



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

**ECC REPORT 167**

**THE PRACTICAL IMPLEMENTATION OF REGISTRATION/COORDINATION  
MECHANISM FOR UWB LT2 (LOCATION TRACKING TYPE 2) SYSTEMS**

**Miesbach, May, 2011**

## **0 EXECUTIVE SUMMARY**

This ECC Report considers the current regulation of UWB devices and the characteristics of devices such as UWB LT2 which do not comply with these regulations. In order to ensure that the social and economic benefits of these non-compliant devices might be realised, this Report seeks to identify methods of permitting the operation of these non-compliant devices in such a way that the possibility of interference is minimised.

In doing this, the Report recognises that UWB is essentially an underlay system and the use of conventional licensing is not recommended as this would infer that UWB has some status with respect to users of radio services. The Report considers UWB as devices which must not cause harmful interference and for which the operators have no expectation of protection from radio services.

This Report concludes that it is possible to develop a procedure for the operation of UWB LT2 systems which do not comply with the existing regulation while protecting radio services from harmful interference. Administrations might want to consider a coordination/registration process as described in Chapter 5, which includes the recording of the locations of UWB LT2 systems. This would facilitate the identification and, if necessary, removal of UWB LT2 systems which have been proved to be a source of interference.

This ECC Report recognises that the development of a new coordination/registration process could be seen as going against the principle of minimum regulation but it would only need to be applied by those administrations that want to derive the benefits that the operation of UWB LT2 systems offers while avoiding the problems associated with the operation of these devices in unknown locations. In the long-term, it is conceivable that the need for registration might eventually disappear should experience show that the interference from these UWB systems is at such low-levels that controlling their location is no longer considered to be necessary.

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**LIST OF ABBREVIATIONS**

<b>Abbreviation</b>	<b>Explanation</b>
BWA	Broadband Wireless Access
CEPT	European Conference of Postal and Telecommunications Administrations
CRAF	Committee on Radio Astronomy Frequencies
DAA	Detect and Avoid
ECC	Electronic Communications Committee
e.i.r.p.	Equivalent Isotropic Radiated Power
ETSI	European Telecommunications Standards Institute
EU	European Union
FS	Fixed Service
FSS	Fixed Satellite Service
FWA	Fixed Wireless Access
ITU	International Telecommunication Union
LDC	Low Duty Cycle
LT2	Location Tracking Applications Type 2
PSD	Power Spectral Density
RAS	Radio Astronomy Service
SRD	Short Range Device
TPC	Transmit Power Control
UWB	Ultra Wide Band
VSAT	Very Small Aperture Terminal
WG FM	Working Group Frequency Management
WG SE	Working Group Spectrum Engineering

## Practical implementation of registration/coordination mechanism for UWB LT2 systems

### 1 INTRODUCTION

ECC/DEC/(06)04 [1], *on the harmonised conditions for devices using Ultra-WideBand (UWB) technology in bands below 10.6 GHz*, and ECC/DEC/(06)12 [2], *on supplementary regulatory provisions to ECC/DEC/(06)04 for UWB devices using mitigation techniques*, define the harmonised generic conditions for the operation of devices using UWB technology on a non-interference and non-protected basis in Europe. This regulation is primarily intended to respond to the market demand for UWB indoor and handheld devices providing communications applications. Some categories of UWB devices characterised by predominantly outdoor usage are explicitly excluded, as they can present a significant risk of interference to radio services deployed outdoor and operating in frequency bands where maximum UWB emission levels would be allowed.

CEPT Report 34 [3], *Report B from CEPT to European Commission in response to the Fourth Mandate on UWB*, stipulates that:

- Individual licensing of fixed outdoor UWB infrastructure could challenge the rights of Radiocommunication Services with primary status and contradicts the principle of an “underlay” regulation;
- It could furthermore imply that a certain degree of protection is granted to the UWB operator and is therefore not supported by CEPT. Further investigation could take place within CEPT on other forms of registration and coordination as interference control mechanism, like in the case of Location tracking applications Type 2 (LT2).

Following a request from industry for new regulatory provisions to enable fixed outdoor UWB installations for location tracking applications, at its meeting in Montegrotto (18-22 May 2009), CEPT/WG FM tasked Project Team FM47 to investigate such other forms of registration and coordination that could be applied to location tracking fixed installations.

This ECC Report describes and evaluates possible solutions on practical implementation of registration/coordination mechanism for UWB LT2 systems, and also investigates if the registration/coordination process for UWB LT2 systems could be applied more widely to a variety of UWB systems that are excluded from existing regulations.

It should be noted that this Report is supplemented by an ECC Report on compatibility studies developed by CEPT/WG SE.

### 2 CHARACTERISTICS OF UWB LT2 SYSTEMS

The ETSI System Reference Document TR 102 495-5v1.2.1 [4] specifies the characteristics for UWB LT2 systems operating in the frequency band from 3.4 GHz to 4.8 GHz, for person and object tracking and industrial applications.

The following description is intended to convey the kind of system proposed and some typical applications. Whether the system can be authorised should not depend on the purpose of a specific location tracking installation, but rather on the site itself and perhaps the pattern of usage.

UWB location tracking is a viable positioning technology that meets industrial requirements in markets such as workplace/office, public buildings, security, manufacturing assembly lines, etc.

In UWB location tracking, small mobile or portable tags, operating as either transmitters or receivers, or both, are attached to the objects to be located, or are carried by personnel within an area under surveillance. A network of fixed equipment around the area to be covered, communicate with the tags. By analysing, e.g. the time-of-arrival and/or angle-of-arrival of the radio signal relative to the known reference stations, the 2D/3D position of the tag can be found. Typically, the range between a tag and a reference station might be up to 200 m, depending on the area to be observed.

There is evidence that these devices can address versatile industrial requirements in many different markets. It is also possible that such a system will significantly enhance the security and safety of persons monitored, or of the plant itself, in different applications such as process industries and lone workers.

A high precision in range measurement is required and also very good range resolution to permit operation in very cluttered environments. This means that the signals necessarily must have a very large bandwidth to provide the required accuracy and resolution.

It can be seen from this description that there are benefits to be gained from permitting the operation of systems that are used at fixed outdoor locations, which is currently excluded in the generic regulation. The purpose of this report is to establish how such services might be permitted so that the possibility of interference into radio systems is minimised.

### 3 REASONS FOR EXCLUSION OF UWB LT2 FROM THE EXISTING REGULATION

It is recognised that there are a number of emerging UWB applications that are able to provide economic or safety benefits. However they are not able to do so because they either operate at powers levels which exceed limits at which studies have determined that there is a possibility of harmful interference, or they are simply excluded due to operational constraints (e.g. fixed outdoor installations). This Report explores the possibility of enabling the operation of these applications while minimising the potential of interference by requiring their location to be assessed and registered.

#### 3.1 Existing generic limits and rules

Within the CEPT, the main regulation for generic UWB devices on a licence-exempt basis is specified in ECC/DEC/(06)04 [1] and ECC/DEC(06)12 [2]. The power levels permitted for generic UWB use are summarised in Table 1.

	3.1-3.4 GHz	3.4-4.8 GHz	6.0-8.5 GHz	8.5-9.0 GHz
<b>Limit</b>	-41.3 dBm/MHz mean e.i.r.p., 0dBm/50MHz peak e.i.r.p.			
<b>Indoor and mobile applications</b>	Permitted with ➤ LDC (Note 1) ➤ or DAA (Note 2)	Permitted with ➤ LDC (Note 1) ➤ or DAA (Note 2)	permitted	Permitted with DAA (Note 2)
<b>Vehicle installations (Note 4)</b>	Permitted with ➤ LDC (Note 1) ➤ or DAA + TPC (Note 2 and 3)	Permitted with ➤ LDC (Note 1) ➤ or DAA + TPC (Note 2 and 3)	Permitted with ➤ TPC (Note 3) ➤ or LDC (Note 1)	Permitted with ➤ DAA + TPC (Note 2 and 3)
<b>Airborne installations</b>	Currently excluded	Currently excluded	Currently excluded	Currently excluded
<b>Fixed outdoor installations</b>	Currently excluded	Currently excluded	Currently excluded	Currently excluded
Note 1: LDC from ECC/DEC(06)12 Annex 1 Note 2: DAA from ECC/DEC(06)12 Annex 2 Note 3: TPC with a dynamic range of 12 dB; without TPC the max permitted limit is -53.3 dBm/MHz e.i.r.p. Note 4: the generic rules for vehicle installations were under revision at the time when the report was developed; the scope of its application should in particular be further clarified.				

**Table 1: Summary of the generic UWB rules**

Outdoor use of equipment using UWB technology covered by these Decisions does not include use at a fixed outdoor location or connected to a fixed outdoor antenna. UWB LT2 systems are requesting operation at fixed outdoor locations and this is the main reason why they do not fit into the existing regulation.

In developing these generic limits and conditions, some of the following assumptions were made:

- The majority of UWB devices are expected to be consumer products bought and used by the general public and that these products will comply with existing regulations;
- The number in use is expected to be large, and aggregation of interference and single interferer analysis were taken into account;
- A general authorisation (“licence-exempt”) was agreed. Rescinding this authorisation and taking devices out of use after sale may not be feasible;
- If interference is produced, it will usually not be possible to identify the user, still less to prevent interference happening in the future due to this or another user. Thus protection must be ensured by limits based on studies carried out in advance;

- UWB portable devices could be carried about, and may be anywhere that the public can go and held at any orientation;
- Users are likely to have both UWB terminals and other radios (in particular BWA terminals) that can be very close to each other.

One type of location tracking applications is permitted under the generic regulation. In fact, Location Tracking Applications Type 1 operating in the frequency band from 6.0 GHz to 8.5 GHz (as defined in ETSI TR 102 495-3 v1.3.1 [5]) are allowed under the existing regulation. The main reasons for that are the emission levels in conformity with the existing regulation, the operation of fixed transmitters only in indoor environments, and these systems have only passive fixed outdoor base stations.

As mentioned in the introduction, the generic UWB regulation contains various regulatory provisions aiming to minimise UWB outdoor activity.

CEPT Report 27 [6] underlines the case of the Fixed Service, as it appears from ECC Report 064 [9] finding that a maximum mean e.i.r.p. density of  $-41.3\text{dBm/MHz}$  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. This element, together with the need to minimise potential aggregate interference on outdoor stations of Radio Services, supported the exclusion of fixed outdoor installations from the generic UWB regulation.

### 3.2 How a UWB LT2 system is different

For a large site under the control of one occupier, such as a factory with no very close neighbours (i.e at least the width of a street away), the regulatory provisions applicable under the generic UWB regulation, may not be appropriate. The following should thus be taken into account due to the characteristics of UWB LT2 systems:

- Actual locations and antenna types may be chosen by the UWB LT2 installers so as to meet the long-term coexistence requirements on a case by case basis (assuming that the required coexistence informations like the location or max power level are available);
- The very short distances for BWA user terminals will only arise where both UWB emitters and BWA receiver are within the site boundary, and the use is primarily a matter for the site's occupiers;
- UWB LT2 systems will not be used by the "general public";
- UWB LT2 systems will be "closed", i.e. only authorised terminals will operate within the system;
- The number in use is expected to be much smaller than UWB "consumer products" that are available for the general public;
- If interference is produced, it will be possible to identify the UWB LT2 site, if the solution proposed in Chapter 5 of this report is implemented;
- UWB portable devices will be carried only in a well defined area.

This Report investigates how such features could provide a basis for regulation and the means to achieve coexistence with radio services.

## 4 COMPATIBILITY WITH EXISTING SERVICES

Within this report, the term "radio services" is used to identify services operating within one of the categories identified in Article 1 Section III of the ITU Radio Regulations [7]. UWB technology, as with most other forms of Short Range Devices (SRD), operates on a strict no protection/non-interference basis with respect to Radio Services.

The potential victim radio services that could be affected by UWB LT2 systems operating in the band 3.4 – 4.8 GHz are the following:

- Fixed Service: 3.4-4.2 GHz;
- Fixed Satellite Service: 3.4-4.2 GHz and 4.5-4.8 GHz;
- Mobile Service (Wimax in future LTE): 3.4-4.2 GHz;
- Aeronautical Radio Navigation Service: 4.2-4.4 GHz;
- Fixed Service (military): 4.4-4.8 GHz;

- Mobile Service (military): 4.4-4.8 GHz;
- Radioastronomy.

Assuming that UWB LT2 systems and its fixed terminals are authorised only for specific sites, the potential for them to cause interference will depend on the location and mobility of the relevant receivers of the affected radio services in the areas close or within the UWB LT2 site.

For each of the affected radio services in turn, the following considerations can be made:

- Stations of the FS and FSS, whose positions are known by the Administrations as part of the licensing process:
  - Registered stations should be duly protected, taking into account adequate long term protection criteria;
  - If the technical requirements for UWB LT2 fixed installations do not ensure the protection of such stations, then appropriate measures are needed with defined boundaries;
  - In this case the fixed LT2 terminals can be installed so that their emissions towards such potential victims is below the protection criteria needed to protect them, given their distance.
- Stations of FS and FSS located close to the LT2 installation but whose positions are not known to any licensing authority (e.g. VSATs, which may be receive only):
  - The LT2 operators would have to identify the visible fixed stations (e.g. VSAT terminals) within defined boundaries and take necessary measures to protect them;
  - Alternatively, proper engineering measures could be implemented in order to reduce the emissions outside the site in unobstructed directions (in particular in order also to mitigate potential impact on future stations of the FS and FSS which would not be registered).
- Temporary installations of the FS and FSS:
  - Technical requirements for LT2 systems need to be defined in order to ensure an adequate protection of such installations during temporary use;
  - Site authorisation and coordination mechanism rather aims to address long term interference potential.
- Mobile and nomadic terminals:
  - Technical requirements for LT2 systems need to be defined in order to ensure the protection of such terminals.

Concerning Radio Astronomy Service (RAS) there are no primary allocations, nor any spectral lines protected by footnote 5.149 of the Radio Regulations, in the band 3.4-4.8 GHz. The band 3.4-3.6 GHz is listed by CRAF as “secondary”, but not allocated to the RAS at all.

Concerning the Aeronautical Radio Navigation Service (ARNS), it should be ensured that the technical requirement for LT2 systems will ensure the protection of radio-altimeters, and in particular around airport areas.

Some administrations may have difficulty with a registration procedure for LT2 in the band 4.4-4.8 GHz because the location of victims cannot be made publicly available due to security reasons; for those bands a limit to be fulfilled at the boundary of the area of a company (which is the owner of the LT2 installation) could be discussed.

The detailed compatibility studies will be presented in a separate ECC Report developed by CEPT/WG SE.

## **5 COORDINATION/REGISTRATION MECHANISM FOR UWB LT2 SYSTEMS**

ECC does not support the principle of promoting fixed outdoor installations subject to individual licensing but some other forms of registration and coordination may be possible. In any case, it is important not to confer any primary rights to what is essentially an underlay service.

Taking into account the characteristics of UWB LT2 systems and the possibility to cause interference in some radio services, this Report considers the principle where a coordination process may be employed to register the location of UWB systems that have the potential to cause interference, in conjunction with a “site authorisation” or registration process which would not confer any rights on those UWB systems with respect to radio systems.

A practical proposal of implementation of a coordination/registration mechanism for UWB LT2 systems is analysed in this chapter to better assess their feasibility. It has to be noted that UWB LT2 systems do not exceed the e.i.r.p. limits which have already been agreed and which have been embodied in the relevant Decisions. However, they do not conform to some of the other conditions imposed in those Decisions.

The objective of the coordination/registration mechanism is to allow the operation of UWB LT2 systems in suitable areas, such as large offices or industrial premises, within which these devices can be operated while minimising the possibility of harmful interference to radio services operating outside the boundary of those areas.

Information about various possible schemes for light-licensing systems can be found in ECC Report 132 (Moscow, June 2009) [8].

## 5.1 Background

Registration systems are not new. For example, one Administration operates some systems including one for 5.8 GHz FWA systems, the aim of which is to protect primary radio services. Under this system, installers of equipment complying with the relevant interface requirement register on the database. It is made quite clear to applicants that registration does not provide them with protection from or the right to cause interference to primary systems. In the event of interference to other FWA systems, users are expected to resolve the problem between themselves. This has been in operation for over five years without problems. In fact, due to this problem-free operation, some thought is being given to the possibility of dispensing with this system.

UWB systems operate on the basis that they have no right for protection from interference from radio services, and on condition that they do not cause harmful interference to radio services. Compatibility studies have been conducted to determine the levels within which UWB devices might operate while respecting the rights of radio services to operate in an interference free environment. However, it can be envisaged that there may be instances where there is a requirement to permit the operation of a UWB device or service which do not fit in current regulation like UWB LT2 systems. In these cases, the risk of interference can be minimised by employing a coordination process which enables the location of those devices to be registered and removed or modified as necessary should they prove to cause an interference problem.

This alternative approach would not be appropriate for most UWB applications, particularly those intended for general mobile use, but is well suited to a location system operated in an area such as a large industrial site. Such a system consists of fixed terminals at known locations and mobile terminals carried by staff or fixed to vehicles. The whole system operates on private property, and is “closed” in the sense that mobile terminals from outside will not work with it. Fixed terminals can be sited, and if necessary screened to give directional coverage, so as to reduce radiation towards any sensitive receivers. Receivers that might suffer harmful interference only at short range need not be considered, as they would be within the site boundary.

## 5.2 Basic Methodology

The registration solution should rely on a database containing the location of the potential “victim” radiocommunication services that could be adversely affected by UWB LT2 systems. Depending on national legislation, this could be an open database to which the UWB operator could have access. When the UWB operator plans to install a new UWB LT2 system he should search in the database to determine whether the planned location has some potential “victim” radiocommunication services already installed. If not and if the compatibility conditions are fulfilled then a new UWB LT2 system can be installed and the database updated accordingly. If there are “victim” services in the planned location the UWB operator should contact the affected “victim” service operator and initiate the coordination process in order to install the new UWB LT2 system. If approved this new UWB LT2 system should be updated in the database. Before the UWB system is put into operation, the Administration requires to satisfy itself that the necessary steps have been taken to prevent harmful interference to existing radio services.

With this solution the UWB system applicant would

- a) Identify the site;
- b) Look up the existing services close to it;
- c) If there are victim services choose protective measures where needed in order to fulfill the protection requirements of the victim system;
- d) Register it provisionally in a database;
- e) Install and test the system;
- f) Make any changes needed;
- g) Finalise the registration.

In summary, this solution implies that:

- There is a need for a “DATABASE” containing the location of UWB LT2 installations and the location and protection requirements of victim services;
- UWB LT2 operators have to consult the “DATABASE” to identify potentially affected victim stations of primary radio services;
- UWB LT2 operator needs an authorisation to operate in a specific area, subject to demonstration that he can protect victim stations. The registration process should make this information available to the Administration that can grant an “authorisation site” in conformity.

In case of future radio stations of primary services deployed in the vicinity of existing UWB LT2 system (i.e. within given separation distance), the UWB LT2 operator is informed by the Administration and instructed to take necessary measures to ensure protection of primary service within a limited time frame. If the protection is not possible the actions described in section 5.4 should be applied.

Figure 1 shows how this process would work.

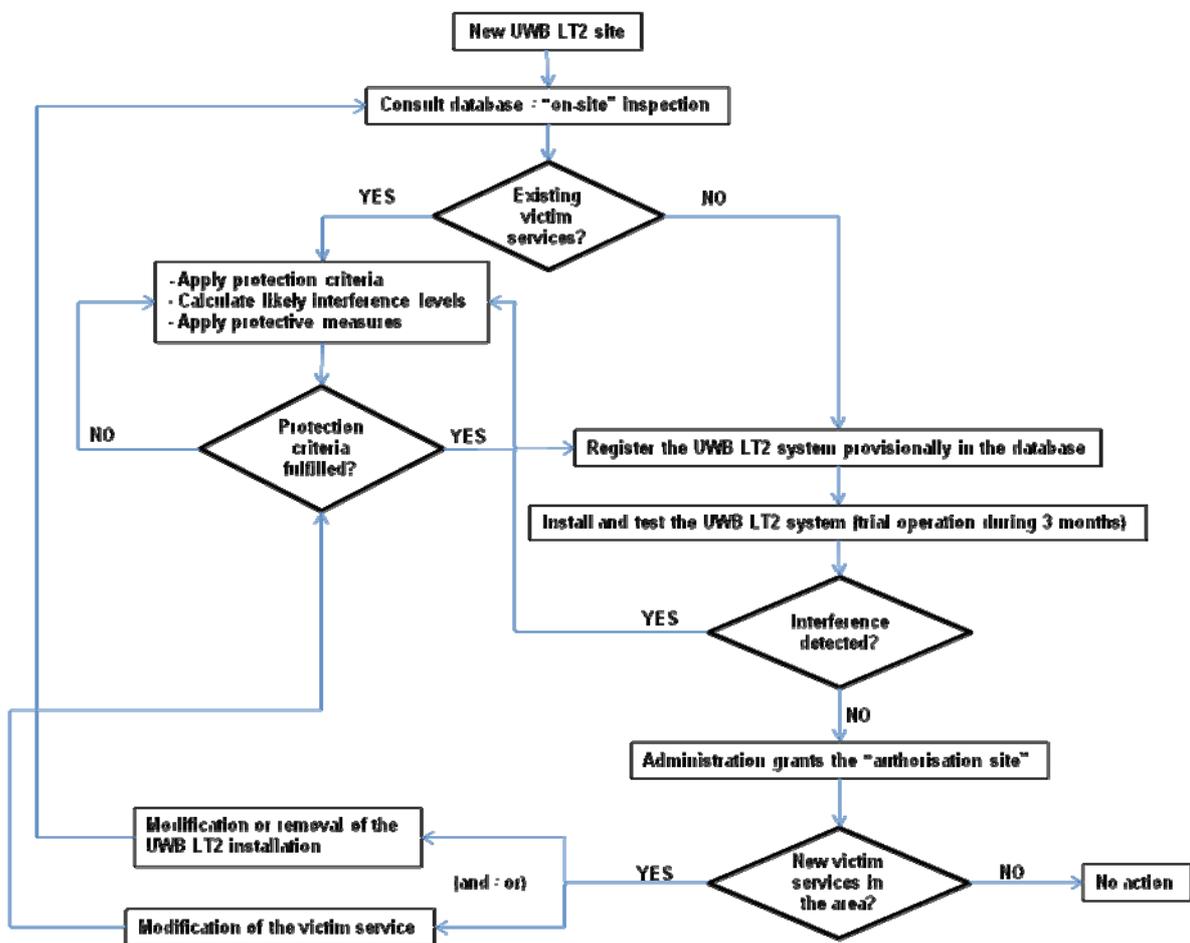


Figure 1: Flowchart describing the coordination/registration mechanism

Some concerns should be highlighted with the proposed solution:

- Administrations may not be in a position to implement easily such coordination/registration mechanism;
- If there are too many victim stations the proposed mechanism is not practical to implement;
- Difficulties if multiple databases need to be developed by Administrations for similar requirements.

In any case, it should clearly be defined who manages the UWB LT2 equipment registry, noting that a nominal registration fee can be introduced to cover the expense of managing the database.

It is recognised that not all Administrations will be able or prepared to establish a new registration database.

In the long-term, it is conceivable that the need for registration might eventually disappear should experience show that the interference from these UWB systems is at such low-levels that controlling their location is no longer considered to be necessary.

### 5.3 Authorisation regime

UWB is considered as an underlay technology that can share or collectively use the spectrum on an unlicensed basis. However if a UWB device exceeds the levels determined by the studies done in CEPT or otherwise non-compliant devices, which is the case of UWB LT2 systems, there are concerns with regard to whether UWB can be considered as an underlay technology and therefore can share or collectively use the spectrum on an unlicensed basis.

Authorising use at specific sites is considered to be the most practical method of regulating non-compliant UWB systems. In doing this, it is necessary to highlight that such “site authorisation” should not confer any primary rights to UWB LT2 systems, which are essentially an underlay system.

In case the need to use UWB LT2 equipment which is localised in industrial areas or hospitals or universities for example, then local databases can be easily manageable. There should be no problems to authorise well defined sites, such as workplace/offices, public buildings, security and manufacturing assembly lines, where the applicant is able to demonstrate that potential victim stations can be protected.

The authorisation regime should be based in a **site-specific authorisation** and the use of spectrum on a **non-exclusive, non-interference** and **no-protection basis**.

### 5.4 Action to be taken in the event of interference

A number of concerns have been expressed about action which could be taken should interference be received, or predicted to be experienced, from a registered UWB installation. Most of these concerns relate to the rights of the radio service operator and the next steps once interference has been predicted or received. As the whole concept of Registration is based on the need to avoid interference, it is clear that some further action is possible to avoid the problem. These actions could include:

- **Modification or removal of the UWB installation**
  - The UWB equipment would have been installed on the understanding that, if it causes an interference issue, then the responsibility for resolving that problem would lie with the UWB operator.
- **Modification to the victim service**
  - Other solutions to the interference problem can be envisaged. For example, in the case of interference into a fixed link, the UWB operator could negotiate a re-planning of the affected link. In this case, it is assumed that the UWB operator would bear the cost of re-planning the link.

It should be noted that where interference occurs its source has to be identified correctly. For example, if an operator (e.g. FSS or FS/BWA) claims that UWB is causing interference and the source is subsequently found to be unrelated to UWB use then the UWB operator should not be penalised for this misdiagnosis.

## 6 OTHER UWB DEVICES THAT DO NOT COMPLY WITH EXISTING REGULATION

It should be emphasised that the generic UWB regulation shall remain the cornerstone of European regulatory package on UWB, and the development of a specific regulation for location-tracking applications such as UWB LT2 systems could be only possible in duly justified cases.

Besides UWB LT2 systems the industry may develop other kind of UWB systems that do not comply with all the restrictions in existing regulation for UWB systems. In some cases these may exceed the power levels set out in existing regulation for UWB systems.

The possibility of applying the regulation developed for UWB LT2 systems to other UWB devices that exceeds the power levels set out in existing regulation should be carefully considered before this action is taken. In fact, UWB LT2 systems do not have higher “on” power levels, and have special characteristics that were studied in detail and that were subject to

intensive compatibility studies. Only if the characteristics of some new UWB systems that exceed the power levels set out in existing regulation are similar to UWB LT2 systems it is recommended the use of the regulation agreed for UWB LT2 systems. In other cases, particularly where the use of non-compliant UWB devices cannot be restricted to a carefully controlled location, the risk of interference could be high and the use of this regulation is not recommended.

## **7 CONCLUSIONS**

This Report concludes that it is possible to develop a procedure for the operation of UWB LT2 systems, which do not comply with the existing regulation, while protecting radio services from harmful interference. Administrations might want to consider a coordination/registration process as described in Chapter 5, which includes the record of the locations of UWB LT2 systems. This would facilitate the identification and, if necessary, removal of UWB LT2 systems which have been proved to be a source of interference.

This Report recognises that the development of a new coordination/registration process could be seen as going against the principle of minimum regulation but it would only need to be applied by those administrations that want to derive the benefit that the operation UWB LT2 systems offers while avoiding the problems associated with the operation of these devices in unknown locations. In the long-term, it is conceivable that the need for registration might eventually disappear should experience show that the interference from these UWB systems is at such low-levels that controlling their location is no longer considered to be necessary.

**ANNEX 1: LIST OF REFERENCES**

- [1] ECC/DEC/(06)04: ECC Decision of 24 March 2006, amended 6 July 2007, on the harmonised conditions for devices using Ultra-WideBand (UWB) technology in bands below 10.6 GHz
- [2] ECC/DEC/(06)12: ECC Decision of 1 December 2006 amended Cordoba, 31 October 2008, on supplementary regulatory provisions to ECC/DEC/(06)04 for UWB devices using mitigation techniques
- [3] CEPT Report 34: Report B from CEPT to European Commission in response to the Mandate 4 on Ultra-Wideband (UWB)
- [4] ETSI TR 102 495-5v1.2.1: Location tracking applications type 2 operating in the frequency band from 3.4 GHz to 4.8 GHz
- [5] ETSI TR 102 495-3v1.3.1: Location tracking applications type 1 operating in the frequency band from 6 GHz to 8.5 GHz
- [6] CEPT Report 27: Report A from CEPT to European Commission in response to the Mandate 4 on Ultra-Wideband (UWB)
- [7] ITU Radio Regulations
- [8] ECC Report 132: Light Licensing, Licence-Exempt and Commons
- [9] ECC Report 064: Generic UWB applications below 10.6 GHz.