

# Spectrum management and Ultra-Wideband (UWB)

---

*Emmanuel Faussurier*

*Agence nationales des fréquences  
78, avenue du Général de Gaulle  
94704 MAISONS-ALFORT Cedex  
[faussurier@anfr.fr](mailto:faussurier@anfr.fr)*

Chairman of ECC TG3

---

## Summary

This article introduces the spectrum management and regulatory framework that prevails at international level and in Europe. It explains within this context the issue of the introduction of Ultra-Wideband (UWB) devices. It presents the main compatibility studies that were performed within CEPT and finally the European generic UWB regulation that has been developed.

CEPT initial investigations have consisted in establishing protection requirements of Radio Services from generic type of UWB devices. Complementary technical studies have enabled to identify frequency band 6 – 8.5 GHz as the preferred regulatory solution for UWB in Europe. Decision ECC/DEC/(06)04, first adopted March 2006, is basically “generic”, though some categories of UWB devices characterized by predominantly outdoor usage have been explicitly excluded from its scope as they could present a significant risk of interference to Radiocommunication Services deployed outdoor. It was agreed that further technical studies would still be needed in several areas in order to finalize generic regulatory solutions for UWB operation in Europe, in particular concerning power levels in the bands 2.7 – 3.8 GHz and 8.5 – 9 GHz, Detect And Avoid (DAA) and Low Duty Cycle (LDC) mitigation techniques and UWB installations in road and rail vehicles.

In December 2006, the principle of a “phased approach” in frequency band 4.2 – 4.8 GHz was agreed by ECC, allowing first generation of UWB devices operating in this frequency band with a maximum mean e.i.r.p. spectral density of  $-41.3$  dBm/MHz without additional mitigation to be introduced in Europe until end of year 2010. Decision ECC/DEC/(06)12 adopted at this time allows devices implementing Low Duty Cycle (LDC) mitigation technique to operate with a maximum mean e.i.r.p. spectral density of  $-41.3$  dBm/MHz in the frequency band 3.4 – 4.8 GHz. This has been completed by further studies and measurement campaigns to assess the efficiency of LDC to protect military radars in the band 3.1 – 3.4 GHz.

Extensive studies have also been carried for the definition of technical requirements for Detect And Avoid (DAA) mitigation technique. Subject to the demonstration of its efficiency for protecting radar and Broadband Wireless Access (BWA) systems, UWB devices implementing DAA mitigation technique should be allowed to operate with a maximum mean e.i.r.p. spectral density of  $-41.3$  dBm/MHz within the frequency bands 3.1 – 4.8 GHz and 8.5 – 9 GHz.

## 1 Introduction

This article introduces the spectrum management and regulatory framework that prevails at international level and in Europe. It explains within this context the issue of the introduction of Ultra-Wideband (UWB) devices. It presents the main compatibility studies that were performed within CEPT and finally the European generic UWB regulation that has been developed.

## 2 Spectrum management framework

### 2.1 Radio Regulations (RR)

A radio apparatus uses the frequency spectrum resource that is managed by the administration which is responsible for the use of this scarce resource. Administrations should manage frequency in the way to provide quality to existing applications and in the view of the possibility to introduce new ones. This has led to the development of an international regulatory framework which is primarily materialized by the Radio Regulations (RR). The RR is an international treaty to which signatory states commits. It is periodically revised by World Radiocommunication Conferences (WRCs), meetings which are typically held every three

or four years. The RR complements other fundamental texts which are the Constitution and the Convention of the International Telecommunication Union (ITU), the specialised UN agency based in Geneva.

The Radio Regulations (RR) stipulates rights and obligations for an individual state towards other states with respect to the use of the radio spectrum and orbital resources. It does not regulate the different usages within a state, which belongs to national regulation. The RR allocates in the first place frequency bands to Radiocommunication Services.

A Radiocommunication Service is defined as the transmission, emission and/or reception of radio waves for specific telecommunication purposes. One should distinguish terrestrial services from space services. Those two categories can themselves be subdivided in several different types of services (fixed, mobile, broadcasting...). The list of the different services with corresponding definitions is given in Article 1 of the RR. Frequency bands are allocated to Radiocommunication Services on a primary or secondary basis. Stations of a secondary service shall not cause harmful interference to stations of primary services and cannot claim protection against harmful interference from stations of a primary service.

The use of the radio spectrum by Short Range Devices is in principle allowed by national administrations in derogation of the table of frequency allocations which is given in Article 5 of the RR. Such devices typically operate on a non-interference and non-protection basis.

## **2.2 European regulatory framework**

Regional organisations also play a major role in the management of the radio spectrum resource. The prime entity in Europe remains the CEPT (*Conférence Européenne des Postes et Télécommunications*), the European Conference of Postal and Telecommunications Administrations, and more specifically the ECC, its Electronic Communications Committee, formerly known as the ERC. The prime objective of the ECC is to develop harmonised European regulations for the use of radio frequencies. ECC seeks consensus between administrations for the development of Decisions and Recommendations. Their implementation by national administrations is made on a voluntary basis. With now 48 administration members, CEPT covers almost the entire geographical area of Europe.

Among regulatory provisions adopted by the European Union in recent years, one should particularly mention Decision n° 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 (the "Radio Spectrum Decision"). The Commission is assisted by the Radio Spectrum Committee (RSC) and issues mandates to the CEPT, setting out the tasks to be performed and corresponding timetable. The RSC shall then approve CEPT Reports and associated technical implementing measures prepared by the Commission, which implementation by the administrations of EU Member States is mandatory.

The conditions for the placing on the market of radio equipment and telecommunications terminal equipment and the mutual recognition of their conformity is governed by the Directive 1999/5/EC of the European Parliament and of the Council of 9 March 1999 (the "R&TTE Directive"). This Directive was developed in accordance with the principles of the "new approach" which aims to guarantee the free circulation of goods in the European Union market. It has replaced the various national type approval regimes by a harmonised ex-post control regime. It entrusts the manufacturer, his authorised representative or the person responsible for placing the apparatus on the Community market the responsibility for the conformity to the essential requirements of the Directive. Harmonised Standards whose references have been published in the European Union Official Journal are voluntary standards giving presumption of conformity to the essential requirements referred to in Article 3 of the R&TTE Directive. When Harmonised Standards are not used or used only partially, the opinion of a Notified Body is mandatory for the conformity assessment of the product. The Directive includes other legal provisions such as those relating to EC marking of products or the obligation for notification of the placing on the market (Article 6.4) in the case of radio equipment using frequency bands whose use is not harmonised throughout the Community.

Article 3.2 of the Directive which stipulates that radio equipment shall be so constructed that it effectively uses the spectrum allocated to terrestrial/space radio communication and orbital resources so as to avoid harmful interference needs also to be underlined. The European Telecommunications Standards Institute (ETSI) is in this field the leading standardisation organisation delivering Harmonized Standards covering essential requirements under Article 3.2 of the R&TTE Directive.

### **3 Spectrum management and UWB: general considerations**

From a regulatory perspective, UWB devices fall typically within the general category of short range devices.

Like for any radio transmitting station, the use of UWB devices is subject to national regulation; which administrations shall define in accordance with their international commitments. It is also essential to retain that UWB emissions cannot be assimilated to radio noise, spurious or unwanted emissions from a regulatory perspective.

Unlike conventional radio systems whose intended emissions shall remain within the boundaries of specifically assigned frequency bands, UWB emissions may overlap several frequency bands allocated to various Radiocommunication Services.

This regulatory specificity shall primarily lead to the definition of a "spectrum mask" which sets maximum mean e.i.r.p. spectral density across relative wide frequency ranges for one UWB device.

UWB devices may impact simultaneously several radio systems with very different technical and operational characteristics: broadcasting receivers, mobile communication systems, RLANs, wireless local loop systems, microwave links, radars, satellite links, passive sensors for satellite earth exploration, radioastronomy stations... Compatibility studies shall be performed in order to determine conditions of use of the spectrum that ensure the necessary protection of Radiocommunication Services.

Administrations, which manage the radio spectrum resource, are indeed responsible for the quality of the spectrum that is made available to various categories of spectrum users operating as a Radiocommunication Service.

The issue of spectrum management for UWB devices may differ pending the type of equipment that is considered: equipment for a mass market, for specific professional usage with or without the requirement for an individual license or restricted to the use by government bodies.

UWB devices are likely to be mass produced and integrated as components of personal computers, mobile terminals and consumer electronic products. UWB technology offers solutions for high data rate and low cost cable replacement. Low data rate, localisation and various UWB sensors applications are also anticipated. The risk of proliferation of such type of devices associated with the uncontrolled nature of the deployment of UWB devices intended for mass markets is in itself the prime challenge for spectrum managers.

The placing on the European market of radio devices using UWB technology must follow the conditions set by the R&TTE Directive. Past discussions in the context of the introduction of automotive Short Range Radar systems operating in the 24 GHz frequency range had however already shown some difficulties for frequency managers associated with the European regulatory framework: how to forbid or restrict the placing on the market of a radio device that presents a potential risk of aggregate interference when a single device can claim to comply individually with the essential requirements?

The need to facilitate the introduction of innovating technologies leads in this context European administrations to the development of more complex regulatory solutions than a baseline spectrum mask.

## **4 Generic regulation for UWB devices in Europe**

### **4.1 Main elements**

European regulation on UWB has been developed within the frame of several EC mandates. The 1<sup>st</sup> EC mandate on UWB was issued in March 2004. ECC decided at that time to create ECC Task Group 3 (TG3) in order to handle related matters and develop adequate regulatory deliverables.

European generic UWB regulation developed by CEPT identifies the frequency range 6 - 8.5 GHz as the « long-term » regulatory solution for UWB in Europe allowing a maximum mean e.i.r.p. spectral density of -41.3 dBm/MHz without the requirement for additional mitigation. A possible extension to frequency band 8.5 - 9 GHz subject to the implementation of DAA mitigation technique is being considered and should be finalised by the ECC at its meeting in October 2008.

Within frequency range 3.1 – 4.8 GHz, the maximum mean e.i.r.p. spectral density can be increased to -41.3 dBm/MHz in case of devices that implement validated mitigation techniques (DAA, LDC). This requirement does not apply however within the band 4.2 – 4.8 GHz for UWB devices placed on the European market before 31<sup>st</sup> December 2010, as a result of discussions on the so-called “phased approach”.

European generic UWB regulation can be described as an “underlay” regulation in the sense that the intentional UWB emissions are not limited to the boundaries of specific frequency band. Applications that meet the limits of a spectrum mask and other requirements are basically permitted to operate. There is furthermore no restrictive definition given for UWB technology although it is foreseen for technologies with bandwidth significantly wider than 50 MHz.

This regulation contains various regulatory provisions aiming to minimise UWB outdoor activity.

Finally, national administrations are also encouraged to implement adequate monitoring measures in order to assess the effective deployment of UWB devices and their impact on Radiocommunication Services.

## 4.2 Compatibility studies

Initial compatibility studies presented in ECC Report 64 have enabled to set generic limits for the protection of radiocommunication systems operating below 10.6 GHz; based on worst case interference scenarios, in particular concerning UWB deployment scenarios.

Complementary technical studies focused on priority frequency ranges from the UWB industry perspective have considered different propagation models and more realistic assumptions in terms of UWB market and use (e.g. 100% of UWB devices operating indoor with an average 1% activity factor) and have provided some level of confidence regarding the protection of outdoor stations of the Fixed Service and the Fixed Satellite Service from UWB devices transmitting with a maximum mean e.i.r.p. spectral density level of -41.3 dBm/MHz. These studies have enabled to relax under certain conditions the maximum mean e.i.r.p. spectral density limits in order to facilitate the introduction of UWB in Europe.

Based on these studies, one can retain simple principles relating to coexistence between UWB devices and radiocommunication systems.

If the “victim” radio receiver is operated in an indoor environment (mobile/BWA terminals, RLANs, broadcasting receiver, etc.) then the closest UWB interferer also deployed indoor becomes the dominant interference factor. UWB emission limits are based on single interference scenarios. Low separation distances have been assumed (e.g. 36 cm for IMT-2000 at 2 GHz and BWA at 3.5 GHz) and limits may be relaxed subject to the implementation of validated mitigation techniques (DAA, LDC...).

Conversely, for a Radiocommunication Service operated in an outdoor environment e.g. Fixed Service (FS), Fixed Satellite Service (FSS), Earth Exploration Satellite Service (EESS), Radio Astronomy, etc., the increase of the noise level due to the aggregate UWB interference generally determines the UWB emission limits. The relevance of these limits is directly linked to assumptions taken in UWB deployment scenarios (density, activity factor, indoor/outdoor split).

As a noticeable exception, coexistence with the Radiolocation Service (e.g. civil aviation, meteorological or military radars) is primarily driven by single interference scenarios. The case of the Fixed Service need also to be underlined, as it appears from ECC Report 64 finding that a maximum mean e.i.r.p. density of -41.3dBm/MHz would not adequately protect a FS Point-to-Point link against interference from a single fixed outdoor UWB installation located in direct Line of Sight of the victim receiver.

Several additional compatibility studies have been performed in support of the development of the generic European regulation for UWB applications. In the frequency bands 3.1 - 4.8 GHz and 8.5 – 9 GHz, ECC has investigated the efficiency of Detect And Avoid (DAA) and Low Duty Cycle (LDC) mechanisms in order to ensure the protection of Fixed / Broadband Wireless Access (BWA/FWA) terminals and of the Radiolocation Service, with a view of allowing UWB devices in the bands 3.1 – 4.8 GHz and 8.5 – 9 GHz with maximum mean e.i.r.p. spectral density of -41.3 dBm/MHz.

Technical Requirements for UWB LDC mitigation technique to ensure the protection of FWA systems are presented in ECC Report 94 published in December 2006. During ECC TG3 study period, other studies and

measurement campaigns performed in order to assess the efficiency of LDC mitigation technique for the protection of military radars in the band 3.1 – 3.4 GHz concluded that the probability of a single device to radiate into the main beam of the radar can be considered as negligible. Some concerns remain however on the potential cumulative effect with several LDC UWB devices located in the vicinity of a radar station.

Technical requirements for UWB DAA (Detect And Avoid) mitigation technique to ensure the protection of Radiolocation in the bands 3.1 – 3.4 GHz and 8.5 – 9 GHz and BWA terminals in the band 3.4 – 4.2 GHz are presented in ECC Report 120 published in June 2008. The need for a close cooperation between CEPT and ETSI on DAA mitigation technique was particularly emphasized as DAA technical parameters need to be supplemented by adequate DAA measurement procedures and test patterns to be defined in the related ETSI standard. In addition, UWB DAA devices operating in the “lower band” should be capable of selecting an operating channel anywhere within the band 3.1 – 4.8 GHz, recognizing that the spreading of the operation of UWB DAA devices across the whole of the band 3.1 - 4.8 GHz will mitigate the potential aggregate interference to Radiocommunication Services operating in this band. Also, as existing systems are subject to technological change and other systems may be deployed or developed in the future within e.g. IMT, it should be noted that DAA requirements provided in ECC Report 120 may need to be revisited in the future. In particular, the WRC-07 identified the 3.4-3.6 GHz band for IMT applications.

The potential mass deployment of UWB devices installed in road and rail vehicles was also studied and is presented in CEPT Report 17. ECC TG3 recommended making a Transmit Power Control (TPC) mechanism mandatory for such installations in order to minimize potential aggregate interference on outdoor stations of Radiocommunication Services. It was also concluded that this additional TPC requirement is not necessary in case of UWB devices implementing LDC mitigation technique.

### 4.3 ECC Decisions

The generic regulation for UWB applications that has been developed consists of two ECC Decisions:

- Decision ECC/DEC/(06)04 which is the baseline Decision, meant to provide a stable picture of the European spectrum mask for generic UWB devices without the requirement for additional mitigation
- Decision ECC/DEC/(06)12 providing complementary provisions (LDC, DAA...) to the baseline Decision, which by nature could be more subject to changes

Decision ECC/DEC/(06)04 was first adopted in March 2006 subject to further work concerning the “phased approach” in the band 4.2 – 4.8 GHz, power levels in the bands 2.7 – 3.8 GHz and 8.5 – 9 GHz and conditions of use for UWB installations in vehicles. In December 2006, the principle of a “phased approach” in frequency band 4.2 – 4.8 GHz was agreed by ECC, allowing first generation of UWB devices operating in this frequency band with a maximum mean e.i.r.p. spectral density of -41.3 dBm/MHz without additional mitigation to be introduced in Europe until end of year 2010. After completion of these additional studies on the baseline spectrum mask for generic UWB, Decision ECC/DEC/(06)04 was amended in July 2007.

Decision ECC/DEC/(06)12 was first adopted in December 2006. Its first release specified technical requirements for Low Duty Cycle (LDC) mitigation technique allowing operation at -41.3 dBm/MHz e.i.r.p. within the band 3.4 – 4.8 GHz. A draft amended version of this Decision was adopted for public consultation by the ECC in June 2008 and is planned for final adoption in October 2008. It covers LDC mitigation technique also in the band 3.1 – 3.4 GHz and Detect And Avoid (DAA) mitigation technique in the bands 3.1 – 4.8 GHz and 8.5 – 9 GHz.

In case of UWB devices installed in road and rail vehicles, including DAA UWB devices, and in bands where a maximum mean e.i.r.p. spectral density of -41.3 dBm/MHz is allowed, operation is in addition subject to the implementation of Transmit Power Control (TPC). A maximum mean e.i.r.p. spectral density of -53.3 dBm/MHz applies otherwise. This additional requirement does not apply however in case of LDC UWB devices installed in road and rail vehicles, based on the investigations detailed in CEPT Report 17.

As explained previously, the outdoor use of UWB must be minimized. As the strict ban of outdoor use cannot be enforced in case of a mass market which covers a wide range of nomadic or portable products, some categories of UWB devices characterized by predominantly outdoor usage are either subject to specific restrictions or excluded from the scope of this regulation as they could present a significant risk of interference to Radiocommunication Services deployed outdoor:

- Installations in road and rail vehicles

- Fixed outdoor installations
- Installations in flying models, aircraft and other aviation

The implementation of monitoring measures is encouraged but will strongly depend on the will of national administrations to develop the necessary basis for future review of the regulatory framework if effective deployment should sensibly diverge from the original assumptions taken.

During the development of Decision ECC/DEC/(06)12, some countries underlined that they consider possible deployment in the future of passive radars operating in the band 8.5 – 9 GHz and that the effectiveness of DAA to protect these systems has not been studied.

#### **4.4 EC Decision**

EC Decision of 21 February 2007 (2007/131/EC) (“the EC Decision on generic UWB”) has been developed on the basis of the initial versions of these two ECC Decisions and is now widely implemented throughout EU.

The EC Decision on generic UWB is expected to be amended in 2009 consistently with the regulatory provisions given in Decision ECC/DEC/(06)04 amended July 2007 and Decision ECC/DEC/(06)12 which should be formally amended October 2008.

#### **4.5 Harmonised standard**

ETSI has developed a harmonised standard for UWB communication applications on the basis of the regulatory provisions for generic UWB developed by CEPT.

ETSI EN 302 065 V1.1.1 was developed within ETSI ERM Task Group “TG31A” and published February 2008. The essential requirements detailed in this version are basically consistent with the spectrum mask given in Decision ECC/DEC/(06)04 amended July 2007 and the technical requirement for LDC operation in the band 3.4 – 4.8 GHz given in the initial version of Decision ECC/DEC/(06)12. It also contains provisions for installations in road and rail vehicles.

It contains additional requirements such as a minimum operational bandwidth of 50 MHz, a PRF (Pulse Repetition Frequency) > 1 MHz and the obligation for a transmitter timeout to avoid continuous transmission without received signal.

The amended version of this standard expected for 2009 should in particular provide a complete set of procedures and measurement patterns for the validation of DAA mitigation technique, developed in close cooperation between CEPT and ETSI.

### **5 Conclusion**

European regulation for generic UWB has been achieved with a departure from the conservative approach to compatibility studies to adopting a pragmatic approach, taking into account the cost and benefit of introducing such technology. This has resulted in a solution which strikes the balance between the protection to existing services whilst facilitating spectrum access for new innovative radio applications.

The regulation currently being finalised should offer a possible basis for global harmonisation both in the “lower band” (3.1 – 4.8 GHz), assuming that DAA requirements can be harmonized, and in the “upper band” (6 – 9 GHz), pending the outcome of further studies in Korea and Japan in the band 6 – 7.25 GHz.

Some uncertainty remains on the ability of industry to adapt DAA specifications on UWB devices in pace with the evolution of the characteristics of the victim services, particularly in a context where technology neutrality is promoted as a must for Mobile Services.

The concern on potential aggregate UWB interference on Radiocommunication Services in the long term justifies regulatory provisions aiming to minimise UWB being used outdoor. Recent investigations have besides led European regulators deciding to maintain the prohibition on fixed outdoor UWB installations recognizing that it would also limit the operation of mobile outdoor devices.



## **Bibliography**

ECC Reports (available on [www.ero.dk](http://www.ero.dk), cf. *Deliverables/Reports*)

- *ECC Report 64 (February 2005) on the Protection requirements of radiocommunication systems below 10.6GHz from generic UWB applications*
- *ECC Report 94 (December 2006) on Technical Requirements for UWB LDC Devices to ensure the protection of FWA systems*
- *ECC Report 120 ( June 2008) on Technical requirements for UWB DAA (Detect And Avoid) devices to ensure the protection of Radiolocation in the bands 3.1 – 3.4 GHz and 8.5 – 9 GHz and BWA terminals in the band 3.4 – 4.2 GHz*

CEPT Reports in response to EC Mandates to CEPT to harmonise radio spectrum use for Ultra-wideband Systems in the European Union (available on [www.ero.dk](http://www.ero.dk), cf. *Deliverables/CEPT Reports*)

- *CEPT Report 007 (March 2005)*
- *CEPT Report 009 (October 2005)*
- *CEPT Report 017 (March 2007)*