CEPT Report 010

Report from CEPT to the European Commission in response to the Mandate on:

UWB Specific Applications

Final Report on July 2006 by the:

Electronic Communications Committee (ECC)
within the European Conference of Postal and Telecommunications Administrations (CEPT)

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Executive Summary

This is the final Report developed by the European Conference of Postal and Telecommunications Administrations (CEPT) in response to the European Commission (EC) under the Mandate dealing with the harmonised technical conditions for the use in the European Union of the specific UWB applications.

In this report; a list of current specific UWB applications, a summary of general principles for the development of regulations for specific UWB applications and benefits of using UWB technology for this type of applications are given under the general considerations.

Consideration is given to issues relating to the impact of specific UWB applications on the radiocommunication services.

Regulatory status for the specific UWB applications and the concept of "*Undesired emissions*" introduced by ETSI for particular new items on these applications are also discussed in the report.

In addition, enforcement difficulties which could be faced as a result of introduction of the specific UWB application is referred to.

And finally, following conclusions and recommendations are drawn:

The generic ECC Decision on UWB (ECC/DEC(06)04) shall remain the cornerstone of European regulatory package on UWB which is subject to future reviews like the other ECC Decisions on UWB. Technical requirements, including those applicable to mitigation techniques, may evolve based on new evidences.

Additional ECC Decisions for specific UWB applications, which could result in confusion for the industry, spectrum users and market surveillance authorities, should be avoided. Such proliferation may cause excessive derogation to the ECC/DEC(06)04.

The notion of "undesired emissions", which is inherent to most specific UWB applications considered until now by CEPT, could to some extent justify that these applications cannot fit within the generic regulation. Since the concept of "undesired emissions" has not been defined yet, further work on specific UWB applications should not be started until this concept is defined properly.

Draft ECC Decisions for licensed GPR/WPR imaging systems and unlicensed Building Material Analysis devices have been developed. In both cases, it is the "undesired emissions" that are proposed to be regulated.

Finally, the acceptance of a relaxation of the generic limits for UWB devices in some frequency ranges is recommended to be primarily governed by the following key principles:

- Priority shall be given to mitigation techniques approach;
- Strong justification is needed for the application based approach, which can be envisaged only for "niche applications".
- Clear definition and regulation of the "undesired emissions" concept is needed to avoid any misapplication that could be detrimental to incumbent services

Introduction

This report by the European Conference of Postal and Telecommunications Administrations (CEPT) to the European Commission (EC) is dedicated to the analysis performed on possible differentiated solutions for distinct device categories using UWB technology. It completes the report by CEPT submitted to EC November 2005 in response to the Second Mandate from the European Commission on UWB issued to CEPT on June 6th, 2005, noting that a last report from CEPT concerning mitigation techniques would still be needed under this second EC mandate on UWB.

Pursuant to art. 4 of the Radio Spectrum Decision, the second mandate requested CEPT to finalise all relevant work to identify harmonised conditions of use of radio spectrum in the European Union for all significant types of UWB applications (i.e. communications, imaging, location-tracking, etc.), with priority for applications considered to be closest to user take-up.

This report has been developed within ECC Task Group 3 (TG3) with contributions from administrations and observers (industry and international organisations) and was approved by the ECC meeting in July 2006. It provides some key principles that should govern the acceptance of developing application-differentiated regulatory solutions.

1 General considerations

1.1 Types of UWB specific applications

CEPT is being asked by the industry to develop regulations in response to following 7 current ETSI work items:

- Ground Probing Radar / Wall Probing Radars (EN 302 066) : GPR/WPR
- Building Material Analysis and Classification (TR 102 495-1) : BMA
- Object Discrimination and Characterization (draft TR 102 495-2) : ODC
- Location Tracking- indoor (TR 102 495-3) : LT
- Location Tracking- outdoor (TR 102 495-4) : LT
- Object Identification for Surveillance (draft TR 102 495-5) : OIS
- Location Application for Emergency Services (TR 102 496) : LAES[1]

1.2 General principles for the development of regulations for specific UWB applications

The multiplication of specific UWB applications is likely to create various kinds of difficulties. Primary concern within CEPT should be to develop a consolidated approach taking into account, when possible, the various requirements from the industry, as well as the possibilities offered by the “generic” regulation for UWB devices.

Requirements from the industry for specific UWB applications ought obviously to be considered for applications with clear benefits from using UWB technology that cannot fit under the generic Decision on UWB.

The development of possible regulations for specific UWB applications requires studying the impact on radiocommunication services, as well as considering potential regulatory and enforcement difficulties.

[1] ETSI has meanwhile stopped the work on this item

As a key principle, it has to be emphasized that specific UWB applications need be clearly defined and should not present a potential for mass market as these fall under the "generic" regulation for UWB devices (ECC/DEC(06)04).

1.3 Justification for spectrum: Benefits of using UWB technology?

Key expected benefits/features of UWB technology can typically be described as follows:
(a) High Data Rate communication
(b) Transmission in highly cluttered / Non-LOS indoor environment
(c) Accuracy in positioning
(d) Recognition and accuracy in imaging applications
(e) Differentiation between materials or objects by determining their physical properties

Following is an attempt to identify the different regulatory solutions being developed or considered so that industry and users may take the benefits of UWB technology.

- **Communication applications**

HDR/LDR communication applications represent obviously the core market demand addressed by the generic ECC Decision. A wide range of communication applications combining features (a) & (b) can indeed be envisaged under the generic approach.

- **Location / positioning applications**

It is also clearly recognized that technical requirements of the generic Decision in the 6 – 8.5 GHz frequency range offer a good solution for accurate positioning / location tracking (LT) in indoor environment (i.e. combining features (b) & (c)).

LAES systems are also a location/positioning application. Based on information from ETSI, systems proposed in current ETSI SRDoc for LAES systems seem not to be sufficiently mature and the work within ETSI has stopped on this item. Since the frequency range anticipated for such systems is 3 – 5 GHz, the LDC mitigation technique approach should primarily be investigated by the industry as a solution.

- **Imaging applications**

Another key feature offered by UWB technology is "accuracy in imaging applications" (d) and physical/chemical properties of materials (e & d).

Imaging applications shall be understood as applications for the purpose of detecting or obtaining the images of objects buried into the ground or contained within a ‘‘wall’’, or of determining the physical properties within the ground or a ‘‘wall’’; the ‘‘wall’’ being a concrete structure, the side of a bridge, the wall of a mine or another physical structure that is dense enough and thick enough to absorb the majority of the signal transmitted by the imaging system.

The following draft ECC Decisions have been developed and are expected to be finalized by November 2006:

- ECC Decision for licensed GPR/WPR imaging systems
- ECC Decision for Building Material Analysis (BMA) devices

Note: Some administrations expressed a preference for an alternative deliverable (an ECC report or an ECC recommendation) for the licensed professional GPR/WPR systems.

- **Object Discrimination and Characterization (ODC)**

Concerning Object Discrimination and Characterization (ODC); same frequency range and power are requested as for BMA devices; without the mitigations of BMA: in particular "close proximity" to the material being surveyed is indeed certainly not comparable to "direct contact" as mandated by BMA devices. ODC devices are presented by the industry as niche market products and duty cycle limitation may be appropriate as a mitigation technique.

The benefits from UWB are actually far from obvious in many instances of applications proposed under the scope for ODC. Furthermore, beyond the various kinds of applications described under the draft SRDoc for ODC, the notion itself of “Object Discrimination and Characterization” may be misunderstood as RFID like applications, which undoubtedly present a mass market.

- **Object Identification for Surveillance (OIS).**

The case of OIS devices hasn’t been considered yet by ECC TG3. It is expected that such kind of application primarily combines features (b) & (c).

2 Impact on radiocommunication services

2.1 Generic vs specific approach

CEPT has studied in ECC Report 64 the protection requirements of radiocommunication systems below 10.6 GHz from generic UWB applications.

Complementary technical studies focused on three selected coexistence scenarios (Fixed Satellite Services, outdoor Fixed Services and indoor FWA scenarios) and an overall impact analysis structured per frequency range, have then enabled CEPT to identify on one hand the most acute difficulties associated with the potential impact of UWB devices (EESS, RNSS, radars and indoor victim receivers e.g. FWA, broadcasting, mobile…) and on the other hand frequency ranges where relaxation of protection levels resulting from ECC Report 64 can be envisaged.

Concerning Radio Astronomy, the generic approach investigated in ECC Report 64 concluded basically that UWB operation below 10.6 GHz is incompatible with Radio Astronomy. In the draft generic ECC Decision on UWB, a maximum mean e.i.r.p. density of -70 dBm/MHz or less was however retained in frequency bands which are allocated to the Radio Astronomy Service in the Radio Regulations.

Careful monitoring of the potential impact of UWB on RA stations will thus be required by national administrations given the outcome of theoretical studies.

First question that should arise when considering a specific requirement from the industry is; “why should the conditions set in the generic ECC Decision on UWB not apply?”

In case of a potential mass market, as could in particular happen with ODC and OIS devices, it is certainly not obvious why conclusions should seriously differ from that of ECC Report 64. Should dedicated technical studies be initiated within CEPT, it is furthermore believed that the relevance of assumptions for the deployment scenarios in comparison of that of ECC Report 64 has to be analysed carefully.

The accumulation of new specific regulations beyond the generic regulation for UWB devices will increase the risk of interference in the longer term, whereas the cumulative effect of all applications has not been studied yet. A consolidated approach within CEPT is therefore a must, before any ECC Decision on specific UWB applications can be adopted. CEPT otherwise runs the risk that the generic ECC Decision could be progressively overruled.

As a conclusion, with respect to the potential impact on radiocommunication services, other specific regulations for UWB devices may be envisaged only for "niche requirements".

2.2 Technical studies

As a general principle, impact of specific UWB applications on radiocommunication services has to be assessed based on protection levels in ECC decision for generic UWB, taking into account the specificities of the respective UWB application (e.g. density, activity factors, separation distance, LBT). PSD relaxation from the ECC decision for generic UWB has to be justified with mitigation techniques and/or operational constraints, based both on single entry/aggregated interference scenarios and verified by measurement campaigns.

For single entry interference scenario, specific UWB applications have to demonstrate their ability to strictly limit their activity while incumbent radio systems receive within an agreed range. Relaxation of reference separation distances as provided in ECC Report 64 (e.g. 36-50 cm for mobile systems) is certainly acceptable in the case of a limited market segment which deployment can be controlled (e.g. GPR/WPR). In case of unlicensed systems, such relaxation shall be carefully assessed and in any case cannot be agreed on a stand-alone basis. What might be acceptable for the single case of unlicensed imaging systems (i.e. BMA), will obviously be reiterated for future coming specific requirements (ODC, OIS…) unless a consolidated approach is taken and key principles be agreed.

Aggregate scenarios could be avoided under the assumption that specific regulations shall not address potential mass market. One solution to limit the market segment for specific UWB applications is to set a limitation to professional use, provided that the related ECC decision also provides the mean to control such limitation. As a matter of fact, such approach has been followed for the case of licensed GPR/WPR imaging systems. Conversely, the need for aggregate scenarios should be carefully assessed in case of unlicensed devices. In all unlicenced cases, for realistic assessment of deployment scenarios, the specific application has to be clearly defined.

Finally, technical requirements for associated mitigation mechanisms (such as LBT), should be discussed taking into account a wide range of services and on a technologically neutral basis. Once agreed, impact on incumbent services should be assessed by measurements.

3 Regulatory matters

3.1 Regulatory status

All these new UWB applications, regardless of whether they are used by emergency and security services to protect human being or objects, have no regulatory status. They shall neither cause harmful interference nor claim protection from radio services.

This entails a strong responsibility for the industry when designing products using UWB technology. This technology involves the generation and transmission of radio-frequency

emissions that spread over a very large frequency range, which will overlap several frequency bands allocated to a number of radiocommunication services.

The responsibility of administrations is also challenged when defining conditions of use for UWB devices as they are responsible for the quality of spectrum that is allocated to radiocommunication services.

The overall approach followed by CEPT when developing the generic regulation for UWB devices has been proportionate between enabling innovation and requirements for absolute protection, taking into account the uncontrolled nature of the deployment of SRD's and in particular UWB devices.

With the exception of licensed GPR/WPR imaging systems, the deployment of unlicensed specific UWB devices is uncontrolled as it is the case for generic UWB devices.

It is therefore essential that such simple principle be reasserted before CEPT adopts any specific regulation for UWB devices.

3.2 Undesired emissions

ETSI has introduced for particular new items on specific UWB applications the concept of "*Undesired emissions*" as signals that are leaked or scattered into the air.

This concept can be considered as an "ISM-type" application but falling under the classification of communication type services (as e.g. radar-imaging technology). This is because these UWB signals are only targeted for transmission into ground, walls etc and not use the air for free propagation, hence intentional radiation.

The rationale for the introduction of this concept is that the effective radiation resulting from operation of such systems is highly dependent on the operational conditions. In case of imaging systems, the radiation towards the object or probe direction is meaningful only if properly coupled with the material being investigated.

Even though this concept might be well understood, the regulatory implications need however to be further studied by CEPT especially as its introduction legitimates de facto intentional emissions in frequency bands in which all emissions are prohibited by the Radio Regulations (RR footnotes 5.267 and 5.340).

Adequate methods to measure these "emissions" will have to consider "worst case" operating conditions.

Under the R&TTE Directive, operating conditions would obviously need to be described in the user manual so as to avoid misuse of these systems. For example, concerning BMA devices, the operating conditions can simply be described as "operation in direct contact to the material being investigated".

In any case, accordingly with "spurious", "out-of-band" and "unwanted" emissions, "undesired" emissions and their possible applications and restrictions shall be specifically studied within ECC (likely by SE) in a view to adopt an ECC Recommendation that would clarify this concept on a technical, operational and regulatory basis.

4 Enforcement difficulties

Beyond the case for imaging systems, as explained previously, a specific regulation may be envisaged only for “niche markets”.

Transparent and non-discriminatory conditions are needed by the industry: the definition provided for such specific UWB application should therefore be very clear. Market surveillance authorities need also clear definitions so that same interpretation be given throughout all European countries where R&TTE Directive is applicable.

The risk to enter into a process where CEPT would develop regulations that matches the requirements from only very few manufacturers shall in any case not be underestimated. There will also always be some risk that such limitation be challenged by manufacturers supporting different applications with equivalent technical parameters and potential deployment.

This brings two first conclusions:
- Strong justification is needed for an application-differentiated approach;
- Preference shall be given to differentiating regulations on the basis of validated mitigation techniques.

As an illustration, LDC mitigation technique approach is precisely meant to offer "generic" solutions for sensors applications using UWB technologies.

5 Conclusions and recommendations

The generic ECC Decision on UWB (ECC/DEC(06)04) shall remain the cornerstone of European regulatory package on UWB which is subject to future reviews like the other ECC Decisions on UWB. Technical requirements, including those applicable to mitigation techniques, may evolve based on new evidences.

Additional ECC Decisions for specific UWB applications, which could result in confusion for the industry, spectrum users and market surveillance authorities, should be avoided. Such proliferation may cause excessive derogation to the ECC/DEC(06)04.

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Annex 1

SECOND MANDATE TO CEPT TO IDENTIFY THE CONDITIONS NECESSARY FOR HARMONISING RADIO SPECTRUM USE FOR ULTRA-WIDEBAND SYSTEMS IN THE EUROPEAN UNION

Title

Mandate to CEPT to identify the conditions relating to the harmonised introduction in the European Union of radio applications based on ultra-wideband (UWB) technology (Mandate 2).

Purpose

Pursuant to art. 4 of the Radio Spectrum Decision, CEPT is mandated to undertake all necessary work to identify the most appropriate criteria for the timely and harmonised introduction of UWB applications in the European Union.

The underlying objective of this Mandate is to provide the Commission with the necessary information to develop one or more technical implementing measures harmonising the use of the radio spectrum to enable the timely introduction in the European Union of new applications of UWB technology. In view of expected market developments for this sector, the first half of 2006 is the target date for the adoption of initial, possibly time-limited, EU measures in this area, developed on the basis of the deliverables of the present Mandate 2.

Justification

Enhancing competitiveness in the ICT sector by using the EU regulatory framework to foster competition and the introduction of new communication technologies is one of the leading policy goals defined in the Lisbon Agenda. Stronger ICT uptake will lead to greater economic competitiveness, growth and employment.

In this context, it is important to establish regulatory conditions which will encourage the development of economically-viable markets for UWB applications as commercial opportunities arise.

Harmonising spectrum usage rules across the EU shall help establishing an effective single market for these applications, with consequent economies of scale and benefits to the consumer, as well as avoiding the expected difficulties in enforcing divergent national regulations for highly-mobile UWB-enabled products. Any European technical solution which would encourage the global approximation of UWB technical conditions of use would also lead to similar advantages and would therefore be a positive outcome.

The first Mandate given by the Commission to CEPT on April 7th 2004 on this issue led to a final CEPT Report being delivered to the Commission on March 23rd 2005 (doc. RSCOM05-23). The ECC has recognised that a number of elements in the report have not been fully resolved within CEPT and that further work is needed to finalise the harmonised technical conditions of use of the radio spectrum for UWB in the EU.

The present Mandate wishes to provide a continued EU framework for this issue and further guidance on follow-up activities by CEPT to complete the technical work required to introduce UWB applications into the European Union market.

Order and Schedule

1. CEPT is hereby mandated to finalise all relevant work to identify harmonised conditions of use of radio spectrum in the European Union for all significant types of UWB applications (i.e. communications, imaging, location-tracking, etc.) [2], with priority for applications considered to be closest to user take-up.

[2] Except automotive short-range radar, already harmonised in the EU by Commission Decisions 2004/545/EC and 2005/50/EC.

In the work carried out under the Mandate, the overall objective of enabling innovation in ICT by the timely development and introduction in the European Union of new applications based on UWB technologies shall be given utmost consideration. In carrying out this task CEPT shall collaborate with the European Telecommunications Standardisation Institute (ETSI) that has been mandated (M/329) to develop harmonised standards that are to give presumption of conformity with Directive 1999/5/EC (the R&TTE Directive). These standards must ensure that UWB equipment will fulfil the essential requirement to avoid harmful interference.
To do so, the technical feasibility of coexistence of UWB applications with other radio applications shall be further explored in detail. The consequent emission mask and other requirements placed on UWB applications ought to remain proportionate and strike a balance between absolute protection and enabling innovation.
CEPT should also undertake this Mandate in full awareness of the developing regulatory context for UWB outside Europe and of the potential benefits to consumers of achieving globally-compatible conditions of radio spectrum use for mass-market UWB products.

2. In order to achieve the above, CEPT is mandated to:

- **adequately schedule and prioritise activities** under this mandate to optimise the possibilities for a successful conclusion of the work in a timely manner and to reflect activities already undertaken in this area;

- **determine the frequency range(s) to focus upon initially** for specific UWB applications, and justify this selection on the basis of clear criteria (such as maturity of products in such bands); study the possible use of additional frequency ranges in the future;

- **undertake complementary technical compatibility studies** between UWB applications and potentially affected selected radio services, notably for the priority frequency ranges**,** based on realistic interference scenarios;

- **report on the empirical evidence** gathered by current measurement campaigns within and outside Europe. Apply such results to validate or modify theoretical coexistence scenarios between UWB applications and other radio users;

- **carry out a detailed impact analysis on the selected bands**, for a restricted set of alternative regulatory solutions. Analyse in sufficient depth the feasibility and impact of **generic and dedicated regulatory measures, operational conditions and available technical mitigation techniques,** to optimise the compatibility between UWB applications and other radio devices[3];

- on the basis of the above, develop, where justified, **differentiated solutions** for distinct device categories using UWB technology, such as:
    - communications systems, (low-data and high-/v. high-data rate);
    - imaging systems;
    - location-tracking systems.

  and additional categories or specific sub-categories, if required. The feasibility of implementing and enforcing such differentiated application-based regulation ought to be considered;

[3] Such work ought to be carried out in close collaboration with ETSI, since such mitigation techniques are to be embedded in the harmonised standards it is developing pursuant to Commission Mandate M/329.

- in developing its proposals, **give due consideration to the existing analyses of expected costs and benefits** of alternative regulatory scenarios for the introduction of UWB-enabled applications provided by existing or new economic studies;

- **designate harmonised frequency bands for specific UWB uses**; the choice of particular technical conditions of use applicable to UWB in these bands shall be duly justified[4]. Alternatively, technical "options" shall be provided for discussion and approval by the Radio Spectrum Committee;

- **assist the Commission in considering what could be the possible elements of a monitoring and review mechanism** aimed at ensuring that regulation of radio spectrum for UWB remains responsive to technical and societal developments, and to actual or perceived changes in the risk of harmful interference with other radio applications[5];

- **propose a work plan** for further future activities on UWB.

CEPT is expected to summarise the results on the above-mentioned tasks in its reporting to the Commission.

3. CEPT is mandated to provide deliverables according to the following schedule:

Delivery date	**Deliverable**	**Subject**
1st December 2005	Final Report from CEPT to the Commission	Description of work undertaken and final results achieved under this Mandate.

The above schedule is established with due consideration for the optimal timing of regulation needed for the placing on the market of the first expected mass-market UWB applications. However, a limited amount of delay may be proposed by CEPT (up to 1st April 2006) if more time is required to reach concrete results enabling the effective introduction of UWB in the European Union. A readjustment of a final timeframe, if found necessary, should be justified.

In addition, CEPT is requested to report on the progress of its work pursuant to this Mandate to all the meetings of the Radio Spectrum Committee taking place during the course of the Mandate, including by means of an Interim Report, if necessary.

4. The result of this Mandate can be made applicable in the European Community pursuant to Article 4 of the Radio Spectrum Decision[2].

In implementing this Mandate, the CEPT shall take the utmost account of Community law applicable.

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[4] For instance, the differences and similarities of UWB signals from existing EMC background noise ought to be explained, and how the proposed regulation on UWB is taking into account the current real-life coexistence of radio services with such noise.

[5] One possibility to be explored could be to introduce formal modalities to monitor and measure periodically the overall noise floor in order to track any aggregate UWB-induced effects.

[2] Decision 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, OJ L 108 of 24.4.2002, p.1.