

- Authorisation framework

  Administrations may have the possibility to design the authorisation framework to address relevant interference management issues. Nevertheless even if a general authorisation is the starting point according to the EU Electronic Communications Framework (Authorisation Directive), individual authorisation seems more appropriate in this context (see as an example in Annex 3 the national experience on the 800 MHz band usage). RSPG noted that, concerning SRD where an EC framework is in force, it is assumed that this harmonised framework is sufficient to ensure that there is no need for additional measures at national level to solve interference management issues. Moreover, national frameworks may also address, as appropriate, a large amount of spectrum usage outside the scope of “electronic communications services” (Defence, Aeronautical, etc.).

- Negotiation

  National framework may introduce a certain freedom for negotiations between stakeholders (e.g. mobile operators negotiate their network deployment to avoid

interference). Also negotiation between Member States is an example (e.g. cross border issues).

A main aspect of interference management should be an adequate communication and co-operation process between all involved stakeholders on a national and European level including frequency management, standardisation, market surveillance and enforcement aspects (e.g. investigation).

An efficient interference management should be based on an objective evaluation of impairments. It should consider and analyse by an interactive process on all relevant hierarchical steps where potential and actual interference cases are concerned, such as standardisation, market surveillance, frequency planning, frequency allocation, frequency assignments, licensing, frequency use, operation and monitoring, in the most efficient way for an efficient use of spectrum.

An efficient interference management therefore requires a careful and comprehensive balancing of all substantial interests between the sides concerned with regard to economic, social, spectrum policy, spectrum efficiency, industrial, market, operator and consumer aspects.

4 PRINCIPLES AND APPROACHES OF EFFICIENT INTERFERENCE MANAGEMENT

The RSPG addressed already carefully in the RSPG Opinion "Streamlining the regulatory environment for the use of spectrum" the co-operation between various bodies involved in spectrum policies in order to improve the efficient use of the radio spectrum and to avoid harmful interference. Since the date of adoption of this RSPG Opinion, additional interactions have been established during the last years, in particular between ADCO R&TTE, ETSI and ECC on issues related to conformity assessment and market surveillance.

In particular, RSPG noted that administrations are deeply involved in the drafting of spectrum regulation in order to avoid harmful interference. In the ex-ante process, this implies input contributions and participations of various experts from the administrations and the industry to provide confidence in that framework (sharing studies and regulatory issues). The same applies in the various entities cooperating for the development of the spectrum regulation and, before placing the equipment on the market, the entity in charge of the application of standards and procedures.

Interference management and its efficient use on a national as well as on a European basis, as described in chapter 3, require from a technical and regulatory point of view, defined values of accepted and harmful interference which have to be considered by all involved stakeholders.

Whereas the level of "harmful interference" is evaluated by clear technical criteria, the level of "accepted interference" may be evaluated by an appropriate combination of technical and regulatory criteria which were agreed among the parties concerned.

For efficient interference management, the definition and use of well balanced values of accepted interference is very important in order to form a reliable basis for an appropriate protection of incumbent services on the one hand and the introduction of new services on the other hand.

Because of the complexity of this approach the evaluation of accepted interference criteria and values requires ex-ante and ex-post measures. In order to ensure the operation of incumbent services without any unacceptable chance of harmful interference and to provide the technical and regulatory framework conditions for the operation of added, modified or new services also without any unacceptable chance of harmful interference, the ex-ante measures are most important in comparison to ex-post measures under consideration of technical, economical, market, consumer and costs aspects for all sides.

RSPG proposes to develop and to use ex-ante measures for an efficient interference management with first priority in order to minimise the use of ex-post measures.

RSPG also notes that ex-ante interference management should be included in harmonised approaches on a European scale as far as possible, whereas national measures are taken when the harmonised decisions do not provide solutions.

Among the various activities which could be mentioned in ex-ante and ex-post processes, RSPG noted in particular the following:

Examples for ex-ante issues

- *Drafting the regulatory framework based on sharing studies (knowledge of characteristics of all spectrum users, incumbents and new entrants (applications requiring access to spectrum, CEPT with ETSI contributions)*
- *Drafting Harmonised Standards respecting the results of sharing studies (ETSI, industry and administrations) including receiver and transmitter requirements*
- *Drafting EU regulatory text based on CEPT Reports in response to EC mandates*
- *Drafting EMC standards taking into account the evolution of spectrum usage (ETSI /CENELEC)*
- *Conformity assessment of equipment to R&TTE and EMC Directives (issue of manufacturers and Notified Bodies)*

- *Drafting cross border co-ordination recommendations and agreements (CEPT Recommendations, HCM agreement[3])*
- *Licensing conditions*
- *Market surveillance to ensure the conformity of radio equipment with the essential requirements of the Directives in order to prevent interference caused by the functionality or unintended mode of use of the equipment (issue of Administrations)*
- *Spectrum monitoring to investigate unauthorised or unlawful use of radio equipment in order to prevent interference and to provide information to frequency management and enforcement*
- *Inspection of radio equipment*

Examples for ex-post issues

- *National measures, where appropriate, in addition to EU regulation and standards (e.g. shared use of spectrum for mobile and broadcasting services)*
- *Market surveillance*
- *Inspection of radio equipment*
- *Spectrum monitoring*
- *Interference investigation and removal*
- *Identification of the need to update Harmonised Standards respecting the results of interference cases (involving ETSI, industry and administrations) including receiver and transmitter requirements – including update of standards if needed further to initial market phase (see example RLAN 5 GHz in Annex 4)*

Some of the examples as given above have been already subject to careful consideration by RSPG – see RSPG Opinion on "Streamlining EU regulation", while this Report focuses on the impact of receiver issues in spectrum management in conjunction with efficient interference management aspects.

Nevertheless, RSPG emphasises that administrations actions are making efforts in carefully drafting regulation ex-ante due to the lower associated costs for them compared to the investment in human resources and in various equipment (inspection, monitoring, vehicle) which are needed in market surveillance and the interference investigation[4] and removal. It

[3] HCM: Harmonised Calculation Method

[4] See relevant figures in ECC Report 160

should also be noted that the enforcement organisations need to have a minimum amount of personnel resources for basic operations despite the size of the country. RSPG highlights that, in a context of budget reduction, intensive efforts should be maintained to develop spectrum regulation in order to avoid harmful interference. An appropriate time frame taking into account the amount of studies which needs to be done should be taken in due consideration.

5 ANALYSIS AND IMPACT OF THE CURRENT REGULATORY FRAMEWORK OF MEMBER STATES, THE CEPT AND THE EU INSTITUTIONS ON EFFICIENT INTERFERENCE MANAGEMENT

At the end of 2008, the RSPG approved and published the RSPG Opinion on "Streamlining the Regulatory Environment" (Document RSPG08-246) by taking into account the Final Report of the "Study on radio interference regulatory models in the European Community"[5]. This section of the RSPG report on interference management refers to the main follow up actions further to the publication of this opinion and recommends some additional improvements.

Evolution of the regulatory framework since 2008

This RSPG Opinion approved in 2008 emphasised the various interactions between the regime applicable for the radio equipment to be put in the European market and the regulatory regime for the usage of this radio equipment. RSPG could note at this stage that this liberal approach to placing equipment on the market, which replaced the type-approval approach, is still unique at worldwide level.

The regulatory framework for the electronic communication services has been subject to review in 2009 and the resulting updated framework is currently in force in Member States. In particular, this framework established the multi annual Radio Spectrum Policy Program which was published in April 2012. This Program emphasises that a coherent link between spectrum management and standardisation shall be maintained in such way to enhance the internal market.

The RSPG confirmed that a number of actions further to the publication of this RSPG Opinion moved concretely in support of this policy demand and are still valid in the new framework where the Spectrum Decision[6] plays a key role for the definition of technical conditions for the usage of spectrum. In practice RSPG noted that Commission Decisions

[5] "Study on radio interference regulatory models in the European Community" commissioned to Eurostrategies and LS telcom, published 29 November 2007

[6] DECISION No 676/2002/EC OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 7 March 2002 on a regulatory framework for radio spectrum policy in the European Community (Radio Spectrum Decision) http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CELEX:32002D0676:EN:NOT

on spectrum are not be adopted before the final adoption of CEPT Reports after the public consultation process and emphasises that Commission Decisions should respect the conclusion of these technical studies.

A new Directive is proposed by the European Commission (Radio Equipment Directive) to replace the R&TTE Directive and will be subject to discussion, examination and amendment at the Council and European Parliament level.

Follow up actions to the RSPG Opinion on "Streamlining the regulatory environment"

The RSPG recommends when assessing the update of the regulatory framework applicable to radio equipment, including transmitter and receiver components, to take into utmost consideration the various follow up actions further to the adoption of this RSPG Opinion and relevant improvement of the framework.

Responding to a recommendation of the RSPG Opinion inviting for better visibility and understanding of complex framework in order to ensure the participation and contribution of relevant stakeholders at the relevant level in the development of spectrum regulation and Harmonised Standards:

> The European Commission, the CEPT ECC and ETSI in co-operation have developed a communication leaflet to explain to the stakeholders how the various component are interrelated and how the industry should request an access to spectrum and how the standardisation framework and the spectrum framework are interrelated. This communication leaflet is available on various websites including those of ECC and ETSI. A brochure has been developed to explain the interaction between ECC and ETSI to all spectrum stakeholders. The online version of the brochure is available at http://www.cept.org/ecc/about-ecc/ecc-etsi and http://www.etsi.org/e-brochure/radio/.
>
> When the regulatory framework for placing radio equipment on the market is updated, in particular a new Radio Equipment Directive,
>
> **RSPG recommends a review and an update of this leaflet in co-operation between the various organisations.**

The RSPG Opinion on "Streamlining the regulatory environment" provided short term recommendations emphasising the key role of various entities in the overall process. Based on these short terms recommendations:

- ETSI and ECC have improved their day-to-day co-operation mechanisms under the Memorandum of Understanding (MoU) framework of co-operation. This improved day-to-day co-operation ensures better efficiency and transparency of the process and ensures coherence between spectrum framework and relevant Harmonised Standards developed in respect of the results of CEPT/ECC sharing studies. The

workflow between ECC and ETSI has been updated. The document describing the co-operation process between ECC and ETSI has been reviewed and the revised document was endorsed at the ECC-ETSI meeting in October 2010 (and subsequently editorially updated). A better co-ordination is in place to react in case of a need to update the framework.

- The co-operation between R&TTE CA and ECC has been reinforced. An ECC representative participates to the R&TTE CA meetings ensuring that issues that ECC is informed of issues that come up in R&TTE CA. This ensures more visibility to the results of sharing studies from CEPT/ECC and a better knowledge and understanding in the context of the Notified Bodies environment.

- The current work in ADCO R&TTE, including common market surveillance campaigns and the co-operation mechanism between various authorities, has been improved since the last year.

Improvements of the framework

The RSPG recommends that every effort be made to ensure the consistency of ECC and Commission Decisions on spectrum, recognising that ECC Decisions also contain sharing conditions which are respected in ETSI Harmonised Standards rather than specified in Commission spectrum Decisions. RSPG recommends that this objective should be maintained in order to ensure confidence in the process and a better flexibility when there is a need to update the regulatory framework.

RSPG confirmed that the possibility to introduce new innovative applications and to increase spectrum sharing relies on the confidence of all spectrum users that the conditions and parameters required to ensure compatibility will be effectively considered, met and enforced. This recommendation is more than ever valid in a context of increased sharing of spectrum and shall be carefully considered for any development of new regulatory measures.

RSPG recommends the following improvement of the framework:

- For an efficient frequency management as well as for an efficient interference management mandatory technical parameters in EU Decisions should be aligned with corresponding technical parameters in ECC Decisions although basically EU Decisions on spectrum are developed with consideration of CEPT Reports based on mandates to CEPT.

- The transparency of the work of notified bodies in the case where a Harmonised Standard is not applied could be enhanced. These notified bodies must inform the Commission and Member States when they deliver a certificate for equipment where a Harmonised Standard is not followed to show compliance to the applicable Directive.

- RSPG supports the creation of a network inside notified bodies of people used to deal with innovative products with the aim of supporting focused discussion and mutual learning; this could be done through R&TTE CA.

- RSPG considers that efficient market surveillance is essential to complement the conformity assessment procedure without a type approval process. An essential factor for efficient market surveillance is the knowledge of equipment placed on the market. It is important to further investigate having a tool available in order to better regulate placing equipment on the market. The impacts of the New Legislative Framework (NLF)[7] should be taken into account.

The future framework applicable to radio equipment should follow the aim of both providing an increase of confidence in compliance of radio equipment on the market and simplifying the administrative provisions where they are not well understood.

RSPG proposes that TCAM and RSCOM should work in close relation regarding the development of mandates to ETSI and CEPT and where similar issues of interference aspects are concerned. RSPG recommends maintain such coordinated activities of both committees even if a new Directive for radio equipment will be established.

RSPG still recommends that mandates to ETSI and CEPT should complement each other both in content and timing.

Finally, the RSPG Opinion on "Streamlining the regulatory environment" mentions that receiver parameters are important for spectrum management and for facilitating the introduction of new applications in spectrum.

Therefore, the RSPG still considers that:

- **Receiver parameters should be included in harmonised and/or product standards for all equipment and that administrations should encourage the development of good performance receiver specifications.**

- **Receiver parameters should be used consistently by CEPT in sharing studies as part of the assumptions for the intended use of the band, taking into account equipment already in use before the adoption of standards including receiver parameters. The RSPG provides additional recommendations focusing on that issue in section 7.**

[7] The EU's regulatory framework for electronic communications is a series of rules which apply throughout the EU Member States. The framework is made of a package of **five Directives** and **two Regulations.**
http://ec.europa.eu/digital-agenda/en/telecoms-rules

Market surveillance and Risk assessment

The RSPG noted the Regulation (EC) No 765/2008 of the European Parliament and of the Council of 9 July 2008 setting out the requirements for market surveillance relating to the marketing of products.

According to that regulation, market surveillance authorities are forced to perform appropriate checks on the characteristics of products on an adequate scale, by means of documentary checks and, where appropriate, physical and laboratory checks on the basis of adequate samples. Such preventive measures are essential basics of an efficient interference management.

When market surveillance administrations enforce such measures they shall take into account the principles of risk assessment, complaints and other information.

Risk assessment should take all relevant data, such as frequency allocation and interference cases, into account, including, where available, data on risks that have materialised with respect to the product in question. Account should also be taken of any measures that may have been taken by the economic operators concerned to alleviate the risks.

The RSPG noted also that the European Commission published a proposal for a new regulation of the European Parliament and of the Council on market surveillance of products (COM (2013) 75 final).

This proposal defines in Article 9 the procedure in relation to a product presenting a risk and defines in Article 3 (13) the product presenting a risk.

According to that definition a

"product presenting a risk" means a product having the potential to affect adversely health and safety of persons in general, health and safety in the workplace, consumer protection, the environment and public security as well as other public interests to a degree which goes beyond that considered reasonable and acceptable under the normal or reasonably foreseeable conditions of use of the product concerned",

including the duration of use and, where applicable, its putting into service, installation and maintenance requirements, RSPG recommends that, in the context of risk assessment done by market surveillance, to maintain a co-operation with ECC, where appropriate, in order to share knowledge on issues of common interests.

6 DESCRIPTION AND ANALYSIS OF THE CURRENT REGULATORY REGIME FOR STANDARDISATION AND THE PROCESSES WITHIN THE EU STANDARDISATION ORGANISATIONS

The RSPG Streamlining Opinion 2008 describes the basic procedure for developing Harmonised Standards under article 3.2 of the R&TTE Directive (1999/5/EC) within ETSI, and how this interfaces with the procedures for developing ECC Reports and Commission Decisions under the Radio Spectrum Decision (676/2002/EC).

RSPG noted that a new process is in place for the approval of mandates to ESO (European Standardisation Organisation) based on art. 10 of the REGULATION (EU) No 1025/2012 OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 25 October 2012 on European standardisation.

This chapter builds on the RSPG Opinion on "Streamlining the regulatory environment" by describing:

- the impact of the Regulation 1025/2012 on European Standardisation on the procedure for the Commission to request standards from the European Standardisation Organisations (mandates) and on the procedures to follow should the standards fail to provide the necessary protection (safeguard clauses).
- the procedures for developing Harmonised Standards under article 3.1b of the R&TTE Directive (1999/5/EC) and under the EMC Directive (2004/108/EC) in CENELEC and ETSI, including the relationship (Dresden Agreement) between CENELEC and the International Electrotechnical Commission (IEC) and its International Special Committee for Radio Disturbance (CISPR).
- the comparison between the mechanisms of CENELEC and ETSI to ensure participation in the standardisation work by the necessary stakeholders.

RPSG identified the following impact of the Regulation 1025/2012 on the approval of standardisation Mandates and on safeguard procedures:

a) Standardisation Mandates

Whereas previously standardisation mandates had been managed by the Committee under the Directive 98/34/EC, the process for the Commission to request standards from the European Standardisation Organisations (ESOs) is now governed by the new Regulation on European Standardisation. Draft mandates to ESOs are subject to the full Examination Procedure defined in Regulation 182/2011 on Commission's exercise of implementing powers, which require a formal vote in the Member States' Committee set up under the Standardisation Regulation. Mandates are treated as "implementing powers" conferred on the Commission.

Although the Regulation on European Standardisation allows the Commission to address mandates to one or several ESOs, in practice mandates are addressed to all three ESOs in parallel. The ESOs co-ordinate amongst themselves to ensure any necessary work repartition and co-operation.

RSPG noted that the ESOs have agreed that ETSI has responsibility for all standards for radio spectrum. For EMC, the responsibility is split depending on the type of standard and the type of equipment concerned (see below).

RSPG noted that the process followed by the Commission to provide mandates to CEPT under the Radio Spectrum Decision is not affected by the above.

RSPG proposes that mandates to ETSI and CEPT should complement each other both in content and timing.

b) Safeguard procedures

Article 11 of REGULATION (EU) No 1025/2012 provides revised procedures for a Member State or the European Parliament to raise an objection to a Harmonised Standard which it considers does not entirely satisfy the requirements of the relevant legislation. Member States or the European Parliament may object to a Harmonised Standard before or after its reference has been published in the Official Journal of the European Union.

The Commission before taking action, consults with the Member States' Committee set up under the Directive (if any) and with the Member States' Committee established under the Standardisation Regulation. The consultation process is lighter ("advisory procedure") if the reference has not been published. After publication, it is necessary to invoke the full Examination procedure (as for the adoption of a mandate).

RSPG identifies the following procedures for developing EMC standards (article 3.1b of the R&TTE Directive 1999/5/EC or the EMC Directive 2004/108/EC):

The EU standardisation organisations CEN, CENELEC and ETSI are responsible to internally organise and structure their standardisation activities.

The responsibility for EMC standards is subject to a work-repartition agreement between CENELEC and ETSI, signed in 1992. Under this agreement:

- CENELEC is responsible for "generic" EMC standards
- ETSI is responsible for EMC product standards for radiocommunications equipment, with the exception of broadcast receivers for consumers
- CENELEC is responsible for EMC product standards for wired communications equipment, including cable TV equipment.

When one body has the responsibility, the other body may participate as an observer ("mode 4 co-operation").

In this context RSPG identifies that development of Powerline Telecommunication (PLT) standards need to be monitored in order to identify the radio services and their required protection from interference by PLT systems. **RSPG invites administrations to exchange views and information on the CENELEC approval process of PLT standards in order to contribute to CENELEC process where appropriate.**

Co-operation between ETSI and CEPT for radio standards (article 3.2)

The co-operation procedures are described in the RSPG Opinion on "Streamlining the Regulatory Environment". ETSI takes part in compatibility studies in CEPT which define sharing conditions. ETSI respects these sharing conditions in the development of its Harmonised Standards.

Co-operation between CENELEC and IEC/CISPR (the "Dresden Agreement")

Most European EMC standards under the responsibility of CENELEC are developed within the IEC under the "Dresden Agreement". Under this agreement CENELEC first offers a New Work Item (NWI) to its international counterpart. If IEC accepts, CENELEC does no further work in the scope of the NWI. When IEC completes its draft, CENELEC carries out Public Enquiry and Vote among its European members. If successful, the IEC Standard is also adopted as a European Standard (EN). If IEC refuses, CENELEC starts work on the development of a European Standard, keeping IEC closely informed and give IEC the opportunity to comment at the public enquiry stage.

The "Dresden Agreement" also determines that CENELEC and IEC vote in parallel during the standardisation process. If the outcome of the parallel voting is positive, CENELEC will ratify the European standard and the IEC will publish the international standard.

This close co-operation has resulted in some 76% of all European standards adopted by CENELEC being identical or based on IEC standards.

IEC TC (Technical Committee) 77, created in 1973, is a committee with horizontal functions. It is responsible - together with other committees to some extent - for Basic EMC standards having general application and for Generic EMC standards, although in some circumstances it may also prepare EMC immunity standards and low-frequency emission standards for products or product families.

IEC/CISPR also has horizontal functions and also develops Basic and Generic EMC standards. In addition it has extended its field of activity to EMC Product standards, e.g. for multimedia products and certain household equipment.

The IEC established its Advisory Committee on Electromagnetic Compatibility (ACEC) to ensure co-ordination among these special EMC committees and with the outside world, as well as to provide advice to the numerous product committees that develop EMC standards specific to their products.

In most IEC member countries, national bodies corresponding to TC 77, CISPR or the product committees take care of EMC matters at the national level.

Participation in CENELEC and ETSI standardisation processes

CENELEC and ETSI have different mechanisms for participation. In CENELEC the route for participating in the development of European Standards is through CENELEC national members (National Committees). Each National CENELEC Member sends a delegation to represent their concerned interests in a standardisation project. ETSI was set up around the "one table" approach, in which all interested parties from government and from industry can participate directly at the European level on equal terms to come to consensus. In CENELEC, National Administrations may participate at the National level only, unless appointed to a National delegation by a CENELEC National Committee.

Ex-post management of interference in the context of the proposed Radio Equipment Directive (RED)

In the case of harmful interference being detected, the proposed RED foresees the possibility to invoke safeguard procedures, in consultation with a Member States' Committee (TCAM). This is the same as the existing Member States' committee under the R&TTE Directive (1999/5/EC). The European Standards Bodies ETSI and CENELEC are regular participants to TCAM Working Group. Any action to withdraw references in the Official Journal or to impose restrictions on the use of Harmonised Standards, is subject to the Examination Procedure defined in Regulation 182/2011, which requires a formal vote in the Member States' Committee set up under the Standardisation Regulation.

Under the R&TTE Directive 1999/5/EC, when interference issues which have required improvements to standards (e.g. interference to meteorological radar, congestion in the 2,45 GHz ISM band), have been reported to the Commission via TCAM, necessary corrective actions have been put into place without the need for the formal procedures described above. It is necessary that TCAM should continue to provide such communication in the new RED.

Under the current proposal of the European Commission, the RED would not apply to receive-only equipment. Such interference issues would therefore not be the business of TCAM.

The proposed new EMC Directive (aligning with the New Legislative Framework) has no Member States' committee (Directive 2004/108/EC referred issues to the 98/34/EC Committee, which has since been replaced by the Committee on Standards under 1025/2012). In the event of objections to Harmonised Standards, article 11 of the Standardisation Regulation (1025/2012) would apply. In the case of the EMC Directive, consultations with "other forms of consultation of sectoral experts" would be required as no Member States' committee has been established.

The RSPG encourages the Commission to consult with the European Standardisation Organisations (ESOs) to ensure that Harmonised Standards can be modified quickly when necessary.

7 RECEIVER PARAMETERS IN SPECTRUM REGULATION AND IN RADIO HARMONISED STANDARDS

This section focuses on the role of the receiver parameters in the context of a more, intensive spectrum usage and on the improvement of the relevant regulatory framework.

How receivers should be addressed by spectrum regulators and by spectrum users is becoming an increasing and also a sensitive issue. The receivers issue is not new, but as wireless now permeates social and economic activities at almost every level it has become more prominent. Rapid technological advances have made radio equipment, in general, smarter, more efficient, smaller and cheaper than before. RSPG already raised the issue of receiver role in previous Opinions, such as the RSPG Opinion on "Streamlining the regulatory environment for the use of spectrum".

7.1 WHY ARE RECEIVER PARAMETERS BECOMING KEY PARAMETERS TO SUPPORT AN EFFICIENT USAGE OF THE SPECTRUM?

Radio communication links include transmitters and receivers. In consequence for frequency planning, the characteristics of receivers as well as transmitters are important and central to the decisions which need to be taken on channelisation, frequency re-use and the planning of systems in adjacent frequency bands.

Moreover RSPG highlights that potential applications and spectrum (or interference) environments are very diverse.

- For instance, not all users of the spectrum transmit. There are many uses that are reception-only, e.g. passive services, such as radio astronomy, do not use transmitters but do rely on very sensitive receivers with relatively wide bandwidths.

- In some particular cases, such as broadcasting, the broadcaster operating the service has no direct control over the performance or deployment of the user's receivers.

In consequence, receiver parameters are key parameters in the case of sharing and compatibility studies between systems. There is a balance to be struck between the protection of incumbents' services and allowing new entrants to use the spectrum.

- Stringent restrictions on transmissions have the potential to reduce the market for new uses of spectrum.

- On the other hand, any imposition of stringent receiver requirements could lead to over-engineering of the equipment's design with the associated high costs. This could also limit technological design choices or inhibit innovation. It is this balance to be struck between incumbents and new entrants where the spectrum manager is involved when developing spectrum regulations and frameworks and standards.

When spectrum regulations are modified to permit the introduction of a new system, CEPT carries out spectrum sharing studies with the participation of ETSI members to assess the compatibility of the proposed new system with existing users. This study is based on presumed technical requirements of the proposed new system, normally contained in a "System Reference Document", plus technical requirements of the existing users.

Relevant receiver parameters in Harmonised Standards reflecting the state of the art are taken into account in sharing studies. In the past, when receiver parameters were not available from standards for existing equipment, they had to be inferred from market studies, communicated from industrial representatives or determined by administrations as so called "reference receiver parameters".

When developing sharing studies, CEPT benefits from information from various spectrum users, manufactures and administrations, and CEPT has the possibility to assess all relevant sharing parameters.

The implementation of receiver parameters in Harmonised Standards will create an extra possibility to identify at an early stage the limitations that existing and other planned applications could raise to new applications and their demand for access to the spectrum. This identification can lead to propose extra measures (refarming, delay, technical measures, etc.) to avoid harmful interference. There is the possibility to identify when weaknesses from receivers parameters could reduce the opportunity for new applications demanding access to spectrum.

ETSI Harmonised Standards specify requirements for equipment using the spectrum, (receivers, transmitters and combined receivers/transmitters). They respect conclusions of the CEPT spectrum-sharing studies.

This process allows an appropriate balance to be achieved between the need to use best the spectrum, and the need to keep costs for the various spectrum users at a reasonable level.

Receiver parameters which are covering a number of features (receiver sensitivity, selectivity, blocking, desensitisation, co-channel rejection and others – see Annex 2) are becoming more and more essential within spectrum management due to the increasing number of sharing scenarios, increasing demand for additional spectrum resources for

various radiocommunications services and their applications including the request for reduction of guard bands.

As mentioned by CEPT ECC in ECC Report 127: *"A radio receiver's immunity to interference depends on a number of factors in its technical design and, in addition, the characteristics of the signals it receives. These factors may be closely related and in many cases interdependent, and a receiver's performance in one factor may often affect its performance in others. The factors determining receiver immunity performance generally include selectivity, sensitivity, blocking, desensitization, spurious response, required protection ratio, co-channel rejection, adjacent band rejection, intermodulation rejection, cross modulation rejection, dynamic range, automatic RF gain control, shielding, modulation method, and signal processing."*

RSPG noted this context and recalled in Annex 2 the description of these various factors.

In consequence, the inclusion of receiver performance specifications in spectrum planning and regulation serves to promote more efficient utilisation of the spectrum and creates opportunities for new and additional use of radio communications.

For example, with better selectivity features and improved strong signal handling, radio receiver equipment is better protected from Out of Band emissions from services in adjacent bands, in fact, the immediate impact could be the reduction of guard bands between services. It should be noted, however, that requiring better receiver performance can imply additional cost.

7.2 RECEIVER PARAMETERS AND HARMONISED STANDARDS

Receiver parameters are crucial to ensure co-existence of systems in adjacent bands and therefore to optimise the use of scarce spectrum resources. Moreover, receiver parameters are an essential part of innovative band sharing schemes.

It can be necessary to set limits for technical parameters (such as receiver parameters) that are specific to the radio environment and operational conditions. Parameters characterising receiver performance should therefore be treated in a similar way to emission parameters and when necessary they should be included in the same Harmonised Standards applying to the corresponding transmitters.

The setting of such parameters can only be done in the context of Radio Harmonised Standards based on the results of sharing studies provided by the CEPT.

The RSPG Opinion on "Streamlining the regulatory environment" recommends:

"Receiver parameters should be included in Harmonised and/or product standards for all equipment and administrations should encourage the development of good performance receiver specifications. The RSPG further considers that receiver parameters should be used consistently by CEPT in sharing studies as part of the assumptions for the intended use of the band, taking into account equipment already in use before the adoption of standards including receiver parameters."

RSPG confirms its support to this approach and recommendation.

RSPG noted that ETSI discussed the issue of receiver standards in TR 102 914 "Aspects and implications of the inclusion of receiver parameters within ETSI standards". This Report emphasized the role of receivers in the relevant ETSI standards and highlighted that they are included in a number of areas.

Receiver parameters contribute to an efficient spectrum management. Some of these receiver parameters determine the performance of equipment against interference from other sources.

Harmonised Standards however do not always detail these into technical requirements, thereby leaving some ambiguities whether in case of harmful interference this is due to insufficient performance or to emissions. ETSI is currently considering the issue (see also section 6 of this report).

RSPG therefore supports the promotion of adequate receiver performance and recognizes that relevant radio receiver parameters become increasingly necessary to facilitate the introduction of new systems, to extend sharing opportunities and to ensure efficient spectrum management.

7.3 EMC ISSUES

EMC issues shall also be considered, in particular on the relationship between immunity and radio receiver parameters.

RSPG noted that for radio equipment, immunity requirements to electromagnetic disturbance are defined in the EN 301 489-x family of EMC Harmonised Standards (which are listed in the OJEU under article 3.1b of the R&TTE Directive (and a few under the EMC Directive) and are drafted under the responsibility of ETSI).

- The EN 301 489-1 sets the general test methods and requirements while the specific standards EN 301 489-x define the performance (and necessary specific tests) expected for each type of equipment.

- Immunity requirements (for the receivers) to radio electromagnetic fields are defined in § 9.2.2 of EN 301 489-1 for frequencies within the bands 80-1400 MHz and 1400-2000 MHz.

In contrast to standards specifying equipment for managed use of radio spectrum, standards for EMC are specified with respect to a general operating environment specified in IEC standards (IEC 61000-6-1 for emissions and IEC 61000-6-3 for immunity in the domestic and light industrial environment). They do not take account of specific sharing scenarios.

For this reason, EMC standards for radio equipment are only applicable at frequencies which are sufficiently far from its operating frequency for the planned interaction to be considered as minimal. This is reflected in the specification of an "exclusion band" around the operating frequency within which the EMC standard does not apply. Within the

exclusion band, radio equipment standards are developed based on spectrum-sharing studies (see clause 7.1).

- The test level for immunity to radio electromagnetic field is generically defined as 3 V/m (see EN 301 489-1 §9.2.2, there could be exceptions in specific standards). In order to pass the test on equipment there are several performance requirement possibilities: for instance to be able to operate in the presence of the test signal, or to be affected during the presence of the test signal but recover to normal operations when the test signal is switched off.

- This test level of 3 V/m corresponds to a strong field: around -10 dBm for a receiver with a 0 dBi antenna at 900 MHz (noting that a typical sensitivity would be around -90 dBm).

RSPG confirms that this context implies the necessity of an exclusion band around the receiving band, otherwise the receiver would not be able to pass the EMC immunity test.

For equipment covered by the R&TTE Directive, the minimum performance of the receiver within the exclusion band is sometimes specified by receiver parameters in the relevant Radio Harmonised Standard.

The EMC Directive covers parameters which describe radio disturbance and immunity aspects in the terms of the electromagnetic environment but not radio parameters such as transmitter and receiver selectivity, sensitivity, blocking, Out of Band and spurious emissions. The radio parameters are based on completely different physical phenomena than EMC parameters and require different technical measures in order to ensure an efficient and interference-free use of the radio spectrum.

RSPG concluded that the EMC Directive cannot cover radio parameters necessary for efficient spectrum usage and efficient interference management.

RSPG noted the ongoing process of the Revision of the EMC Directive and concluded that those parts defining the essential requirements as specified in particular in Annex 1 of the Directive, remain unchanged. This status of the Revision supports the conclusion of the RSPG above.

7.4 TREATMENT OF RECEIVERS IN THE PROPOSED NEW DIRECTIVE ON RADIO EQUIPMENT (RED)

The RSPG noted that the European Commission published a proposal for a new Directive on Radio equipment (RED).

This proposal states in Article 3(1):

"Radio equipment shall be constructed so as to ensure:

(a) the protection of the health and the safety of the user and any other person, including the objectives with respect to safety requirements set out in Directive

2006/95/EC, but with no voltage limit applying;

(b) the protection of electromagnetic compatibility as set out in Directive 2004/108/EC, including in particular levels of immunity which lead to improvements in the efficient use of shared or adjacent frequency bands"

In Article 3(2) is stated:

"Radio equipment shall be so constructed that its transmitted signals efficiently use the spectrum allocated to terrestrial/space radio communication and orbital resources so as to avoid harmful interference. Only radio equipment that can be operated in at least one Member State without infringing applicable requirements on the use of spectrum can comply with this requirement."

At this stage, this proposal ignores the role of receiver parameters in spectrum management and their contribution to the avoidance of harmful interference. Such a proposal considers that only essential requirements under EMC Directive 2004/108/EC will be applicable to receivers (see Recitals 9, 10 and 12). It is mentioned that efficient use of spectrum according to the state of the art should be ensured to avoid harmful interference.

Nevertheless, such a proposal has a direct impact on spectrum and interference management by transferring the conformity of receivers to the EMC Directive.

- **RSPG considers that the EMC Directive is not the relevant tool to cover receiver parameters dealing with Radiocommunications issues.**

- **RSPG recommends that the definition of radio equipment should include the receiver part and that receive - only equipment should also be included in the scope of the new framework on Radio Equipment Directive.**

RSPG recalled in previous sections the role of receiver parameters in the spectrum management and how they are embedded in the Harmonised Standards and is making the following recommendations:

- **The EMC immunity parameters and radio receiver parameters are designed differently. They are intended to deal with two different regulatory environments: generic environment (EMC) versus specific system (Radio).**

- Receiver parameters are becoming more and more essential in a context of densification of the usage of the radio spectrum and the introduction of new sharing mechanisms. **Both, emission parameters and receiver parameters should be considered under the same framework.**

- The proposed Directive on Radio Equipment (RED), by excluding receiver parameters from Art 3(2) essential requirements, undermines the elaboration of coherent Radio Harmonised Standards (which must describe the radio parameters enabling a radio system - both transmitters and receivers - to operate in a specific spectrum environment).

8 MEMBER STATES EXPERIENCE ON BEST PRACTICES FOR EFFICIENT INTERFERENCE MANAGEMENT

RSPG noted that administrations have already established some forms of co-operation between enforcement organisations. CEPT conducted an Enforcement Benchmarking in the Year 2010 (ECC REPORT 160). It provides, among others, an excellent picture of similarities and differences between enforcement organisations and their priorities as well as to find best practices and ways to improve co-operation. Enforcement encompasses the following tasks: market surveillance, inspection of radio equipment, spectrum monitoring, and interference investigation and removal.

In this report, RSPG discussed in more details the issue of interference investigation and removal.

- The most common tasks are actions against illegal or unlicensed use of radio equipment, interference investigations, on-site inspections of radio installations and market surveillance of radio and telecommunications terminal equipments.

- The nature of interference cases vary from case to case and from country to country due to national situations and processes. The solutions to solve them also vary from case to case and from country to country (see Annex 3). **In the future, descriptions concerning interference removal and on-site inspections should be more widely shared between enforcement organisations.**

- In case of repetition of interference cases, enforcement is able to report some structural issues to be investigated in more details in order to solve it. This issue implies a form of co-operation between administrations in order to assess relevant solutions. CEPT already established this form of co-operation on a case-by-case basis.

The illustrative case of the introduction of RLAN 5 GHz summarised hereafter is an example of the co-operation between various entities to solve the issue and revealed the complexity of efficient interference management in this context.

- RSPG noted that introduction of RLAN in 5 GHz frequency band revealed the complexity of sharing conditions, the need to implement a specific mechanism to ensure the compatibility between radars (primary users of the frequency band) and RLAN (as co-primary users). Numbers of interference cases on meteorological radars operating between 5600 and 5650 MHz have been reported during the preliminary introduction of RLAN equipment in this band.

- An update of the Harmonised Standards had been identified as the way forward in order to ensure coherence with sharing conditions. This update of relevant Harmonised Standards involved ETSI, CEPT, in charge of technical studies, and the European Commission which provided useful guidelines to the standardisation process (ETSI) for the relevant update of the Harmonised Standard. The co-operation process between ETSI and CEPT contributed also to these updates of

Harmonised Standards. This updating process has been rather complex due to the necessary support and guidance to be obtained by the European Commission.

- Despite the update of Harmonised Standards, meteorological radars are still subject to a number of interference cases. In the majority of the last reported cases, the interference was caused by non-compliant equipment or non-compliant operation of the equipment.

Nevertheless, RSPG highlights that market surveillance faces difficulties with this type of products, which in some cases can (easily) be modified by the user. For example, an RLAN user when moving to another country is not aware of possible consequences generated by the usage of RLAN, sales via Internet are not controlled, users could try to deactivate the DFS (Dynamic Frequency Selection) system by erroneous location software declaration.

In consequence, all effort shall be made in ex-ante interference management; in particular, sharing conditions shall be carefully conducted taking into account incumbent users and applications requiring access to the spectrum. Mechanisms to share spectrum differ and lessons should be learned from the weaknesses of sharing mechanisms which are respected in practice.

RSPG recommends that,

- Without delay, some guidance should be defined in order to assist notified bodies in their task and to put the stress on particular difficult points which could lead to interference when the equipment is installed and in operation.

- TCAM, based on recent analysis on the sources of interference, develops recommendations in order to update the Harmonised Standard, where appropriate.

- Monitoring inspection should take care of follow up of resolution/removal of interference in order to avoid repetition of interference.

In Annex 3 an overview is given about national examples on efficient interference management based on national regulatory best practices.

<u>RSPG identified the following conclusions based on national experience</u>

The national examples on efficient interference management based on regulatory best practices clearly indicate that no favoured or best appropriate approach can be proposed as a general rule for all Member States. The different national conditions as described in Annex 3 require adequate national measures on efficient interference management which best meet the national expectations and demands and may differ from country to country.

But some general conclusions can be drawn from the national experience proposed as common and basic guidance.

In particular, **common conclusions** for practical measures on efficient interference management based on national experience can be stated as follows:

- Interference management should start and be organised as early as possible, i.e. just at the first investigations for frequency and service planning and standardisation activities.
- Interference management is a continuous process which goes together with all stages and phases of frequency planning, allocation, assignment and use for radiocommunications services and applications.
- Interference management strategies and measures may be developed and used in general terms as a basic for all scenarios but require a detailed adaptation and a flexible response for the scenarios in question.
- Independent of different national measures especially in case of new introduced frequency usage scenarios and market penetration of new services and technologies administrations may improve their efficient interference management by an exchange of their national approaches and experience.
- Ex-ante measures are the most important part in comparison with ex-post measures in order to ensure an efficient interference management. Ex-post measures should be used as supporting and corrective actions to ex-ante measures.
- The definition of clear technical and regulatory criteria are necessary for an efficient interference management and form a reliable basis for all sides in the whole process of frequency planning, definition of radio interface parameters and operation.

9 CONCLUSIONS AND PROPOSALS ON FURTHERING EFFICIENT INTERFERENCE MANAGEMENT

Best practices for an efficient interference management

Efficient use of spectrum requires efficient interference management together with efficient frequency management and radio equipment management. RSPG notes that the emphasis should be put on ex-ante interference management to avoid harmful interference, which saves resources compared to ex-post interference management. RSPG also notes that ex-ante interference management should be included in harmonised approaches on a European scale as far as possible, whereas national measures are taken when the harmonised decisions do not provide solutions. Exchange of national experience and examples supports the Member States to solve interference problems, when harmonised solutions are not available. RSPG encourages Member States to exchange their national best practices on interference management.

Role of EU spectrum policy for improved receiver standards

Radio receiver parameters are key parameters to support an efficient use of spectrum. RSPG notes that the current situation of receiver parameter standardisation is not sufficient to meet the future requirements for more efficient spectrum use. RSPG notes that radio parameters should be defined for radio receivers in the future. The EMC Directive does not cover radio parameters such as selectivity, sensitivity, blocking and Out of Band or spurious emissions. Therefore, the RSPG suggests that the new Radio Equipment Directive (RED) should cover all radio receivers including receive-only equipment. In particular, RSPG provides explanation and proposals in section 7 of this Report.

Standardisation aspects

The performance of equipment against interference from other sources is an important parameter for interference management. RSPG recognises that radio receiver parameters are increasingly important to facilitate the introduction of new services, to extend sharing opportunities and to ensure efficient spectrum management. RSPG supports the promotion of adequate receiver performance through standardisation of receivers.

In addition, RSPG took note the environment of the European standardisation and analysed the various interactions with efficient interference management. RSPG proposes measures in section 6 to improve the role of standardisation in the interference management.

Market surveillance and Risk assessment

RSPG recommends that, in the context of risk management carried out by market surveillance authorities, ADCO R&TTE should continue close co-operation with all interested stakeholders (e.g. ECC, ETSI, CENELEC, R&TTE CA).

Current regulatory framework

RSPG analysed the current regulatory framework on efficient interference management issues and, taken into account the follow up of the RSPG Opinion on “Streamlining the regulatory environment for the use of spectrum”, proposes in section 5 of this Report some measures to improve the overall process.

Annex 1

Extract of Radio Regulations 2012, Definitions on Interference

Section VII – Frequency sharing

1.166 *interference:* The effect of unwanted energy due to one or a combination of *emissions*, *radiations*, or inductions upon reception in a *radiocommunication* system, manifested by any performance degradation, misinterpretation, or loss of information which could be extracted in the absence of such unwanted energy.

1.167 *permissible interference*[8]*:* Observed or predicted *interference* which complies with quantitative *interference* and sharing criteria contained in these Regulations or in ITU-R Recommendations or in special agreements as provided for in these Regulations.

1.168 *accepted interference*[8]*: Interference* at a higher level than that defined as *permissible interference* and which has been agreed upon between two or more *administrations* without prejudice to other *administrations*.

1.169 *harmful interference: Interference* which endangers the functioning of a *radionavigation service* or of other *safety services* or seriously degrades, obstructs, or repeatedly interrupts a *radiocommunication service* operating in accordance with Radio Regulations (CS).

1.170 *protection ratio* (R.F.)*:* The minimum value of the wanted-to-unwanted signal ratio, usually expressed in decibels, at the receiver input, determined under specified conditions such that a specified reception quality of the wanted signal is achieved at the receiver output.

1.171 *co-ordination area:* When determining the need for co-ordination, the area surrounding an *earth station* sharing the same frequency band with *terrestrial stations*, or surrounding a transmitting *earth station* sharing the same bidirectionally allocated frequency band with receiving *earth stations*, beyond which the level of *permissible interference* will not be exceeded and co-ordination is therefore not required. (WRC-2000)

[8] **1.167.1** and **1.168.1** The terms "permissible interference" and "accepted interference" are used in the co-ordination of frequency assignments between *administrations*.

Annex 2

Receiver parameters in interference management

A2.1 Technical description of receivers

There are a variety of possible design architectures for receivers. Some are more suited to certain applications than others. The chosen design for a particular receiver is usually driven by cost balanced against performance. This would involve the designer weighing up the pros and cons of a long list of possible parameter values. A further consideration is the complex interaction between these parameters. Some equipment standards specify minimum values for some parameters and others do not. The designer should also take account of the expected spectrum environment but may not anticipate how this will change in the future.

The design is based around a number of key requirements, including:

- **Receiver sensitivity** – The level which in-band signals (within the designated operating band) must reach before they can be detected;

- **Receiver selectivity** – a measure of how well the receiver can discriminate between in-band signals and out-of-band signals i.e. how well adjacent channel signals are rejected. If the neighbours in adjacent channels are relatively quiet there is no need for the out-of-band signals to be strongly suppressed, but the arrival of a new "loud" neighbour can cause reception problems. Some applications have historically required reception of out-of-band signals for good operational performance e.g. GPS relying on auxiliary out-of-band signals for high-resolution operation.

- **Receiver blocking**: measure the receiver ability to receive a wanted signal at its assigned channel frequency in the presence of an unwanted interferer on frequencies other than those of the adjacent channels. It is caused by gain compression due to overloading from a very strong signal in the receiver front end.

- **Receiver desensitization** occurs when a strong off-channel signal reaches a receiver front end and mixes with the local oscillator side bands (noise), producing a signal in the IF (which includes base-band indirect conversion) and thus reduces the sensitivity to weaker on-channel signals. This effect is caused by reciprocal mixing, due to phase noise

- **Dynamic range** – the signal range over which the receiver is considered to operate properly; the upper side of a receiver's dynamic range determines how strong a received signal can be before failure due to overloading occurs. Automatic RF gain control allows a receiver to adjust the level of a received signal as it appears at the unit's signal processing and demodulation sections. It can also be used to improve a unit's dynamic range and provide protection against overload. Shielding can consist of metal boxes, foil or other materials that isolate sections of a receiver from undesired RF energy.

Dynamic range – is a term conventionally used to define "spurious free dynamic range" i.e. 2/3 of the difference between third order intermodulation intercept point and the receiver noise floor.

There is also a "phase noise limited dynamic range". This is the range of OFF-TUNE signal strength to raise the noise floor by 3 dB.

- **Inter-modulation rejection** – rejection of unwanted interference caused by the mixing of interfering signals;

- **Blocking rejection** – ability to reject strong interfering signals;

- **External spurious responses** are signals propagated at frequencies outside of the tuned principal response frequency to which the receiver responds with measurable output power. They reveal frequencies where the receiver is most susceptible to undesired signals.

- **Internal spurious responses** are caused by harmonics and/or mixing products of internal oscillators, which can lead to a sensitivity reduction on certain frequencies. This can lead problems with one design, and not with another – or never, depending on frequency allocations, never lead to a problem at all!

- **The co-channel rejection** is a measure of the capability of the receiver to receive a wanted modulated signal without exceeding a given degradation due to the presence of an unwanted modulated signal, both signals being at the nominal frequency of the receiver. It is worth stating if the interfering signal is of the same or a different modulation type – this can have a major effect. Where digital signals using the same modulation type are concerned, the time correlation between wanted and unwanted signals also comes into play, so this definition is a little simplistic.

- **The inter-modulation response** rejection is a measure of the capability of the receiver to receive a wanted modulated signal, without exceeding a given degradation due to the presence of two or more unwanted signals with a specific frequency relationship to the wanted signal frequency.

A2.2 Receivers and interference

In assessment of performance it is usually essential to consider the combined performance of transmitters and receivers providing the service or application. They both operate within a radio (or interference) environment, but it is normally only the reception side that suffers detrimental performance due to the radio environment.

Interference in the radio environment to users of allocated spectrum can be from: a) the user (or licensee) within their own allocated spectrum; b) users in adjacent spectrum (not necessarily immediately adjacent to the allocated spectrum); c) sharers of the allocated spectrum; or d) unauthorised use.

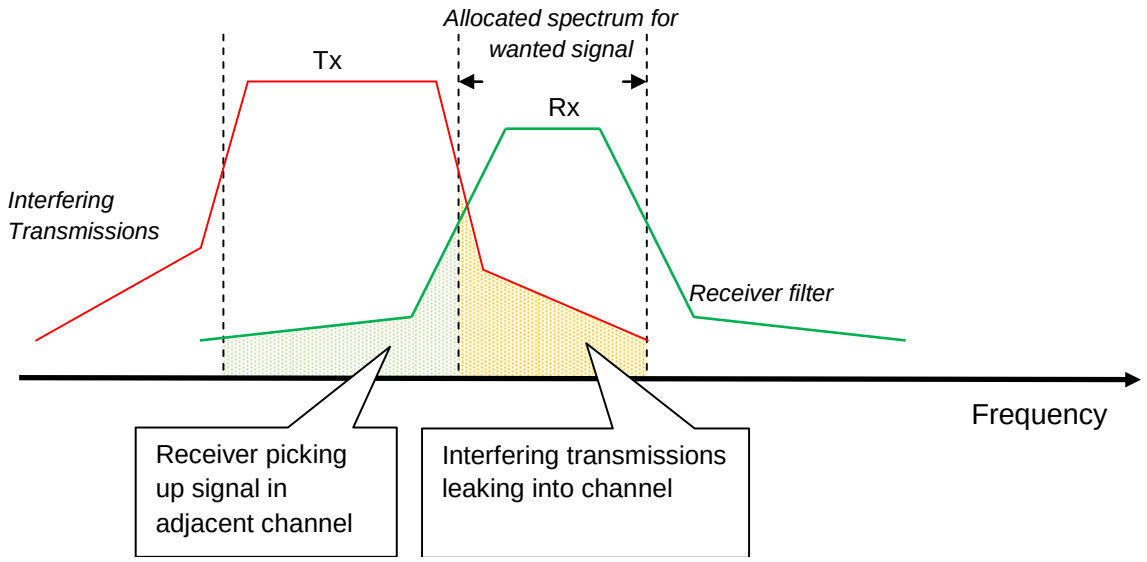
The primary concern of a regulator during planning is with (b) and (c).

Co-existence between users of spectrum has historically been managed by limiting transmissions, usually by specifying the maximum in-block (and in some cases also the out-of-block) power limits in technical licence conditions. Traditionally the type of service that could be deployed in a band was also limited. Out-of-band emission limits of transmitters would normally be specified separately in equipment conformance standards developed by standards bodies (ETSI). Some of these standards also specify minimum receiver performance requirements and others do not. Specification of the allowed transmission limits for proposed systems have largely been based on co-existence studies, usually co-existence with usage in adjacent bands, but also studies of users sharing the same band.

There are drawbacks to this approach. Providing protection to incumbent users of the spectrum whose receivers pick up, not only signals within the incumbent's allocated block, but also signals outside of the incumbent's allocated block, means that the transmission limits for the incoming services can be restricted by the characteristics of the incumbent's receivers. Restricting transmission limits can limit the potential utilisation of the spectrum for new services. The transmission limits are also influenced by the performance and interference assumptions made by the incumbent when designing its service.

See Figure 1 for further technical details and an illustration of the relationship between transmitter "power leakage" and receiver "selectivity".

Figure A1: Illustration of impact of interfering transmissions upon reception of wanted signals



It can be seen that even if the leakage of interfering transmissions into the incumbent's allocated spectrum were completely eliminated, reception of signals can be impaired by low adjacent channel selectivity of the receiver. In this situation, if the interfering signals are particularly strong, possibly through small geographic separation or the interfering party

being licensed to transmit too much in-band power, the receiver could go into overload and fail to function properly.

If we now consider the case where the unwanted signals are present because two systems have operating frequencies that overlap, for example if systems are spectrum sharing, the situation is potentially more challenging. In this case, in order to avoid the effects of in-band interference it is necessary for other coordinated measures to be employed e.g. geographic, time or frequency separation or coding techniques.

There is a balance to be struck between the protection of incumbents' services and allowing new entrants to make productive use of the spectrum. Stringent restrictions on transmissions have the potential to reduce the market for new uses of spectrum. On the other hand, any imposition of stringent receiver requirements could lead to over-engineering of the receiving equipment's design with the associated high costs and could possibly limit technological design choices or inhibit innovation.

A2.3 Current framework for receivers

Receiver performance requirements are generally customer / market driven. However, in some cases, e.g. safety of life, the minimum receiver requirements are also embedded in regulations set by relevant governing organisations or agencies (e.g. ICAO[9] and IMO[10] for aeronautical and maritime equipment respectively). Within this framework manufacturers should be able to design receivers that are fit for purpose at the time of design.

The R&TTE Directive covers most radio equipment that is placed on the EU market. But it does not generally deal with functional safety, functionality, fitness for purpose or interoperability between systems. These requirements, unless covered by specialised sector legislation (e.g. as described for aeronautical and maritime safety equipment in the above paragraph) are normally left to be optimised by market forces alone. In some cases voluntary industry standards stipulate receiver performance parameters but the incentives for manufacturers to adhere to them are purely commercial. The limits given in these standards are sometimes used in co-existence studies, but they are not enforceable in the framework of the R&TTE Directive. It has been found that equipment in the field can under-perform or out-perform these limits. Therefore testing of real equipment that is out in the field may also be required to provide evidence of its susceptibility to new types of signals that were not anticipated at the time of design.

[9] ICAO is the International Civil Aviation Organisation and sets standards and regulations necessary for aviation safety.

[10] IMO is the International Maritime Organisation and sets standards and regulations necessary for the safety of shipping.

A2.4 What has changed?

In recent decades there has been an unprecedented surge in technological development and demand for wireless connectivity. This has led to a plethora of devices coming to the market to meet the demand. The main drive has been for additional bandwidth for high data rate services. Many of these devices are not aimed at professional market sectors (such as aircraft and shipping) but the consumer market. In some cases new devices can go from the drawing board to market in 12-18 months.

Users with incumbent status may be sometimes considered to have "inadequate" receivers, but this is not a particularly valid view as they have simply adapted to the interference environment at the time their equipment design choices were made. Some receivers may be necessarily designed to ensure that useful signals are picked up outside of their allocated band, particularly for interpretation of weak signals e.g. GPS and radar. Historically such systems may have been used to working in "quiet" spectrum environments with "quiet neighbours" and could become prone to overload if, upon re-allocation of adjacent spectrum, a dense mobile broadband deployment (relatively speaking this could be considered as a noisy neighbour) enters an adjacent spectrum block.

When an administration decides to re-allocate frequency bands to a different type of use, co-existence studies are carried out to assess the interfering potential of the proposed new system to existing systems and vice versa.

In the studies, engineering assumptions are made about receiver performance, for both receivers deployed in the same frequency band and those deployed in neighbouring spectrum. As mentioned above, the transmission characteristics of the proposed new system may have to be limited to avoid undue interference to existing systems. If these limits are so constraining on the power levels or technology choice of the proposed new system that it could not provide a viable service, then possible options for remediation of existing receivers in the field may need to be considered. The resulting clearance activity can involve considerable cost and effort as well as delays in the introduction of new services.

The value of any co-existence study to determine restrictions is partially determined by knowing what receivers are in the field and knowing their characteristics. This is easier said than done, as usually there is no publically available inventory of the location and characteristics of potential victim receivers. Even licensees operating a service may not have detailed information on receivers operated by their users (e.g. TV, GPS). It is also notoriously difficult to accurately predict co-existence problems between different systems. This difficulty is compounded when the proposed new system is still under development and its precise transmission and deployment characteristics may not yet be fully known or understood (e.g. UWB, LTE).

It is important to bear in mind that the potential applications and spectrum (or interference) environments are very diverse. For instance, not all users of the spectrum transmit. There are many uses that are reception-only e.g. passive services, such as radio astronomy, do not use transmitters but do rely on very sensitive receivers with relatively wide bandwidths. In

the case of broadcasting and GPS services, for example, the licensee operating the service has no direct control over the performance or deployment of their user's receivers.

The current criteria for defining harmful interference can also vary widely between different applications. For instance, what is considered "good service" could be related to the speed of data transfer over a broadband link, clarity of audio/video in analogue broadcast reception, radar resolution and range, etc. In addition, the number of users affected and how often (harmful) interference occurs is also relevant.

Spectrum is an increasingly valuable resource, but historically efficient use of that resource has focused on the transmission side of systems. Indeed, within Europe, receiver performance parameters are not normally included in technical standards used to demonstrate conformance of radio equipment to legal requirements.

Nevertheless, receiver characteristics have an impact upon how the spectrum can be used by others. When CEPT/ECC is developing sharing studies ("adjacent" studies, "co-channel" studies), CEPT needs, where appropriate, to collect information and characteristics/features also for receiving equipment/components.

A2.5 Illustrative examples for the consideration of receiver parameters in the spectrum regulation

This section provides illustrative examples (SRD, TV receivers) supporting the consideration of receiver parameters in spectrum regulation, in particular in Harmonised Standards.

SRD

In particular, the SRD market is organised around specific and generic standards and relevant frequency bands.

At this stage, in the case of generic frequency bands, the sharing issues between various SRDs operating in the band are not considered by the regulation. In particular, this approach leaves the market to decide according to the foreseen usage/application to implement suitable receiver performance. This is not an optimal approach for the usage of spectrum. Nevertheless, in the case of generic SRDs, it should be noted that requiring better receiver performance implies additional cost and affects the size, weight and power consumption of the equipment. Taking into account that SRDs are small size equipment and, in general, low cost devices, enforcing better receiver performance may be regarded either as impossible (due to an increase in size of the device that is not acceptable for certain applications, e.g. as for Ultra Low Power Active Medical Implants (ULP-AMIs)) or as unjustified constraints since some SRD applications may implement other mechanisms to operate and avoid interference (e.g. frequency agility in case of interference). **The SRD industry should be invited to use receivers with better performance when applicable.**

There is also a need to improve the performance of short-range devices operating e.g. in the 800 MHz and adjacent bands.

In the case of specific SRDs, regulation may require some relevant receiver parameters to be taken into account in sharing studies. The performance of the receiver depends on the type of application. Better performance is usually the case when an SRD application is identified as a safety related or high reliability application (e.g. social alarm).

Sound and TV broadcasting receivers

In the case of sound and TV broadcast receivers and based on the present regulatory regime, the mandatory technical requirements are covered only by EMC standards (which are produced by CENELEC) and describe exclusively EMC phenomena. Sound and TV broadcast receivers have been treated as a "special case": excluded from the scope of the R&TTE Directive. TV receivers only need to conform to EMC standards (such as CISPR 20[11] and the new CISPR 35[12] pending approval).

Following the designation of the 800 MHz "digital dividend", the environment of the TV broadcasting bands has changed. The upper part of the "TV band" is now shared with the Land Mobile Service. Now the issue of interference to TV receivers by mobile networks (LTE) must be carefully dealt with. It can be foreseen that the use of other "broadcasting bands" may be reviewed in the pursuit of the aims of the Radio Spectrum Policy Programme. It is no longer appropriate to treat broadcast receivers as a "special case", as has been done in the past. They should be treated as other radio equipment using shared spectrum in a managed way.

When interference occurs in sound or TV broadcast receivers, the equipment (or at least some channels) is not usable for the consumer. In such a case, the consumer cannot be expected to make an informed choice when purchasing equipment that will not be susceptible to interference, at least not without guidance. Therefore it is necessary to ensure a minimum performance standard for sound and TV broadcast receivers responding to the future radio environment via Harmonised Standards. There is a need to improve the performance of all broadcast receivers and other equipment used in the installations for the reception of broadcast services, i.e. amplifiers, cables and filters.

These improvements shall be better addressed in the context of an update of Harmonised Standards responding to the requirements for an efficient usage of the spectrum.

[11] EMC Standard CISPR 20: Sound and television broadcast receivers and associated equipment - Immunity characteristics - Limits and methods of measurement

[12] Draft EMC Standard CISPR 35: Electromagnetic Compatibility (EMC) – Immunity standard for multimedia products

Annex 3

National Examples on efficient interference management based on national regulatory best practices

Austria

General

Interference cases will be reported to the locally responsible telecommunications authority / radio monitoring Station in Austria. The first check will be executed by the radio monitoring service with support of a remote radio monitoring network of dislocated direction finders and receivers. Could the interference case be not detected by the mentioned system, the inspectors of the responsible regional Radio Monitoring Station start investigation direct at the location of the disturbed radio equipment.

The interference databases are led respectively regionally. The regional Radio Monitoring Station is obliged monthly to submit statistics in a simple form to the centralized office for monitoring in the Federal Ministry.
As an internal working basis a so called service regulation "ADA" (general instructions) was introduced which defines the fundamental working procedure.
(Remark: The internal working regulation "ADA" as well as the monthly submitted statistics can not be published or presented to the RSPG sub group "Interference management".)

The statistical data meet the required interference requests only into a small perimeter. It is planned to replace the regional database by only one central Austrian wide database. Once implemented, the database will be more efficient and creates more possibilities to collect the interference reports and introduced measures as well as resulting statistical information.

Example of best practices for efficient interference management

Excerpt of the Private Mobile Radio Regulation in Austria

(Federal Law Gazette II No 12/2012; Directive 98/34/EC Notification 2011/151/A)

Scope of application and purpose
The Regulation establishes the prerequisites for frequency usage and frequency allocation for radio systems of the fixed radio serves and non-public mobile land radio service in the band from 29.7 to 925 MHz in order to ensure efficient and interference-free use of the radio spectrum.
The domestic planning criteria such as

- **Area of use and protected useful field intensity in non-public mobile land radio service**
  (The area of use is an area with an edge at which the protected useful field intensity has been reached or exceeded.)
- **High-frequency output in fixed radio service**

(The RF output power will be determined by taking into account the system loss of the radio stations of the fixed radio service.)

- **Equivalent radiated power for stationary radio stations in non-public mobile land radio service**
  (With stationary radio stations in the non-public mobile land radio service, the equivalent radiated power shall be limited to a value which is required to meet the communication requirement in the area of use being applied for in consideration of the effective antenna height and terrain roughness.)
- **Antennas**
  (When establishing a stationary radio station, the antenna's installation location, the directional characteristics and elevation angle must be selected in such a manner as to cause an interference field intensity which is as low as possible outside of the area of use, while adequately providing for the area of use at the same time. Directional antennas at elevated locations must be set up at the most favourable elevation angle in terms of radio technology.)

are only to be applied if doing so is necessary for an efficient and interference-free use of the frequency spectrum in the area of use in question.

Frequency type

(1) Exclusive frequencies or exclusive frequency pairs shall only be allocated if:
   a) the radio network is operated for the protection of human life, or
   b) is operated for public purposes, or
   c) at least 40 radio transmission systems per local area of use, at least 300 radio transmission systems throughout the country, or at least 100 radio transmission systems in an area of use other than a local or nation-wide one are to be used in a voice radio network, or a high communication density is anticipated for the radio network, or
   d) a radio network operated on a common frequency has an increasing usage density or particular circumstances prevent the communication requirement on a common frequency from being met, or
   e) the radio network is connected to a public communication network.

(2) Common frequencies or common frequency pairs shall be allocated if the prerequisites for allocating an exclusive frequency or exclusive frequency pair are not present.

(3) Long-term transmissions are not permissible on common frequencies.

(4) A frequency is deemed to be overloaded if the average occupied time in the peak hour amounts to at least 15 minutes in 14 consecutive days.

(5) Radio networks on already allocated exclusive frequencies may be relocated to common frequencies if the prerequisite for allocating an exclusive frequency is no longer met.

Mode of operation

(1) In principle, frequencies shall only be allocated for the simplex mode of operation.

(2) Frequencies for the modes of operation semi-duplex and duplex shall only be allocated if the communication requirement cannot be met in the simplex mode of operation.

(3) If stationary radio stations are operated in the simplex mode of operation, frequencies for the simplex mode of operation shall also be allocated for any potentially required feeder lines.

Radio transmission system call signs
With each message transmission, the call sign allocated to the own radio station must be transmitted either openly at the beginning of the transmission or via automatic recognition Protection of the telecommunication authority's sounding reception system.

Protection of the telecommunication authority's sounding reception system
In order to protect the telecommunication authority's stationary sounding reception systems, the field intensity peak value caused by the transmission systems (measured with the authorised bandwidth) may not exceed the value of 105 dB(μV/m) at the location of the telecommunication authority's antenna systems under any circumstance.

Permissible interference field intensity and cross-border interference range
(1) If the permissible interference field intensity is exceeded at the state border at a height of 10 m above ground according to the following table, it will be mandatory to coordinate with the telecommunications administrations of the affected neighbouring states. Co-ordination with the telecommunications administrations can also be carried out if the permissible interference field intensity is fallen short of, if doing so is necessary for technical radio reasons.
(2) If co-ordination with the telecommunications administrations of the neighbouring states affected has been conducted, the permissible values for the interference field intensity must be complied as laid down in the above motioned regulation at a height of 10 m above ground at the distance of the maximum cross border interference range.
(3) Co-ordination with the telecommunications administrations of the affected neighbouring states shall be conducted upon application if the applicant deems it expedient to ensure the interference-free operation of his radio network and doing so is also justified for radio-technical reasons.

Handling interference
(1) Radio interference can be reported to the radio monitoring organisation with local competence without an official form. The authorisation data of the radio system suffering from interference must be specified in the process.
(2) An interference report will only be treated as such if:
a) The radio system has been established and is operated in accordance with the operating authorisation.
b) the response threshold of the receiver (squelch setting) of the radio system suffering from interference is set to the radio-technical planning value of -107 dBm or higher,
c) a common frequency is blocked by a long-term transmission or is being occupied by transmissions which are not covered by authorisations,
d) the field intensity of the desired signal reaches at least the protected useful field intensity value as laid down in the above motioned regulation at the location of the mobile radio system suffering from interference, and
e) the measured interference field intensity is greater than the value of the permissible interference field intensity in consideration of the loss or gain of the reception antenna in the direction of the source of the interference, in which the following time values must be exceeded:

Service provider group	Total duration per hour	or	Individual interference duration	or	Number of impulse interferences (less than 1 second per minute)
Safety radio services (police, rescue, fire department, customs, shunting and train radio)	40 s		20 s		2
Radio services operated for other public purposes	120 s		60 s		7
Other service providers	360 s		180 s		20

(3) Reception interference is present in particular if the impairments of radio traffic on common frequencies are caused by other authorised radio systems at the same frequency in the same area of use, with the exception of long-term transmissions.

Finland

Reception of terrestrial television - regulation for antenna installations

Cases, where reception of digital terrestrial television (DTT) is interfered by other radio systems, have been reported over the years. In a majority of cases the problem is the quality of the reception antenna system. A new regulation defining the minimum requirements for new antenna installations for DTT reception is under public consultation and will become effective from 2014. A change of legislation is prepared to enable the application of the requirements also to existing antenna installations.

In Finland UHF and VHFIII bands are used for DTT. The two network operators, operating in the two bands, use different network topology. Thus, separate antennas should be used for reception of VHFIII and UHF bands covering frequency bands 174 - 230 MHz and 470 - 790 MHz respectively. The amplifier gain should be adjustable by band. The regulation also defines the antenna gains and how to direct and locate the antenna. The same regulation also defines community aerial networks. The installer is required to measure and document his work.

Inspection of radio transmitters with a great risk of causing interference

Due to a great risk of interference on site inspection of all analogue FM-transmitters in 87,5 - 108 MHz is conducted before bringing into use. The power, frequency accuracy and deviation of the transmitter are measured. In case of limitation sectors to the effective radiated power in the license conditions, the licensee is also obligated to provide the directional pattern of the antenna. Finally, a spectrum analyzer measurement from the far field is performed to reveal any intermodulation emissions.

The regulation on inspection of radio transmitters with a great risk of causing interference was renewed in 2013 to include inspection of DTT transmitters and radars.

The licensee can choose to have the inspection conducted based on documents or on site. The reason for the bringing into use inspections is to ensure license conditions and to avoid harmful interference caused by intermodulation and spurious emissions.

Weather radar spurious emissions

When the 5 GHz weather radar network in Finland was under construction it was found out that these radars could cause a problem to radio links on 6 and 7 GHz bands. It was noted that general reduction of the radar spurious emissions was required. A national decision was made to require additional filtering to 5 GHz weather radars to protect 6 and 7 GHz radio link bands. Low pass filters were installed to all weather radars build since. Later the filtering was changed to band pass.

Today new generation weather radars are installed with modern filtering.

800 MHz mobile broadband and DTT co-existence

The 800 MHz band will be used for mobile broadband in Finland starting from 2014. The 800 MHz network operators are responsible of removing possible interference to DTT reception. The operators should establish a common contact point for providing support and for receiving reports of interference. The mobile operators should cover the expenses for the work and material to remove the interference. The role of the national regulator is supervision of network license conditions and solving disagreements.

France

800 MHz authorisations for use of Mobile Radiocommunication Service

Authorisations have been granted by the beginning of 2012 to three mobile operators (the “licensees” are Orange, SFR, Bouygues Telecom).

Further to an assessment done by ANFR and based on the results of initial experiments various mitigations techniques to solve interferences from LTE systems to DTT reception in households are foreseen: from the update of the installation of DTT reception in households (filter of the LTE signal with a possible limited impact on the use of the channel 60) to an alternative mode of TV reception such as ADSL or satellite. The resolution of interferences is managed on case by case basis by the mobile operators (licensees).

In ex-ante (before putting a LTE base station in operation), the mobile operators (the licensees) shall conduct an initial impact assessment of the consequences on DTT

reception of the LTE introduction in the implementation area. This assessment also describes the process around the LTE roll out (communication plan, means of interferences resolution etc.) and will be controlled by the ANFR.

Further to this assessment, relevant communications measures towards local authorities, antennas professionals, buildings managers and households will be developed on the given geographical area before the launch of LTE systems – In particular, this communication process explains how to solve interferences on the installation of TV viewers.

A web site "www.recevoirlatnt.fr" is also fully operational to provide guidelines and recommendations to TV viewers. A call center managed by ANFR ensures additional support where appropriate.

The web site and the call center are not just dedicated to LTE launch/roll out in 800 MHz but are also covering others issues aimed at the DTT reception protection (in case of launched of new multiplexes R7 and R8, for example).

In ex-post, in case of interferences from LTE systems to DTT reception, mobile operators are required according to their 800 MHz authorisation to financially support resolutions interferences cases due to the introduction of LTE systems in the given area and solve them as soon as possible.

ANFR is involved at each stage of the process: impact assessment of the introduction of LTE (trials , experiments), communication process towards local authority, development of guidelines, maintenance of relevant web site, management of a call center to collect and respond to complaints from TV viewers, to transfer, where appropriate, the complaint to the relevant mobile operator which shall solve it and reimburse for any update, to assess the right to benefit from FAN found and to manage this found, to monitor the spectrum usage where appropriate.

Details mechanisms of this practical organisation are under finalisation based on initial launch of LTE and experiments with 3 operators in a given location. ANFR has also established an observatory of the number of LTE base stations in operation: http://www.anfr.fr/fr/observatoire-deploiement-3g4g.html

2.6 GHz band authorisations for use of Mobile Radiocommunication Service

Authorisations have been granted by the beginning of 2012 to four mobile operators (the "licensees" are Bouygues Telecom, Free, Orange and SFR).

In addition to the studies carried out by CEPT, more detailed national studies were carried out by the ANFR, with the support of all the interested parties, to accurately assess the impact of LTE base stations emissions on the operation of radars operating above 2700 MHz. These radars are operated by the Civil Aviation, Météo France and the Ministry of Defence.

These studies showed that radars may suffer interferences from LTE base stations emissions due to two phenomena:

- Unwanted emissions from LTE falling into the in-band radar receiver;
- In-band LTE emissions falling into the radar receiver. This phenomenon was due to the insufficient selectivity of the radar receiver filter.

So as to cope with these two phenomena, it was decided to:

- Impose to LTE emissions a maximum power flux density at the antenna of each radar sites;
- Impose an upgrade of the radar receiver filter so as to ensure an appropriate filtering of the in-band LTE emissions.

These upgrades of the radar receivers were planned to be finalised in 2013 for Météo France (this is actually already the case) and in early 2014 with regard to the Civil Aviation. According to the Ministry of Defence, its radars did not require any upgrade.

During the transition period before these radar receiver upgrades are effective, an intermediate procedure has been established consisting in requiring to the mobile operators that an aggregated (for each operator) threshold of interference at the radar antenna is not exceeded with the deployment of LTE BS. In case the installation of a given LTE BS in the proximity of a given radar results in exceeding the above mentioned threshold, a co-ordination procedure is engaged between the mobile operator and the radar operator, with the assistance of the ANFR as necessary. According to the result of this co-ordination, the LTE BS considered may or may not be deployed.

This intermediate procedure ceases to be applied to protect a radar as soon as the receiver filter of the latter has been upgraded.

Details about the studies and procedures applicable to the 2500-2690 MHz band to protect radars operating above 2700 MHz are given at the following webpage (in French):

http://www.anfr.fr/fr/planification-international/etudes/compatibilite/bande-2700-mhz.html

Germany

(Regulatory) Interference Management in Germany

General

Frequencies can only be used after assignment subject to "their compatibility with other frequency usages" and "their efficient and interference-free use by the applicant being secured".

The German frequency assignment procedure therefore is carried out in two constituent steps: At first, frequencies assignments include general frequency usage conditions, for

example block edge masks. And secondly, site-related frequency usage parameters must be set before the frequencies are put into use to protect adjacent radio services, cross border co-ordination aspects and the operability of fixed stations of the radio monitoring service.

In planning their network build and rollout, frequency assignees must therefore apply for the site-related frequency usage parameters to be set before the individual frequencies can actually be used.

Applications for the use of frequencies must take account of the general frequency usage conditions provided with the assignment (first step).

Example: Use of the 800 MHz Band by Electronic Communications Services

The procedure for setting site-related frequency usage parameters aims on guaranteeing protection for the broadcasting service, as required by the legal provision of the Telecommunications Act and also usage provision 36 of the Frequency Band Allocation Ordinance. This is particularly relevant if there is a residential area within a certain radius of a wireless access base station in the broadcast coverage area.

Preventive studies aimed at avoiding interference to terrestrial digital television reception can be restricted to a certain radius around a base station. It can be assumed that the probability of interference to DVB-T reception outside this radius is extremely low. If, nevertheless, interference occurs in a particular case, contrary to expectations, the notice setting the parameters can be revoked by exercising the right provided for in the notice, and further safeguard can be put in place accordingly.

In cases where interference could be caused to DVB-T reception within the radius referred to above, the applicants must show which appropriate measures they will take in order to take account of the protection requirements of the broadcasting service. The applicant must show how the requirement for frequency assignment – and hence for setting the site-related frequency usage parameters – is met. In this connection, the network operators are required to take account of broadcasting interests starting at the planning stage and to take any necessary preventive measures (e.g. radiation characteristics, orientation of sectors, antenna height).

The probability of interference below DVB-T channel 52 in individual cases has not been looked at separately because, as matters stand at present, the current interference studies cover the interference potential at these frequencies.
Taking account of the limit on LTE out of block emissions below 790 MHz (max 0 dBm per 8 MHz given a planned maximum LTE radiated power) and broadcasting coverage with the lowest minimum median wanted field strength of 41 dBµV/m (exactly 41.9 dBµV/m for fixed terrestrial broadcasting coverage with DVB-T system variant A1 on channel 52 in accordance with the regulations in the Geneva 2006 Agreement), a maximum (protection) radius of approximately 1.1 km is considered sufficient. This (maximum) radius is assumed for all system variants in operation.

The probability of interference then depends on:

1) whether or not there is actually any DVB-T coverage within the (interfering) radius of the base station; and

2) whether or not there are actually any relevant digital terrestrial television broadcasting application situations within the (protection) radius.

If both these factors apply, it is necessary to see in each particular case if the DVB-T field strength available seems high enough in order to make interference to broadcasting reception from the LTE base station improbable. In this case, the applicant must explain how he will protect the broadcasting service (further remedies may be required) or why interference to broadcasting reception is improbable.

This procedure for setting site-related frequency usage parameters takes account of the fact that such parameters in the 800 MHz band at the interface with broadcasting are being, or have been, set for the first time and may need to be refined, depending on the actual effects the operational mobile networks have.

Corrective steps in case of unforeseen interference

In case unforeseen interference is reported to Bundesnetzagentur, the authority´s radio monitoring service will investigate the cause of the interference problem. Principally interferer is responsible to clear the interference. Therefore in terms of the situation in the 800 MHz band, if the mobile service base station is causing interference to DVB-T or other systems the operator has to enact sufficient measures to stop the interference.

The Netherlands

Use of de DECT guard band

An example of ex-ante Interference Management by self co-ordination is the use of the DECT guard band for low power GSM private use in The Netherlands. The DECT guard band was intended and used as a protective measure to prevent harmful interference between DECT and GSM. But it turned out that it was possible to use this guard band for low power GSM applications like pico-cells without harmful interference.

The use of the former DECT guard band started a few years ago with a registration requirement. The purpose of this requirement was to keep a view on the actual use and to have detailed information in cases of interference. All went well and from the beginning of 2013 registration is no longer needed. It turned out that the providers who are active in this special market are professional enough to coordinate the frequency use between themselves and each other customer to avoid interference.

More frequency space for this type of private use has now been added. The whole frequency band between 1780–1785 MHz and 1875–1880 MHz is available for this type of low power use. An investigation is going on to see if it is possible to also use low power UMTS and LTE in this band under the same conditions.

Interference Management by negotiation

The introduction of LTE systems for mobile communication in the 800 MHz band in The Netherlands introduced a certain change of interference to TV signals provided by cable systems. The same frequencies used by LTE are used in the cable systems, and due to the fact that these signals can only be shielded to a certain extent in cable used in the home, set top boxes and TV receivers, interference was expected. Especially from the LTE terminals used indoor, but there was also the possibility of interference close to base stations for LTE in the 800 MHz band. An independent report showed the circumstances and predicted the associated probability of the expected (mainly co-channel) interference. Also measures to avoid or to solve interference were explored (1).

The Dutch Ministry of Economic Affairs and its National Radio Agency brought all parties together, and they worked an acceptable way out. Under the lead of an independent mediator, the stakeholders negotiated about possible and acceptable measures and solutions. To avoid or solve interference, channel formats could be rearranged. Otherwise mobile operators are willing to contribute in cases of (severe) interference. But all the parties agreed that not all cases of interference could be solved beforehand. But the change was acceptable and therefore the occurrence likely to be limited. In addition to that the parties promised to act and work together in cases of interference where none of the solutions were applicable or sufficient.

On the basis of these principles a binding agreement was made. The cable companies accepted a certain change of harmful inference and the national mobile operators will try to avoid or solve harmful interference.

(1) http://www.agentschaptelecom.nl/binaries/content/assets/agentschaptelecom/Rapporten-reports/Report-analysis-of-interference-to-cable-television.pdf

United Kingdom

UK experience in 800 and 2.6 GHz spectrum bands

800 MHz – DTT co-existence

In 2013 the UK plans to hold auctions for spectrum bands in 800 MHz and 2.6 GHz. Historically the 800 MHz spectrum band (790-862 MHz) has been used for terrestrial television broadcasting. However, as a result of digital switchover (DSO), and more recently the clearance of channels 61 and 62, this spectrum has been made available for new mobile services.

The current generation of TVs, set top boxes and other equipment used to receive digital terrestrial television (DTT), are designed to receive signals across the whole TV band, including the 800 MHz spectrum. This means that when mobile services begin transmitting in the band, there will be the potential for interference from mobile base stations. This could affect the ability of some people to receive DTT services.

The UK set out proposals for managing co-existence between new mobile services in the 800 MHz band and existing DTT services. This included updating technical and costing models and commissioning consumer research to investigate consumers' ability to self-install receiver filters to their DTT reception equipment.

The UK's technical analysis showed that without action to mitigate the interference, approximately 2.3m households in the UK may lose the ability to access DTT services, either partially or completely. Approximately 40% of households in the UK use DTT as their primary means of accessing TV services, so around 900,000 DTT-only households could be affected. This would mean those households losing access to some, or all, of their TV channels.

The UK carried out an analysis on the impacts and costs of options for mitigating DTT co-existence issues. This resulted in certain policy decisions being taken:

- A single implementation body will be set up to manage the delivery of DTT interference mitigation and will provide support to DTT consumers. This will be led by the new 800 MHz licensees.

- The implementing body will be provided with funding of £180m. This money is expected to come from the new 800 MHz licensees. The UK Government will bear the risk of any overspend and there will be a 50:50 gainshare of any underspend between new licensees and Government when The implementing body is closed down.

- The implementing body will provide support to DTT consumers. This will include information and providing DTT receiver filters to households proactively and reactively. Platform changes (for instance to satellite or cable) will also be offered to households where filters do not solve the issue of interference.

- A Supervisory Board will be established to monitor the implementing bodies performance.

- Additional support will be provided to vulnerable consumers, including installation support; approximately £20m of the £180m fund is intended to cover the cost of this support.

2.6 GHz – Aeronautical / maritime radar co-existence

The UK identified an issue created by the sensitivity of UK radars using S Band frequencies, particularly in the range 2.7-3.1GHz, to transmissions made in adjacent bands. These radars are predominantly used for aeronautical and maritime navigational purposes.

Radars are designed to detect very low power signals in their own frequency bands, but their receivers can be filtered to ensure that transmissions from adjacent frequency bands are not also detected. However, where the filtering is insufficient, higher power transmissions from adjacent bands, even those that are well separated in frequency terms, can still be detected by radars and their performance can be degraded as a result.

The UK commissioned research into the issue. This work concluded that the performance of certain existing Air Traffic Control (ATC) radars would be degraded if no mitigating action was taken. The possible mitigating actions were either to ensure geographical separations of some tens of kilometres between the sensitive radars and any 2.6 GHz base station transmissions or to improve the performance of the radars receivers to render them less sensitive.

Given these initial findings the relevant official bodies cooperated to undertake a more extensive work programme to confirm the issue and investigate potential solutions to it in more depth. This included the design and testing of a filtering solution for the radars receivers that would address the sensitivity issue.

Following the initial work on aeronautical radars, the UK also commissioned an investigation into the potential sensitivity of ship-borne maritime radars in the S Band. Because they use higher frequencies, the key susceptibility for these radars was likely to be to transmissions from the adjacent 3.4GHz band. The conclusion of this investigation was that ship-borne radars might also need protection or remediation and further work was needed on this.

Given the significance of the various study results, the UK submitted a technical paper to the relevant specialist radar group in the ITU for consideration, in order that the information could be shared internationally.

The implication is that there is a need for significant restrictions on 2.6GHz spectrum use to protect radars that have not yet been modified.

The UK believes that a coordinated programme is needed to ensure the optimal use of the 2.6GHz and S Band spectrum over the longer term. The scope of such a program is likely to comprise:

- Developing a full understanding of the sensitivity of the different radar types and their deployment to relevant neighbouring transmissions, including mobile terminals, building on the work to date. This work will include examination of ship-borne radars, although given the use of S Band radars in proximity to the UK coast by non-UK ships in international waters, the relevant analysis and consideration of regulatory options will have an international dimension;

- Identifying, testing and piloting feasible and cost-effective mitigation solutions for the different types of radar. This will require examination of other radar types which may present different design issues;

- Drawing up and implementing a coordinated and prioritised implementation programme to ensure that the identified mitigation solutions are deployed across the UK radar fleet to a timescale which maximises the value of spectrum to

citizens and consumers. This will require close liaison with the relevant stakeholders;

- Defining a consistent set of transitional restrictions for 2.6GHz spectrum licences that ensure the continued safe operation of the radars before mitigation solutions are identified and implemented.

We have also alerted individual affected radar licensees that we shall, in due course, be giving them reasonable notice of the need to ensure their radars can coexist with adjacent future services.

Because of the different technical, legal and operational environment affecting the ship-borne maritime radars in the S Band, further investigative work will be required before conclusions on the most appropriate and proportionate regulatory response to specific issues can be drawn. The UK intends to work closely with the stakeholders in the maritime sector during this process of further investigation.

Recent clearance issues

In the recent 800 MHz and 2600 MHz combined award in the UK, a number of clearance issues in connection with existing services came to light:

- **Radar**

A potential risk to radars operating in the 2.7 – 3.1 GHz band, just above the 2.6 GHz band, was identified. The solution was multi-faceted and included:

- Imposition of out-of-band emission limits up to 3.1 GHz for 2.6 GHz licensees, which may prove challenging for the base stations of small cells and femtocells;
- The development of a radar remediation programme to provide better protection to radar stations from interference;
- A co-ordination procedure including radar protection thresholds with which 2.6 GHz licensees must comply;
- Potential Civil Aviation Authority requirements for radar to change frequency.

- **Digital Terrestrial Television (DTT)**

New mobile services in the 800 MHz band have the potential to interfere with the reception of existing DTT services. Mitigation measures include:

- Out-of-band (base station) emission limits for frequencies below 790 MHz;
- Provision of DTT receiver filters.

- **Short range devices (SRDs)**

A number of short range devices operate in the EU harmonised frequency band between 863 and 870 MHz. The deployment of mobile services in the 800 MHz band introduces a potential risk that these SRD applications may experience interference from mobile handsets transmitting in 832 to 862 MHz. However, technical work has led the UK to consider that it is not appropriate to consider any licence restriction in this regard.

All the above clearance issues required a significant amount of effort to estimate the risks and develop, as appropriate, a plan to mitigate the risks. As is usual, it was necessary to identify and agree funding for the implementation of the interference mitigation measures.

The obvious question to raise is whether or not any measures could have been taken some years ago that would have led to the radar and DTT co-existence issues, and other issues world-wide, requiring less re-engineering work. It can be difficult to predict what test cases and combinations of these must be examined ahead of time, and even completion of detailed theoretical analyses may not predict problems that ***appear in the field.***

Annex 4

RLAN 5 GHz issue

The following section illustrates on the "RLAN 5 GHz case" the complexity of establishing an efficient interference management.

Introduction of RLAN in the 5 GHz frequency band

RSPG noted that the introduction of RLAN in the 5 GHz and the usage if these systems in this band raise relevant issues to be considered in the interference management context.

The usage of RLAN in the 5 GHz band refers to complex sharing issues with others systems operating in the same band. In particular, Radio regulation includes specific provisions (e.g. the usage of the DFS) to protect the incumbent systems; including military and weather radars. The EU framework has been developed taking into account the results of sharing studies as proposed by CEPT. The Harmonised Standard RLAN has been developed in coherence with the results of sharing studies and relevant technical conditions to be implemented (including the mitigation mechanism as Dynamic Frequency Selection). The drafting of Harmonised Standards has been subject to an iterative process in order to be aligned with the regulatory conditions and to reduce the number of interferences from RLAN to others systems in the band.

Nevertheless, the current usage of RLAN, even if the market is still on an early stage, revealed some interference issues in number of EU countries which needs to be carefully analysed and addressed in order to identify the relevant solution to update the standards, if appropriate, and to improve the market surveillance process in order to reduce drastically the number of interferences in the bands and to ensure a proper co-existence of various systems in the given band

Regulation and standards

- **Radio Regulation**

The International Telecommunications Union (ITU) agreed at its World Radio Conference 2003 (WRC-03) on a new frequency allocation on a co-primary basis to the Mobile Service for the implementation of wireless access systems including radio local area networks (WAS/RLANs) systems in the frequency bands 5150-5350 MHz and 5470-5725 MHz. It has been noted however that in the bands 5250 MHz to 5350 MHz and 5470 MHz to 5725 MHz, stations in the Mobile Service shall not claim protection from Radiodetermination Services. This includes specific provisions (e.g. the usage of the DFS) to protect the incumbent systems; including military and weather radars.

- **Dynamic Frequency Selection (DFS)**

This major evolution in the Radio Regulations refers to the usage of the Dynamic Frequency Selection (DFS) mechanism to be implemented by RLAN. In order to ensure the compatibility between radars and RLAN, CEPT developed in the year 1998 and 1999 this mechanism. The RLAN equipment has to sense regularly its environment before transmitting in order to detect potential radar signals and to switch into another channel if

necessary to avoid any transmission on channel occupied by a radar signal. Incidentally, it also enables the RLAN device to not be interfered by the radar.

- **EC Framewok**

By mid of 2005, the European Commission published Commission Decision 2005/513/EC requiring all EU Member States (27 Member States) to open the 5 GHz bands for the implementation of Wireless Access Systems including Radio Local Area Networks by 31 October 2005. Member States of the EU are not able to impose additional constraints in their nation regulations beyond those specified in the EC Decisions.

- **Standards**

Moreover, the placing on the market and putting into service of radio equipment within the EU is regulated by the Directive1999/5/EC (R&TTE Directive). The European Commission mandates European Standards Organisations (ESOs) to develop so-called Harmonised Standards. With the respect to the spectrum aspects of radio equipment, the relevant Harmonised Standards are developed by ETSI. For 5 GHz WAS/RLANs, the appropriate Harmonised Standard is EN 301 893. When the spectrum sharing studies and early version of the standards were developed, the receiver characteristics of meteorological radars were not known. The RLAN standards were updated as information about characteristics of meteorological radars became available as a result of interference cases.

Interference issues

Since 2005, numbers of interference cases on meteorological radars operating between 5600 and 5650 MHz have been reported.

In terms of impacts on meteorological and hydrological forecasting capability, interference can have three main consequences:

- Missed warnings: Interference could obscure real precipitation signals, resulting in the failure to issue a warning.

- False alarms: Interference can be incorrectly interpreted as precipitation, in some cases triggering false warnings of heavy rainfall and flooding (with associated costs). There is a risk that these false alarms could reduce public confidence in and reaction to warnings.

- General deterioration in forecast accuracy.

Monitoring of weather using radar relies on the detection and quantification of very weak return signals and being able to scan close to the ground. The technique is thus particularly sensitive to disruption and even low levels of interference was “insidious” as there was no overt indication to the radar operators or even to sophisticated radar software that losses were occurring.

Such interference case is difficult to report to spectrum management authorities, as the weather monitoring operators would probably not be aware that targets that should detected were missing, nor that any interference was occurring.

After investigations, all interferences were caused by WAS/RLAN devices.

How to solve interference?

Updating the Harmonised Standards for RLAN

First interference cases reported involved some failures in the standard. This was solved by several updates of the standard.

See hereafter

- **Initial version of EN 301 893 (V1.2.3) was published by ETSI in August 2003**. That standard detailed only 3 specific radar test signals. However, this was not sufficient to protect all radar systems operating in the frequency band.
- **EN 301 893 (V1.3.1)** was produced in conjunction with the administrations of several EU Member States including military experts and was published in August 2005 to address this issue.
- In 2006, regulators had reported the first interference cases (RLAN interference into weather radars) due to the fact that the DFS mechanism was disabled by the user or the operator of the network.
- **EN 301 893 V1.4.1** (and later versions) now specifically includes the requirement that DFS controls (hardware or software) related to radar detection shall not be accessible to the user.
- **EN 301 893 (V1.5.1) (mid 2008)** entered into force on 1 July 2010. This new version took into account other radar patterns which should grant a full protection to meteorological radars. **From this version of the standard, no interference cases were reported in relation with a failure of the standard.**

The last version of EN 301 893 produced by ETSI is version 1.7.1.

This update of relevant Harmonised Standards involved ETSI, CEPT, in charge of technical studies, the European Commission and TCAM which provided useful guidelines to the standardisation process (ETSI) for the relevant update of the Harmonised Standard. The co-operation process between ETSI and CEPT contributed also to these updates of Harmonised Standards. This updating process has been rather complex due to the necessary support and guidance to be obtained by the European Commission.

> In practice, the definition of exact DFS characteristics required much more work in close co-operation between CEPT and ETSI, in order to define all the appropriate parameters and associated values to take into account to carry out a reliable detection of a radar signal and how the RLAN should behave when this is achieved. One initial difficulty was to persuade industry that the application of a simple “intra-system” DFS would not be sufficient to ensure the “inter-system” compatibility with radars and then to ensure that all category of radars could be adequately protected. It is noted that, in this respect, DFS has not been designed to protect frequency agile radars.

Improving performance of meteorological radars

The solutions to solve this issue does not only involve the RLAN industry but also the meteorological community that took a number of commitments with regards to the future radar design, such as, transmitting time by time detectable signals by RLAN as well as moving all meteorological radars in the 5600-5650 MHz band in which specific detection features will be applied by RLAN.

Role of market surveillance

Despite the update of Harmonised Standards, meteorological radars are still subject to number of interference cases.

In the majority of the last reported cases, the interference was caused by non-compliant equipment or non-compliant operation of initially compliant equipment.

The situation frequently met is an alteration/disabling DFS settings possible by the user (Equipment standard version 1.4.1 and higher does not allow user to disable DFS or alter the DFS settings). In a number of these cases, a Notified Body was involved in the assessment procedure and had issued a positive opinion to this non compliant equipment.

Reported interference cases have involved the operation of outdoor fixed installed devices. These devices were operating co-channel with the radar. A vast majority are due to unauthorised operation of devices. At this stage, there is no interference case which may lead to conclude that the DFS has failed.

- A considerable number of the reported interference cases were caused by equipment where the DFS mechanism was disabled.
- In some cases, higher gain antennas were used resulting in e.i.r.p. levels above the regulatory limits. Although if the DFS mechanism is active and efficient then use of higher gain antennas should not result in an interference.

In 2011, a questionnaire was initiated in CEPT to collect information on the number of interference cases identified in CEPT countries and, from a total of 32 countries that responded, 17 countries reported more than 200 interference cases which occurred during 2010/2011.

This issue is still under investigation in co-operation between market surveillance authorities inside ADCO. The analysis of several interference cases on radars were due to WLAN 5 GHz either without the DFS functionality or with a DFS functionality which may be deactivated by the user.