CEPT Report 007

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

Harmonise radio spectrum use for Ultra-Wideband Systems in the European Union

Final Report on 18 March 2005 by the:

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

Pre-amble

The ECC at its 10th meeting, Sorrento, 14 – 18 March 2005, recognising that work on UWB will continue in TG3, agreed to send the report on UWB prepared by ECC TG3 to the EC in response to their mandate.
The ECC recognises that there are a number of elements in the report which have not yet been fully resolved within CEPT, however, it contains valuable technical information e.g. in relation to sharing between UWB and radiocommunication services. It also provides guidance on how to progress on this matter.
The ECC also considered that, due to the complex nature of the issue, it is more appropriate to concentrate on the development of a solution rather than spend time improving the report.
The ECC has adopted new terms of reference for the ECC TG3 which is tasked to continue the work in order to provide a complete proposal for regulation of UWB by the end of 2005. It should be noted that instead of the two-step approach initially proposed by ECC TG3, the ECC has decided that a CEPT regulation should be developed without any intermediate step. In addition, the ECC asked TG3 to develop a work plan in order to take into account further development in this area and the possible need to continue the work after the end of 2005. These ToR are annexed to this pre-amble for information.

Chris van Diepenbeek
Chairman CEPT Electronic Communications Committee

Revised[1] Terms of Reference for ECC TG3

1 ECC TG3 shall develop provisions for a CEPT regulation on the basis of further impact analysis initially considering a PSD limit of -55 dBm/MHz in the band 3.1-10.6 GHz for indoor UWB communication applications, taking into account technical studies, measurement campaigns and mitigation techniques including those used in the TG3 report and in ECC Report 64.

2 Complementary regulatory measures required for the protection of radiocommunication services from harmful interference shall be identified and developed.

3 For specific UWB applications, such as Ground- and Wall-Probing-Radar imaging systems, draft final regulatory deliverables shall be developed for consideration at the ECC meeting in October 2005.

4 ECC TG3 shall provide the following deliverables for consideration at the following ECC meetings:

June 2005	Provisional technical parameters and regulatory provisions for indoor UWB communication applications
October 2005	draft final deliverables for CEPT regulation, based on the form agreed by ECC at its June 2005 meeting

5 ECC TG3 shall provide a detailed work plan in October 2005 based on the latest developments.

6 ECC TG3 shall coordinate European positions in preparation for ITU-R TG1/8 on Ultra Wide-band issues.

7 ECC TG3 shall consult with relevant European organisations in particular ETSI.

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[1] Revised at 10th ECC Meeting, 14-18 March 2005, Sorrento.

“Technical, operational and regulatory criteria for the harmonised use of radio spectrum for UWB-based applications”

Final Report by the ECC to the EC
in response to the EC Mandate to CEPT to
Harmonise radio spectrum use for Ultra-wideband Systems
in the European Union

0 Executive summary

This Report has been developed by CEPT in response to the “Mandate to CEPT to harmonise radio spectrum use for ultra-wideband systems in the European Union” and provides the conclusions of the work undertaken towards developing the necessary regulatory provisions for the introduction of UWB in Europe.

A two-step approach is proposed in response to the mandate on UWB:
1) An interim solution should be developed on the basis of the Impact analysis of a -55 dBm/MHz PSD limit in the band 3.1-10.6 GHz for indoor equipment.
2) Future work should be performed based on latest UWB requirements and taking into account detailed mitigation techniques.

An overview is given of the status of UWB implementation both within Europe and outside Europe. Technical specifications of UWB devices and related relevant ETSI and IEEE standardisation are then described.

Possible regulatory framework in Europe based on the results of the studies presented ECC Report 64 is considered. The results of these studies are significantly lower than the FCC limits in terms of maximum UWB PSD.

Considerations are also given to the related regulatory provisions of ITU Radio Regulations such as No 5.340.

A possible monitoring and review process, for the proper implementation of UWB devices in Europe, is also considered together with a discussion on the experimental rights to use radio spectrum (or licences) for UWB applications which concludes that the mechanism for experimental use of radio spectrum already exists through national procedures for test and development licences.

The main conclusions of the CEPT studies in response to EC Mandate on UWB are:

- the FCC Indoor UWB mask does not by itself provide adequate protection from interference to the existing services,
- the majority of the radio services considered requires more stringent generic limits than defined in the FCC masks, indoor as well as outdoor,
- The solution could be the two step approach as described above.

1 Introduction

This is the final report by the European Conference of Postal and Telecommunications Administrations (CEPT) to the European Commission (EC) in response to the Mandate from the European Commission on UWB[2] (Annex 7). Pursuant to art. 4 of the Radio Spectrum Decision, CEPT is mandated to undertake all necessary work to identify the most appropriate technical and operational criteria for the harmonised introduction of UWB-based applications in the European Union.

UWB technology holds potential for a wide variety of new Short Range Devices (SRD) for communications, measurement, imaging, surveillance and medical systems. The EC Mandate suggests three types of UWB applications which are generally grouped as:

- **communications equipment**: used as a "cable replacement system" in high-speed data transmission (Personal Area Network), in high-speed wireless networking, as an alternative RLAN technology, and also to provide innovative types of wireless "smart tags";
- **imaging systems**: ground penetrating radar, "see-through-walls" systems, motion detectors for security and surveillance applications, industrial measurement gauges and medical imaging;
- **Short Range Radar** for automotive collision-mitigation and proximity sensing systems.

The Mandate was issued to CEPT on March 12th, 2004 and addresses the first two types of UWB applications only. Work on Short Range Radar was already addressed separately, with a Mandate given to CEPT on August 5th, 2003.

This final report has been developed within ECC Task Group 3 (TG3) with contributions from administrations and industry and was approved by the ECC meeting in March 2005 in accordance with the timescales of the Mandate. It identifies the conditions of use of the radio spectrum by UWB required to protect other radio services from harmful interference. Those conditions lead to requirement for UWB in terms of power spectral density which is considered to be too stringent to allow feasible operation for UWB applications. However, there are potential mitigation and regulatory measures which could be used to reduce the impact of UWB on radiocommunication services. Those measures have not yet been taken into account in the analysis. Therefore ECC has requested TG3, to continue its work to establish a regulatory framework for Europe.

2 Background

2.1 Status of UWB in Europe

The first UWB modulation schemes to be developed were based on the emission of short impulses, derived from radar technology. UWB systems for short range communications are still in an early phase of market and technology development. UWB radio systems and applications are developed within the EC Information Society Technologies (IST) *Mobile and wireless systems beyond 3G* project PULSERS (Pervasive Ultra-wideband Low Spectral Energy Radio Systems). Some related work is also performed within IST MAGNET (My personal Adaptive Global NET) project.

[2] DG INFSO/B4/AG/D(2004) 509800; 12 March 2004

ECC Report 64 on the protection requirements of radiocommunication systems below 10.6 GHz from generic UWB applications has been adopted by CEPT in February 2005.

One administration is currently consulting on the position to adopt in Europe on UWB devices in 3.1-10.6 GHz"[3]. An independent study had been commissioned on the "Value of UWB Personal Area Networking Services to the United Kingdom"[4]. The report was commissioned to provide an initial analysis of the costs and benefits which are likely to be associated with the deployment of UWB technology. The assumptions and conclusions of the report reflect the views of the consultants only. Further economic impact studies are currently being undertaken and may be used if appropriate when developing the future regulatory framework.

2.2 Status of UWB outside Europe

At present, the only country that has authorised the general use of UWB is the USA[5].

The Japanese ministry responsible for telecommunications, MIC, published an interim report on UWB that addresses approaches to introducing UWB, as well as studying interference with other radio systems.

Singapore has a UWB Program, initiated by Singapore's Infocomm Development Authority (IDA), comprising a two-year effort to bring UWB technology to Singapore[6]. A "UWB friendly zone", established at the start of 2003 in a science park, allows experimental use of UWB devices in a campus environment. The programme is due to complete in mid-2005.

The South Korean Government has formed an organization to study UWB regulation in Korea; members include government agencies, industry and operators. The regulatory environment for UWB in Korea is similar to that in Japan, where the key factor is the EIRP level for unintentional emissions. ETRI (Electronics and Telecommunications Research Institute), has an activity to look at the Digital Home Network based on UWB.

2.3 Technical specifications

2.3.1 ETSI Standards

The EC issued a Mandate (M/329) to the European Standardisation Organisations on February 25th 2003, with the purpose to establish a set of Harmonised Standards covering UWB applications to be recognised under the R&TTE Directive, and giving a presumption of conformity with its requirements.

The European standardisation organisation ETSI has developed two related System Reference Documents, corresponding to the two types of UWB applications addressed by this Report, to be published as ETSI Technical Reports:

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[3] Available at: http://www.ofcom.org.uk/consult/condocs/uwb/

[4] Available at http://www.ofcom.org.uk/research/industry_market_research/technology_research/cet/uwb/uwbpans/

[5] FCC Rules, Part 15; FCC 02-48: FCC First Report and Order, adopted February 14 2002;
FCC 03-33: FCC Memorandum Opinion and Order… adopted February 13, 2003;
FCC Second Report and Order, adopted December 15, 2004.

[6] Available at: http://www.ida.gov.sg/idaweb/techdev/

- TR 101 994-1: Technical characteristics for SRD equipment using Ultra Wide Band Technology (UWB): Part 1; Communications applications,
- TR 101 994-2: Technical characteristics for SRD equipment using Ultra Wide Band Technology (UWB): Part 2; Ground- and Wall-Probing-Radar applications.

These reports have been completed and published by ETSI.

The harmonised UWB standards for communications[7] will be:

- EN 302 065 (parts 1 and 2) – Communications

ECC envisages that the emissions limits in these harmonised standards will be based on the results of the compatibility studies undertaken by ECC TG3 and continues to work with ETSI to ensure alignment in the time schedule of production of deliverables. The Mandate calls for the delivery of the relevant harmonised standards by December 2004, but this date was not met.

The harmonised UWB standards for imaging systems[7] (Ground and Wall Probing Systems) have been completed, and are:

- Draft EN 302 066 (parts 1 and 2) – Imaging Systems (Ground and Wall Probing Radar)

This latter standard has been offered for approval in ETSI (TC ERM#24) to move into the two step approval process (public enquiry, followed by national vote). It is envisaged that these standards will be published in the autumn of 2005, and Part 2 (Harmonised Standard under Article 3.2 of 1999/5/EC) will be published in the EC Official Journal by the end of 2005. Part 1 of this standard contains the measurement techniques.

The companion EMC Standard Draft EN 301 489-32 has the same status as the EN 302 066 standards (Harmonised EMC Standard under Article 3.1b of 1999/5/EC).

2.3.2 IEEE Standards

IEEE Development of UWB Physical Layer Standards

IEEE 802.15 WPAN High Rate Alternative PHY Task Group 3a (TG3a)

The IEEE 802.15 High Rate Alternative PHY Task Group (TG3a) for Wireless Personal Area Networks (WPANs) is working to define a project to provide a higher speed PHY enhancement amendment to 802.15.3 for applications which involve imaging and multimedia. Two PHY proposals are under consideration as so far neither has achieved the necessary 75% level at confirmation vote. The two proposals are Direct-Sequence UWB (DS-UWB) and Multi-Band OFDM MBOFDM).

Examples of applications demanding the proposed faster bit rates include time-dependent large file transfers, multiple simultaneous instances of high definition audio/video streaming and cable replacement. Examples of devices which can be connected include computers, computer peripherals (similar to USB 2.0's 480 Mbps or IEEE1394 capability), PDA/HPCs, printers, set top boxes, information kiosks, image displays, virtual reality games, DVD players, and camcorders (similar to IEEE 1394's 400 Mbps capability).

It has to be noted that several UWB implementations for High Rate applications are currently under development.

[7] Under Article 3.2 of the R&TTE Directive

The IEEE 802.15 Low Rate Alternative PHY Task Group (TG4a)
The IEEE 802.15 Low Rate Alternative PHY Task Group (TG4a) for Wireless Personal Area Networks (WPANs) has defined a project for an amendment to 802.15.4 for an alternative PHY.
The principle interest is in providing communications and high precision ranging / location capability (1 meter accuracy and better), high aggregate throughput, and ultra low power; as well as adding scalability to data rates, longer range, and lower power consumption and cost. These additional capabilities over the existing 802.15.4 standard are expected to enable significant new applications and market opportunities.
Applications are foreseen for Low-Rate Data and/or Positioning (asset tagging and tracking, locating people, smart homes, real-time tracking of goods on pallets), Industrial control applications (remote sensors, smart devices based on location awareness), Low Probability of Detection Water & Gas Meter Reading, Healthcare applications (preventive medicine, healthcare monitoring, locating assets/staff, workplace safety), Wireless Body Area Networks, and many others requiring low power low duty cycle communications.

2.4 ITU activities

Task Group 1/8 (TG1/8), the body within the ITU-R that is responsible for studies on UWB, continues to study UWB. Its activities are divided into 4 working groups studying UWB characteristics, UWB impact on radiocommunication services, UWB measurements and the spectrum management framework.

TG1/8 will complete its work by the ITU-R Study Group 1 meeting in October 2005.

3 Considerations for establishing the regulatory framework in Europe

3.1 Technical parameters of UWB-based applications

3.1.1 Communications equipment

UWB technology is an emerging technology for wireless communication over short distances, with the potential for communication applications with the data rate up to 500 Mbps. The UWB specifications as described in IEEE allow the system to operate at multiple rates depending upon the range and other channel conditions. The technical parameters that are used in IEEE requirements are referred to in Section 2.3.

3.1.1.1 Smart tags, local positioning systems

UWB technology enables the development of devices which are primarily used for accurate location tracking of people and objects in indoor environments. Although they make use of a similar set of frequencies, the very different operational and deployment characteristics between PAN and location tracking UWB devices suggest that it may be appropriate to consider separate, interim regulation of UWB location tracking technology, in order to permit the greatest benefit to industry (from the use of such devices) whilst still maintaining the required protection of existing radio services. There are numerous applications in Workplace Performance, healthcare process and resource management, asset tracking, security, industrial automation and robotics.
There are indications that this category could be considered separately, these are:

- there are currently market ready products and emerging markets already active
- User demographics, deployment density, activity factors and modulation schemes can be accurately described and will be different from 3.1.1
- There will be different characteristics with regards to mitigation factors and spectrum usage

However, there should be a well defined mechanism how these applications are differentiated from other UWB.

3.1.2 Imaging systems

Ultra Wide Band is an emerging technology with potential benefits for security applications and businesses. There are at least three separate groups of probing radar imaging systems:

- Ground Probing Radars (GPR);
- Wall Probing Radars (WPR);
- Through-Wall Probing Radars (T-WPR).

Through-Wall Probing Radar (T-WPR) applications are included in this document but are normally only considered for military agencies and governmental services usage. T-WPR can detect the location or movement of persons or objects that are located on the other side of a structure such as a wall. Therefore, T-WPR must be recognized as a unique class of device distinct from GPR/WPR for which licensing is likely to be on a case-by-case basis.

More detailed technical definitions and parameters for GPR and WPR are presented in ETSI TR 101 994-2 and Draft EN 302 066-1 and 2.

UWB Sensors, Object Classification are new applications which will, depend on the characteristics, either be intended for licensed or unlicensed applications.

3.2 Considerations relating to operation

3.2.1 UWB-based communications equipment

The studies that have been carried out on the compatibility between UWB systems and radiocommunication services are based on a number of assumptions relating to the characteristics and the deployment parameters of the UWB system. In particular the reference scenarios (UWB penetration, activity ratio, indoor/outdoor use, etc.) have a significant impact on the results in terms of acceptable UWB power spectral density.

3.2.1.1 UWB for smart tag, local positioning systems

Smart tags, local positioning systems have particular and unique modes of operation and deployment, it is reasonable to explore whether existing radio services can be offered sufficient protection from them via the use of specific regulation, tailored to UWB location tracking systems. Operationally these systems are characterised by:

- UWB tracking systems will almost exclusively be used indoors, in the outdoor environment, a number of radio technologies have already been developed for locating objects to an accuracy of a few metres (e.g. GPS and Galileo).
- Location tracking systems require a pre-configured infrastructure of precisely-surveyed base stations in order to operate. Clearly, this mode of operation precludes ad-hoc deployment of location tracking systems.
- Users are likely to be professionals, scientists and engineers, working indoors in healthcare, research or industrial / commercial environments.

- As a result, the expected density of location tracking devices will be much lower than the density of UWB-enabled consumer PAN devices such as cellular telephones, laptops, digital cameras, etc.
- Location system devices are generally required to be very low powered and zero-maintenance (with battery lifetimes of years), and so tend to have very low duty cycles.

3.2.2 UWB for imaging systems

GPR and WPR are surveying instruments intended for professional use, as detailed in the ETSI Technical Report TR 101 994-2. The signals recovered from the ground, or a wall, are coded with much information on the buried or hidden environment which is demanding to decode and interpret. The numbers of equipment are relatively low, they are used intermittently and they are mobile. Systems have been operated for many years under interim arrangements, and have not caused harmful interference to other spectrum users.

Specific requirements for deactivation mechanisms of GPR and WPR and limits for unwanted emissions are presented in Draft EN 302 066-1 (Annex B) and 2. These mechanisms are designed to limit the risk of unwanted radiation signals towards victim receivers.

3.2.3 Relating to other systems

ECC has considered whether design guidelines for existing and new radio standards of other systems could improve suitability of spectrum for underlay by UWB devices. However, this is complicated by the fact that the large bandwidth of UWB signal means that they underlay a substantial number of "conventional" radio systems, so that any change require to improve suitability of spectrum for UWB would impact many radio standards and radio systems.

When deriving conditions for UWB operation, this Report assumes that UWB will "underlay" existing radiocommunication services. In the context of this Report, underlay implies that the noise floor increase for incumbent services would be limited to an acceptable level, which means that it would not cause harmful interference to radiocommunication services.

3.3 Protection requirements of radiocommunication systems below 10.6 GHz against interference from generic UWB applications

3.3.1 Studies carried out within CEPT

3.3.1.1 ECC Report 64

ECC has adopted ECC Report 64 on the protection requirements of radiocommunication systems below 10.6 GHz from generic UWB applications. The conclusions are contained in Annex 1 of this Report.

From the results in Annex 1 it can be seen that the FCC indoor UWB mask does not provide adequate protection to the existing services. Figure A1-2 provides a generic consolidated UWB PSD limit to protect existing services by plotting the minimum PSD limit required for each service.

The graphical illustrations of the results show:

- The majority of the radio services considered require up 20-30 dB more stringent generic UWB PSD limits than defined in the FCC masks, indoor as well as outdoor. Only a few EESS applications are sufficiently protected, whereas some RAS bands require 50-80 dB more stringent limits.

- The consolidated limits in figure A1-2 indicate that the generic UWB PSD limits increase with the frequency. The difference in the PSD limits between 200 MHz and 10 GHz is about 20 dB.
- If the radio service is operated in an outdoor environment only e.g. FS, FSS, RAS, EESS etc, then the increase of noise due to the aggregate UWB interference determines the generic UWB PSD limit. In addition to the above if the radio service is also operated in the indoor environment e.g. DVB-T, IMT-2000, RLAN etc., then the closest UWB interferer is the determining methodology due to the small spatial separation (small path loss).

Finally, it has to be noted that studies which have been carried out in the development of ECC Report 64 are not addressing all frequency bands and all systems. Some of the systems that have not been studied, such as military systems or future mobile systems (subject to discussion at the WRC-07 under agenda item 1.4) in the range below 6 GHz, may be susceptible to interference from UWB.

Note: a statement made by the UWB industry on ECC Report 64 and proposal for an alternate regulatory framework approach is provided in Annex 8.

3.3.1.2 Measurement campaigns

To enable further interpretation and validation of the theoretical results, CEPT is undertaking some measurement campaigns. The current plan for measurements is provided in Annex 2.

The first priority has been to perform UWB interference measurements in conducted mode with victim services. Measurements on Fixed Services have been completed in February 2005. Further measurements on mobile services and DVB-T will be undertaken in March and April 2005.
Measurement campaigns in in-situ environment are also envisaged, but the period for the completion of the measurements has to be confirmed.

A workplan and schedule for measurement campaigns is provided for information in annex 2.

The results of these measurement campaigns are not available at the completion of this report.

3.3.2 Other studies

NTIA have studied UWB compatibility with GPS receivers and selected federal radio systems in the frequency band 335.4 – 7250 MHz, and published their results[8]. Compatibility with the fixed service has not been published, in spite of the fact that this service is intensively used in more than half of the spectrum between 3 and 10 GHz.

As an illustration of the differences between CEPT and other studies, aeronautical and meteorological radars were considered in an additional US study presented to TG 1/8 but only in the 2.8 GHz band, in which the FCC power limit is 20 dB below the one in the 5.6 GHz, and with non typical radar parameters less susceptible to interference.

A comparison of different approaches in compatibility studies has been performed and is provided for information in Annex 3.

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[8] Available at: www.ntia.doc.gov

3.4 Consideration of UWB PSD limits

It can be noted[9] that the results of CEPT sharing studies in terms of maximum UWB PSD are significantly lower than the FCC limits. It is understood that the FCC limits for UWB have been based on 47CFR Part 15 general emission limits. Based on compatibility with GPS a lower limit was provided in the FCC mask for the 0.96 - 1.61 GHz band.

Several mitigation and other interference protection techniques are being considered, with a preliminary assessment as to their feasibility and practicality to UWB (see Annex 4). The possible impact of these techniques on radiocommunication services might be evaluated by ECC TG3 if EC issues an additional mandate to ECC.

When considering the UWB PSD levels, one should also develop clear objectives for UWB applications in terms of bit rates and operating ranges. The achievable bit rate and operating range depend strongly on the PSD level and frequency range.

4 Regulatory framework for UWB applications in Europe

4.1 Overall approach to UWB regulation

Regulating the use of radio spectrum for UWB applications is complicated by the fact that the large bandwidth of their signals means that they occupy the same spectrum as a substantial number of "conventional" radio systems, which require protection from harmful interference to operate effectively. The regulatory framework for the use of radio spectrum for UWB therefore needs to balance all the incumbent services' requirements against the provision of favourable conditions for the introduction of innovative technologies to the benefit of society. ECC has taken account of the large number of EU policies and initiatives that are affected by the regulation of UWB to ensure that regulation adopted in Europe fully takes into account the EU-wide implications of the introduction of this technology.

ECC has worked in close collaboration with ETSI, in its development of harmonised standards for UWB pursuant to Commission Mandate M/329, to identify the technical parameters of UWB systems to be included in the overall harmonised regulatory approach.

It is worth noting that interference issues relating to passive services are generally of international nature (EESS, Radio Astronomy). Particular attention should be paid to frequency bands which are covered in RR footnote **5.340** that states "*all emissions are prohibited*" and hence need a specific regulatory treatment taking into account the current and future protection requirements of those services.

UWB devices that have emissions in bands listed in No. **5.340** (1 400-1 427 MHz, 2 690-2 700 MHz and 10.68-10.7 GHz) may have the potential to affect the global use of the aforementioned passive services. For example, for EESS (passive), interference received over one country may affect data that is used for global applications, including weather forecasting by the international community. Corrupted measurements over one area of the world could translate into incorrect weather forecasts over many regions far removed from the measurement area. Corrupted measurements from several areas may impact reliable weather

[9] ECC Report "Protection requirements of radiocommunication systems below 10.6GHz from generic UWB applications"

forecasts over major portions of the world. The consequences of incorrect forecasts may have significant economic impact.

RR Footnote No. **5.149** urges Administrations "*to take all practicable steps to protect the radio astronomy service from harmful interference*" for frequency bands specified. This footnote applies to 12 frequency bands in the frequency range addressed in ECC Report 64. It was noted that ITU-R Recommendation SM. 1633 states that "*interference exceeding the protection criteria for radio astronomy by 10 dB implies that no service can be provided to radio astronomy*".

4.2 Regulatory regime

ECC has considered the existing and developing regulatory environment, including the on-going activities in ITU-R, and the extent of convergence which is feasible with non-EU regulation.

The current EU regulatory framework[10], once a harmonised standard has been developed and operation has been authorized, does not allow for rapid change in the conditions applicable to placing on the market of UWB equipment, such as withdrawal from the market or decreasing the maximum power. This issue was already identified in the discussion within EC and ECC concerning Short Range Radars at 24 GHz. Consequently, CEPT administrations may have to take a cautious approach to the development of a regulatory framework for a particular class of product.

ECC considered that the overall approach to UWB regulation could consist of:

- a new annex in ERC/Rec.70-03 on Short Range Devices covering generic UWB communications equipment and imaging systems, or separate annexes for each; or
- a new ECC Recommendation covering both UWB communications equipment and imaging systems or separate Recommendations for each; or
- an ECC Decision covering both UWB communications equipment and imaging systems or separate Decisions for each.

4.2.1 Regulatory regime for communication applications

It is envisaged that UWB devices for communication applications would be operated without requirement for an individual right to use radio spectrum ("licence-exempted") and on a "un protected, non harmful interference" basis.

This uncontrolled nature of UWB deployment would not allow for the products to be withdrawn from the market in response to an increase in the risk of harmful interference to other radio applications (see section 4.3 for further information). It justifies that the regulatory regime be defined by taking into account long-term scenarios.

The development of a general regulatory regime for UWB communication applications clearly targets WPAN High Data Rate applications supported by most of the UWB proponent industry and has been identified by CEPT as the priority focus.

A two-step approach is proposed in response to the mandate on UWB:

1) An interim solution should be developed on the basis of the Impact analysis of a -55 dBm/MHz PSD limit in the band 3.1-10.6 GHz for indoor equipment.

[10] RTTE Directive 1999/5/EC

2) Future work should be performed based on latest UWB requirements and taking into account detailed mitigation techniques.

It is also proposed, in the bands below 3.1 GHz and above 10.6 GHz, to adopt the maximum PSD limits based on the generic mask derived from ECC Report 64.

4.2.1.1 Impact analysis of a -55 dBm/MHz "in-band range" PSD limit for indoor equipment

Annex 5 provides a preliminary assessment of the impact of a -55 dBm/MHz PSD limit in the band 3.1-10.6 GHz for indoor equipment on both radiocommunication services and UWB applications.

The first part presents a "simplified generic mask derived from ECC Report 64", basis for the development of the proposed mask for impact analysis.
Second part introduces the proposed mask for impact analysis and how it was built.
Preliminary impact analysis based on the -55 dBm/MHz mask is provided in appendix 1 to this annex.

This impact analysis was stimulated by studies conducted by one administration suggesting that applying an indoor limitation with a maximum UWB PSD limit of -55 dBm/MHz, in their opinion, can protect outdoor Fixed Service stations when taking into account lower activity factors (i.e. in the order of 1%).

Note: a statement made by some administrations on the proposed UWB emission mask and the associated impact analysis is provided in Annex 8.

4.2.1.2 Possible Future work

This section has been developed by the UWB industry.

For the robust operation of UWB communication and measurement applications and for a much needed globally compatible UWB Regulatory Framework in Europe, it is requested to develop a regulatory framework which would allow UWB communication and measurement applications to operate with an effective isotropic radiated power (EIRP) spectral density (PSD) limited to –41.3 dBm/MHz in the frequency range 3.1 to 10.6 GHz in Europe.

It is proposed to accommodate the recognized needs for protection of radiocommunication services from possibly harmful interference from UWB applications by introducing certain differentiating i) regulatory, ii) operational and iii) technical (device level) measures.
ECC TG3 should conduct further compatibility and measurement studies considering this differentiated approach, and adopt adequate assumptions in term of deployment, propagation models, activity factors and aggregation.

This regulatory framework would provide an UWB application/deployment differentiated approach compared to the "generic approach" conducted in previous compatibility studies. These areas have not yet been considered by TG3, and therefore it is premature to simply adopt a very low PSD limit without consideration of this new approach to regulate UWB technology.

Procedurally, after ECC TG3 has defined the PSD limits (mask) – based on a set of regulatory and operational criteria – it is proposed that CEPT/ECC (TG3) cooperates with ETSI to define and standardize mitigating measures at the detailed technical level (physical device), should such a need still arise.

The proposed approach would provide the regulatory framework and subsequent technical standards needed for an economically viable market introduction of UWB radio applications, while providing effective measures for mitigating possibly harmful interference to radiocommunication services.

This possible future work is developed in Annex 6.

4.2.2 Regulatory regime for smart tag, local positioning systems

The regulatory regime for location tracking and local positioning systems can be considered separately due to the characteristics and mitigating factors mentioned above in sections 3.1.1.1 and 3.2.1.1. A possible regulatory regime might include:

- Restricted to indoor use only
- Restricted the transmission to a close proximity to a fixed infrastructure
- Authorised with a PSD of -41.3 dBm/MHz in the range of 6 to 9 GHz, based on existing requirements and subject to the results of the future impact analysis
- Possible "light licensing" requirement (e.g. notification of infrastructure location).

4.2.3 Regulatory regime for imaging systems

Imaging systems have not been addressed specifically within ECC Report 64.

Currently, the licensing regime for imaging systems varies between administrations.

It is recognised that the density of use of imaging systems will be much lower than for communication systems and that the two applications can be regulated in a separate way. Therefore, it is envisaged to have a different spectrum mask for imaging systems compared to communication systems. The users of GPR and WPR are normally professionals, service provider, scientists and engineers and therefore a simple licensing system to suit the needs of these users is required.

An appropriate spectrum mask for imaging systems is conditional on this expected low density of usage. This suggests that some kind of light licensing regime (for example, self-declaration by notification of usage and application) should be considered.

GPR is used in many different applications as set out in ETSI TR 101 994-2 Annex A. These different applications are required to interrogate the ground to different depths. Earth materials act as low pass filters, and for surveys at greater depth, the measurement bandwidth must be moved to lower frequencies with a consequent loss of resolution. These issues are detailed in ETSI TR 101 994-2 Annex B.

New applications in this area have been defined recently for UWB Sensors/Imaging Systems/Object Classification. The regulatory aspects for these applications need to be addressed by ECC.

4.3 Monitoring and review

ECC has considered 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. ECC has noted that the provisions of the R&TTE Directive could make it difficult to limit placing on the market and continuing sale of products in response to an increase in the risk of harmful interference to other radio applications.

Report 64 makes no specific reference to introducing a mechanism of monitoring and review, nor is there a well known precedent mechanism within CEPT. However, in the preparation of report 64 a number of assumptions have been made that by their nature are valid only if kept current. CEPT will look forward to adopting or creating a process whereby the assumptions and conclusions of the UWB regulatory regime can be challenged by industry and radio service incumbents. This process will be most effective centred around a regular public consultation exercise.

This regulatory environment implies that the initial conditions of introduction of UWB should be sufficiently cautious regarding the protection of radiocommunication services, i.e. that conditions for UWB operations, including PSD limits, should give a sufficient confidence that there would be no harmful interference to other radio applications. The review of this situation could take place in several years, leading if justified, to any relaxation of these initial conditions.

4.4 Experimental rights

ECC have considered the possible benefits of experimental rights to use radio spectrum (or licences) for UWB applications. The mechanism for experimental use of radio spectrum already exists through national procedures for test and development licences. However, the provisions of the R&TTE Directive and the Framework Directive cause difficulties in managing limited trials (limited in duration or area) that involve placing products on the market.[11]

Therefore, experimental rights for UWB are not envisaged at a European wide level, under the current regulatory framework, since it would create an unpredictable situation for radiocommunication services. Possibilities of experimental rights at the European level should be further investigated.

4.5 Complementary Band for UWB application

As an alternative approach to meet the requirements from the UWB industry, complementary bands for UWB applications could be considered, based on studies that are also supported by EC, inside the IST MAGNET project[12]. An analysis of the regulatory status of the 17 and 60 GHz frequency ranges has been conducted by an administration to identify these as possible candidate complementary bands for generic UWB applications. As these are already considered within an IST project, one could imagine in the mid term related standardization activities. Target could be to use these bands in complement to the 3.1 to 10.6 GHz bands within the same UWB devices, possibly with a dynamic spectrum reconfigurable mechanism. Another way should be to consider these bands as alternative bands for some UWB applications.

[11] This has some similarities to the situation for the management of automotive SRR at 24GHz. Note also that the regulation for placing on the market is different in Europe than the other countries such as the United States

[12] MAGNET is an integrated project supported within the Sixth Framework Programme of the EU Commission. MaGNET SIGNIFY"My personal Adaptive Global NET".

This approach is a possible solution to alleviate constraints that will be set on UWB in the 3.1 to 10.6 GHz range due to protection of existing services and to conduct any relevant compatibility studies in these ranges.

5 Conclusions

ECC Report 64 on protection requirements of radiocommunication systems below 10.6 GHz from generic UWB applications has been adopted. The main results of the compatibility studies within ECC show that the FCC Indoor UWB mask does not provide adequate protection from interference to the existing services.

The results show that the majority of the radio services considered requires more stringent generic limits than defined in the FCC masks, indoor as well as outdoor.

The solution could be the definition of a generic mask together with some technical and regulatory measures which would ensure the adequate protection of radiocommunication services from harmful interference. This will be the main area of focus for further work in CEPT, possibly in response to a new Mandate.

Having considered the severe discrepancy between the UWB requirements and the protection requirement of radiocommunication services, a two-step approach is proposed in response to the mandate on UWB:

1) An interim solution should be developed on the basis of the Impact analysis of a -55 dBm/MHz PSD limit in the band 3.1-10.6 GHz for indoor equipment.
2) Future work should be performed based on latest UWB requirements and taking into account detailed mitigation techniques.

It is also proposed, in the bands below 3.1 GHz and above 10.6 GHz, to adopt the maximum PSD limits based on the generic mask derived from ECC Report 64.

It is envisaged that UWB devices for communication applications would be operated without requirement for an individual right to use radio spectrum ("licence-exempted") and on a "non protected, non harmful interference" basis. A different licensing regime might be applied to imaging systems and other applications.

Work could be continued in many areas, including on UWB deployment characteristics such as activity factor. CEPT is also undertaking some measurement campaigns to complete the technical analyses needed to ensure the protection of other radio users.

Notes:
A statement made by the UWB industry on ECC Report 64 and proposal for an alternate regulatory framework approach is provided in Annex 8.
A statement made by some administrations on the proposed UWB emission mask and the associated impact analysis is provided in Annex 8.

Annexes

Annex 1 – Conclusions of ECC Report 64
Annex 2 – Measurement campaigns
Annex 3 – Comparison with non-CEPT studies
Annex 4 – Mitigation techniques
Annex 5 – Impact analysis
Annex 6 – Future work
Annex 7 – EC Mandate on UWB
Annex 8 – Statements

Annex 1: Overall conclusions of ECC Report 64

This ECC Report considered the protection requirements of radiocommunication systems below 10.6GHz from generic UWB applications. The presented study was based mostly on theoretical analysis. The following conclusions are based on currently available data on the UWB technical characteristics and propagation models, bearing in mind that no specific mitigation techniques for UWB applications were taken into account as they are still under development the time of writing this report.

The detailed results of the compatibility studies for various considered victim radiocommunications services are given in section 7 and are summarised in the table below. The graphical representation of results of the technical studies, with original FCC mask as a reference, is provided in Figure A1-1.

The required maximum generic UWB PSD values to protect the existing radiocommunications services were shown to be more stringent than the values given in the FCC mask.

To reach a sufficient protection from UWB systems, especially for pulsed UWB, it is necessary to set an average power limit and a peak power limit (alternatively to a peak limit, it is possible to limit the PRF to a minimum value).

Unless specially noted in the comments column, the UWB PSD limits in summary table below are valid for the assumption of AWGN-like interference effects, which is achievable with the following conditions:

- Scenarios with a sufficient number of interferer (nearly >100)
- Pulse- based UWB with a PRF-range of PRF>*VictimBandwidth*, and
- MB-OFDM (without Frequency Hopping)

ECC Report Annex	Service / Applications	Frequency bands	Service protection criteria	Worst reference case analysis	Maximum generic UWB PSD to achieve protection (dBm/MHz)	Comments
1	FS	1000-3000 MHz	ITU-R Rec. F.1094 and WP9A Liaison Statement (I/N = - 20 dB)	Aggregate, Urban (1c)	-74.5	Multiple FS sub-bands within 1-3 GHz, value extrapolated
	FS	3400-4200 MHz	ITU-R Rec. F.1094 and WP9A Liaison Statement (I/N = - 20 dB)	Aggregate, Urban (1c)	-71.5	Wide band peak protection limit in 50 MHz bandwidth was evaluated 42 dB above PSD limit.
	FS	4400-5000 MHz	ITU-R Rec. F.1094 and WP9A Liaison Statement (I/N = - 20 dB)	Aggregate, Urban (1c)	-71.5	Wide band peak protection limit in 50 MHz bandwidth was evaluated 42 dB above PSD limit.
	FS	5925-7125 MHz	ITU-R Rec. F.1094 and WP9A Liaison	Aggregate, Urban (1c)	-71.5	Wide band peak protection limit in 50 MHz

			Statement (I/N = - 20 dB)			bandwidth was evaluated 42 dB above PSD limit.
	FS	7125-8500 MHz	ITU-R Rec. F.1094 and WP9A Liaison Statement (I/N = - 20 dB)	Aggregate, Urban (1c)	-69	Wide band peak protection limit in 50 MHz bandwidth was evaluated 42 dB above PSD limit.
	FS	10.15–10.65 GHz	ITU-R Rec. F.1094 and WP9A Liaison Statement (I/N = - 20 dB)	Aggregate, Urban (1c)	-66.5	Wide band peak protection limit in 50 MHz bandwidth was evaluated 42 dB above PSD limit.
2	GSO MSS systems	1626.5-1660.5 MHz	I/N = - 20 dB	Aggregate, Global beam (2bis)	-75.3	Uplink.
	GSO MSS systems	1525-1559 MHz	I/N = - 20 dB	Single interferer, 20 m separation	-98.4	Downlink. Assuming non-dithered UWB emission Note 3
	MSS Search & Rescue	406-406.1 MHz	I < -120.1 dBm/MHz (Cospas/Sarsat system)	Aggregate, Rural (1a)	-50	Satellite receiver.
	MSS Search & Rescue	1544-1545 MHz	I < -133.2 dBm/MHz	Aggregate, Rural (1a)	-75	Earth station. Assuming an exclusion zone of 6 km
3	EESS	1400-1427 MHz	ITU-R Rec. SA.1029-2	Aggregate, Rural (1a)	-88	Satellite receiver. RR No 5.340 applies.
	EESS	6425-7250 MHz	ITU-R Rec. SA.1029-2	Aggregate, Rural (1a)	-62	Satellite receiver
	EESS	5250-5570 MHz	I < -115 dBm/MHz	Aggregate, Rural (1a)	-21	Satellite receiver
	EESS	2025-2110 MHz	ITU-R. Rec. SA.609-1	Aggregate, Rural (1a)	-35	Satellite receiver. 100% devices outdoor
	EESS	2200-2290 MHz	ITU-R. Rec. SA.609-1	Aggregate, Rural (1a)	-70	Earth station. assuming a 4 km exclusion zone
	EESS	8025-8400 MHz	ITU-R. Rec. SA.1027-3	Aggregate, Rural (1a)	*-41.3*	Earth station. (Note 1)
	EESS	10.6-10.7 GHz	ITU-R Rec. SA.1029-2	Aggregate, Rural (1a)	-57	Satellite receiver. 100% devices outdoor
4	RAS	608 – 614 MHz	ITU-R. Rec. RA.769	Aggregate, Suburban (1b)	-123.2	Continuum observations (broadband).
	RAS	1330.0 – 1400.0 MHz	ITU-R. Rec. RA.769	Aggregate, Suburban (1b)	-121.4	Continuum observations (broadband).
	RAS	1400.0 – 1427.0 MHz	ITU-R. Rec. RA.769	Aggregate, Suburban (1b)	-121.4	Continuum observations (broadband). RR No. 5.340

						applies
	RAS	1610.6 – 1613.8 MHz	ITU-R. Rec. RA.769	Aggregate, Suburban (1b)	-100.6	Spectral line observations (narrow band).
	RAS	1660.0 – 1670.0 MHz	ITU-R. Rec. RA.769	Aggregate, Suburban (1b)	-113.8	Continuum observations (broadband).
	RAS	1718.8 – 1722.2 MHz	ITU-R. Rec. RA.769	Aggregate, Suburban (1b)	-100.2	Spectral line observations (narrow band).
	RAS	2655.0 – 2690.0 MHz	ITU-R. Rec. RA.769	Aggregate, Suburban (1b)	-110	Continuum observations (broadband).
	RAS	2690.0 – 2700.0 MHz	ITU-R. Rec. RA.769	Aggregate, Suburban (1b)	-110	Continuum observations (broadband). RR No. 5.340 applies
	RAS	3260.0 – 3267.0 MHz	ITU-R. Rec. RA.769	Aggregate, Suburban (1b)	-92.9	Spectral line observations (narrow band).
	RAS	3332.0 – 3339.0 MHz	ITU-R. Rec. RA.769	Aggregate, Suburban (1b)	-92.9	Spectral line observations (narrow band).
	RAS	3345.8 – 3352.5 MHz	ITU-R. Rec. RA.769	Aggregate, Suburban (1b)	-92.9	Spectral line observations (narrow band).
	RAS	4800.0 – 4990.0 MHz	ITU-R. Rec. RA.769	Aggregate, Suburban (1b)	-103.4	Continuum observations (broadband).
	RAS	4990.0 – 5000.0 MHz	ITU-R. Rec. RA.769	Aggregate, Suburban (1b)	-103.4	Continuum observations (broadband).
	RAS	6650.0 – 6675.2 MHz	ITU-R. Rec. RA.769	Aggregate, Suburban (1b)	-87.9	Spectral line observations (narrow band).
5	DVB-T	174-230 MHz (band III)	C/N (see ITU-R Rec. BT.1368-3 & Chester 1997 Multilateral Coordination Agreement)	Single interferer, 50 cm separation	-94	Lower limit based on indoor calculation. Note 2
	DVB-T	470-862 MHz (bands IV & V)	C/N (see ITU-R Rec. BT.1368-3 & Chester 1997 Multilateral Coordination Agreement)	Single interferer, 50 cm separation	-89	Lower limit based on indoor calculation. Note 2
6	T-DAB	170-230 MHz (band III)	C/N (see Wiesbaden 1995 Special Arrangement)	Single interferer, 30 cm separation	-97	Lower limit based on indoor calculation. Note 2
	T-DAB	1452-1492 MHz (band L)	C/N (see Wiesbaden 1995 Special Arrangement)	Single interferer, 30 cm separation	-85	Lower limit based on indoor calculation. Note 2
7	Bluetooth	2400-2483.5 MHz	C/I = + 20 dB	Single interferer, 36 cm separation	-75	Note 2

8	RLAN	5150-5350 MHz	10 % frame error	Single interferer, 36 cm separation	-68.2	Note 2
	RLAN	5470-5725 MHz	10 % frame error	Single interferer, 36 cm separation	-68.2	Note 2
9	IMT-2000	1710-1885 MHz	(see Annex 9)	Single interferer, 36 cm separation	-86.4	
	IMT-2000	1885-2025 MHz	(see Annex 9)	Single interferer, 36 cm separation	-85.9	
	IMT-2000	2110-2170 MHz	(see Annex 9)	Single interferer, 36 cm separation	-85	
	IMT-2000	2500-2690 MHz	(see Annex 9)	Single interferer, 36 cm separation	-83.1	
10	RNSS	E5: 1164-1219 MHz E6: 1258-1300 MHz L1: 1559-1593 MHz	(see Annex 2.10)	Single interferer, separation distance1m	-83.5	
11	FSS	3400-4200 MHz	ITU-R Rec. S.1432	Aggregate, urban (1c)	-77	Downlink
	FSS	4500-4800 MHz	ITU-R Rec. S.1432	Aggregate, urban (1c)	-77	Downlink
	FSS	7250-7750 MHz	ITU-R Rec. S.1432	Aggregate, urban (1c)	-77	Downlink. Military band, FSS parameters extrapolated.
	FSS	5725-7075 MHz	ITU-R Rec. S.1432	Aggregate, Global beam scenario (2bis)	*-41.3*	Uplink. (Note 1)
	FSS	7900-8400 MHz	ITU-R Rec. S.1432	Aggregate, Global beam scenario (2bis)	*-41.3*	Uplink. Military band, FSS parameters extrapolated. (Note 1)
12	Amateur	1260-1300 MHz	1 dB receiver noise level degradation	Single interferer, 10 m separation	-85.5	
	Amateur	2300-2450 MHz	“	Single interferer, 10 m separation	*-61.3*	(Note 1)
	Amateur	3400-3500 MHz	“	Single interferer, 10 m separation	-55	
	Amateur	5650-5850 MHz	“	Single interferer, 10 m separation	-51	
	Amateur	10-10.5 GHz	“	Single interferer, 10 m separation	-46	
13	Maritime	156 – 163 MHz	see Annex 13	Aggregate, Suburban (1b)	-73.5	VHF radiotelephony / DSC
	Maritime	457 – 467 MHz	see Annex 13	Aggregate, Suburban (1b)	-55.5	UHF radiotelephony
	Maritime	2900 – 3100 MHz	see Annex 13	Single interferer, 300 m separation	-58.5	S band radar. Preclude the use of UWB devices on board pending further study of the actual effect on ships radars.
	Maritime	9300 – 9500 MHz	see Annex 13	Single interferer, 300 m separation	-48.6	X band radar. Preclude the use of UWB devices

						on board pending further study of the actual effect on ships radars.
14	Aeronautical	0.255 – 0.5265 MHz		Aggregate, Suburban (1b)	-44.5	NDB (airborne)
	Aeronautical	2.85 – 22 MHz		Aggregate, Suburban (1b)	Note 4	HF Comms (ground)
	Aeronautical	74.8 – 75.2 MHz		Aggregate, Suburban (1b)	-25.8	Marker Beacon (airborne)
	Aeronautical	108 - 117.975 MHz		Aggregate, Suburban (1b)	-63.8	VOR (airborne)
	Aeronautical	108 – 137 MHz		Aggregate, Suburban (1b)	Note 4	VHF Comms, VDL Mode 4 (ground)
	Aeronautical	117.975 - 137 MHz		Aggregate, Suburban (1b)	-76.6	VHF Comms, 25 kHz AM (ground)
	Aeronautical	328.6 - 335.4 MHz		Aggregate, Suburban (1b)	-40.9	ILS Glidepath (airborne)
	Aeronautical	590 – 598 MHz		Single interferer 400m separation	-76.1	50cm Radar (ground)
	Aeronautical	940 - 1 215 MHz		Single interferer 30m separation	-61.2	DME/ TACAN (ground)
	Aeronautical	1090 MHz		Single interferer 30m separation	-71.7	Secondary Surveillance Radar (ground)
	Aeronautical	1 215 – 1350 MHz		Single interferer 30m separation	-82.4	23cm Radar (ground)
	Aeronautical	2700 – 3100 MHz		Single interferer 170m separation	-82.6	10cm Radar (ground)
	Aeronautical	1545 - 1559 & 1645.5 – 1660 MHz			Note 4	Satellite Comms
	Aeronautical	4200 – 4400 MHz		Aggregate, Suburban (1b)	-48.7	Radio Altimeters (airborne)
	Aeronautical	5030 – 5150 MHz		Aggregate, Suburban (1b)	-44.7	MLS (airborne)
	Aeronautical	5350 – 5470 MHz			Note 4	Weather Radar (airborne)
	Aeronautical	8750 – 8850 MHz			Note 4	Doppler Radar (airborne)
	Aeronautical	9000 – 9500 MHz		Single interferer 20m separation	-90.2	3cm Radar (airborne)
15	Meteorological Radar	2700-2900 MHz	I/N = -10 dB	Aggregate, Suburban (1b)	-71	
	Meteorological Radar	5600-5650 MHz	I/N = -10 dB	Aggregate, Suburban (1b)	-65	
	Meteorological Radar	9300-9500 MHz	I/N= -10 dB	Aggregate, Suburban (1b)	-60	

Notes to the Table:
Note 1: limits provided in italic were taken from the FCC mask when the study did not evaluate the maximum generic UWB PSD to achieve protection but just confirmed that the FCC limit would offer sufficient protection to the subject radiocommunication service;
Note 2: measurements were performed to take into account pulsed interference effects;
Note 3: *BWCF* of NTIA was used, this result is valid for pulsed UWB;
Note 4: this frequency band is not covered in this report and further work is needed.

In the compatibility study related to the protection of RAS stations, the derived maximum emission levels for UWB devices were stated to be below the thermal emission from a black body at 300 K. These levels are to be interpreted as the maximum allowed emission in excess of the thermal noise level at the impedance matching the antenna.

From the results shown in the table above, graphically depicted in Figure A1-1, it can be seen that the FCC Indoor UWB PSD mask does not provide adequate protection to the existing radiocommunications services. Figure A1-2 provides generic consolidated UWB PSD limits necessary to protect existing services; this is obtained by drawing the line encapsulating the most stringent PSD limits required to protect each of the victim services.

The results show:

- The majority of the considered radiocommunications services require up 20-30 dB more stringent generic UWB PSD limits than defined in the FCC masks, indoor as well as outdoor. Only a few EESS applications are sufficiently protected by FCC mask, whereas some RAS bands require 50-80 dB more stringent limits.
- The consolidated limits in figure A1-2 indicate that the generic UWB PSD limits increase with the frequency. The difference between PSD limit at 10 GHz and that at 200 MHz is about 20 dB.
- If the victim radiocommunications service is operated in an outdoor environment only, as is the case for e.g. FS, FSS, RAS, EESS etc, then the increase of noise due to the aggregate UWB interference determines the generic UWB PSD limit. In addition, if the victim radiocommunications service is also operated in the indoor environment, e.g. DVB-T, IMT-2000, RLAN etc., then the closest UWB interferer becomes the determining interference factor due to small spatial separation (small path loss).

It can also be observed that for Services using narrow band receivers with higher sensitivity more protection is required.

Figure A1-1 Generic UWB PSD limits – All Services

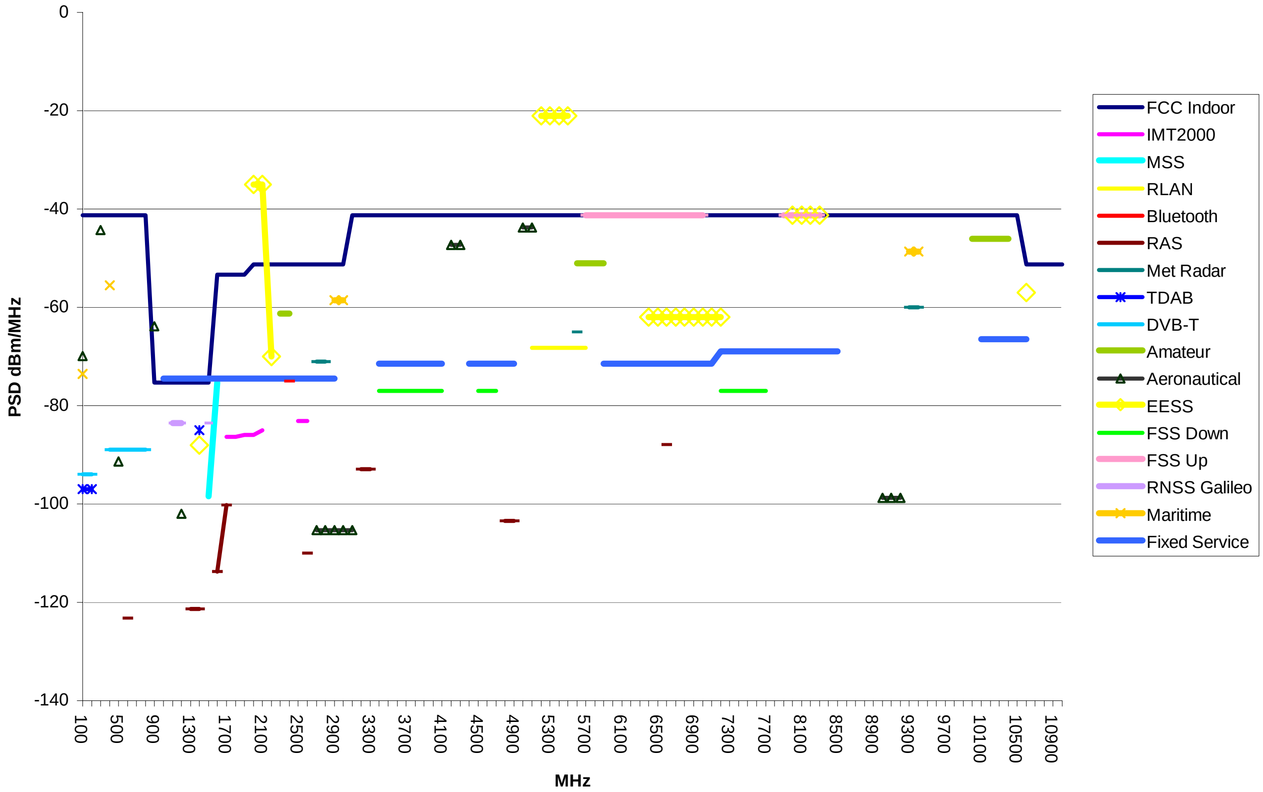
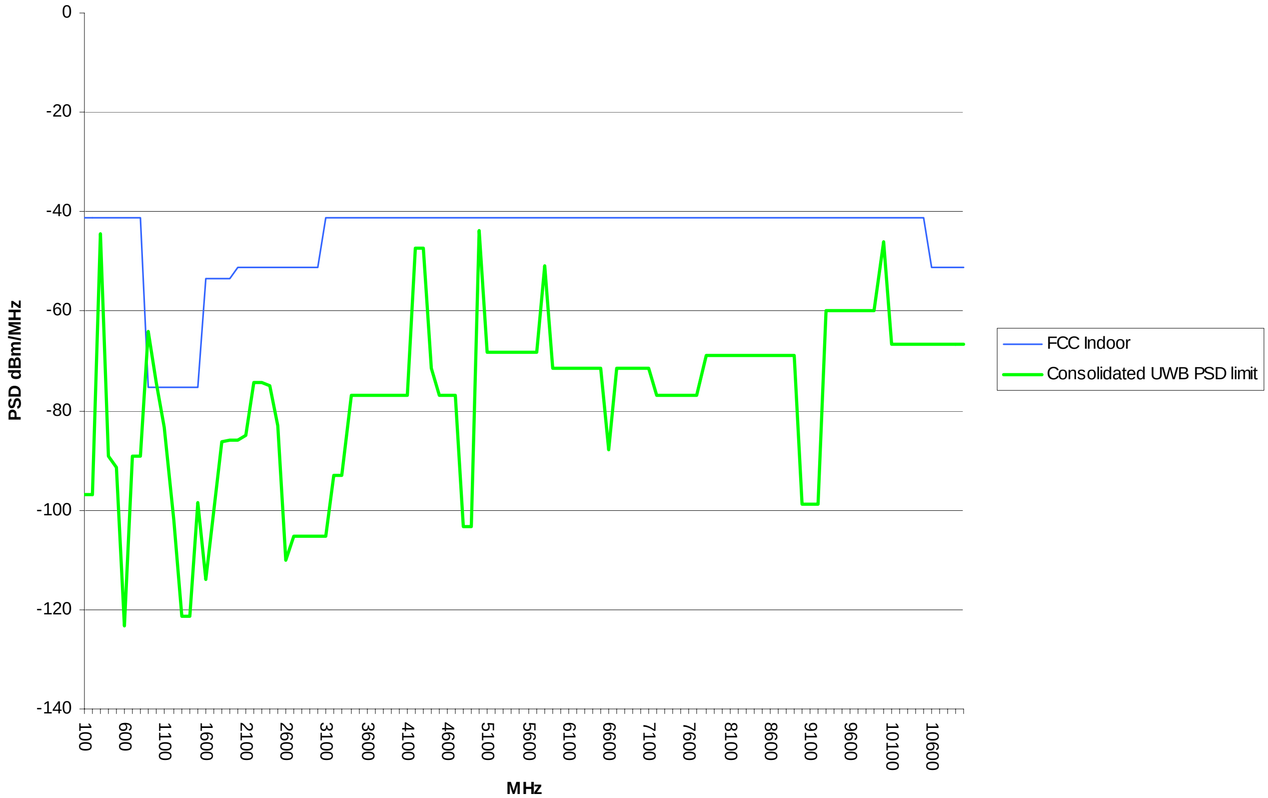


Figure A1-2 Generic consolidated UWB PSD limit and comparison with FCC indoor UWB mask



Annex 3: Comparison with non-CEPT studies

Considerations on the differences in various approaches towards compatibility studies on the protection requirements of radiocommunication systems from generic UWB applications are presented below:

Radiocommunication Service / Application	Bands of interest (Note 1)	References of non CEPT studies (FCC R&O, ITU-R TG1/8 contributions…)	Considerations on differences with the approach and results of CEPT studies
General considerations	Below 10.6 GHz	**NTIA special publication 01–43** Assessment of compatibility between Ultra-wideband devices and selected federal systems (January 2001) **NTIA Report 01-383** The Temporal and Spectral Characteristics of Ultra-wideband Signals (January 2001) **NTIA Special publication 01-45** Assessment of compatibility between ultrawideband (UWB) systems and global positioning system (GPS) receivers (February 2001) **FCC 02-48: FIRST REPORT AND ORDER** Adopted: February 14, 2002 Released: April 22, 2002 **FCC 03-33: MEMORANDUM**	The NTIA indicated that it undertook a comprehensive program consisting of measurements, analysis, and simulations to characterize the potential for compatibility between UWB transmissions and selected federal radio systems operating in the restricted frequency bands between 335.4-7250 MHz. These assessments were performed in two studies: (1) UWB compatibility with GPS receivers; and (2) UWB compatibility with selected federal radio systems. It is generally believed that the FCC limits for UWB have been primarily based on 47CFR Part 15 general emission limits. However, based on compatibility with GPS, a lower limit was in particular provided in the FCC mask for the 0.96 - 1.61 GHz band. From the FCC R&O February 2002, there is no evidence that studies other than in GPS and other Government bands have been carried on (i.e. FCC has privileged the UWB introduction against all other "non-government services"). It has to be noted that US airline and Department of Transportation officials said that NTIA Special publication 01-45 raises serious concerns about potential interference to Global Positioning Systems (GPS) that the Federal Aviation Administration plans to use for all stages of controlled flight, including landings. It might be representative the fact that, if all TG3 studies gives a more or less constant 20/30 dB difference, the levels stated (from the

			OPINION AND ORDER… Adopted: February 13, 2003 Released: March 12, 2003 **FCC 02-48: SECOND REPORT AND ORDER AND SECOND MEMORANDUM OPINION AND ORDER** Adopted: December 15, 2004 Released: December 16, 2004	only detailed study) by FCC to protect GPS are also lower, of around the same amount, than the permitted -41.3 dBm/MHz. The raw conclusion of any study would more or less be that: "if you wish to protect, on the same basis, existing services, the UWB permitted level should, in average, be close to that required by FCC for the GPS protection" (why a GPS receiver should behave differently from any other noise-limited receiver??).
1	Fixed Service (FS)	#Below 1GHz (country-specific) #1.5/2/2.5 GHz #3.4 – 8.5 GHz #10.15-10.65 GHz	None, besides the « WPAN-specific » based on IEEE 802.15.3a, presented by INTEL (not as US contribution)	Compatibility studies with the fixed service have not been published, in spite of the fact that this service is intensively used in more than half of the spectrum between 3 and 10 GHz. - WPAN IEEE 802.15.3a devices density and activity factor, stated to be significantly lower than « generic UWB application assumptions »
2	Mobile Satellite Service (MSS)		Systems considered in **NTIA special publication 01–43**: * Search and Rescue Satellite Land User Terminal * Search and Rescue Satellite Uplink	No analysis has been done for MES service links of GSO MSS Systems. Therefore, it is difficult to compare the results. Concerning Search and Rescue Satellite Systems,the methodology adopted for CEPT analysis for single entry interference is different from that of NTIA analysis. NTIA approach is based on bandwidth correction factor for different PRFs. Eventually, CEPT study addresses the impact of aggregated interference. In that case also, it is difficult to compare the results.
3	Earth Exploration Satellite Service (EESS)	All EESS bands < 10.6 GHz	No US input. Input from JAPAN for EESS(passive)	Apart from the specific case at 24 GHz (automotive SRR), the US administration has not produced any compatibility study between EESS (passive) and UWB applications. It is worth noting that many passive sensors currently in operation are provided by NASA or NOAA or mounted on US platforms. CEPT studies presented at the last ITU-R TG1/8 meeting, taking into account, among others, US instruments, have been agreed, including by the US administration,

				and incorporated within the compatibility report showing major cases of harmful interference if the FCC mask is used. For the cases of EESS and EESS (active), the only inputs are from CEPT.
4	Radio Astronomy Service (RAS)	<10.6 GHz: Used in 16 European countries	No FCC or NTIA studies made publicly available. Current TG1/8 studies comply with CEPT studies.	
5	DVB-T			
6	T-DAB			
7	Bluetooth			
8	Radio LAN	5 GHz range	Contributions to ITU-R TG1/8 (contained in 1-8/256-E Annex 5)	Measurement campaigns performed in Singapore (IDA) and Korea with IEEE 802.11a systems The results can be used for illustration but they can not be used to derive general conclusions because they do not represent critical deployment scenarios. E.g. the radio path length of the RLAN systems is about 5 m. RLAN systems are developed for much larger path length (sensitivity etc.), i.e. the signal degradation (SINR) is significantly less than defined by WP8A.
9	IMT-2000	806-960 MHz 1710-2025 MHz 2110-2170 MHz 2500-2690 MHz	Contributions to ITU-R TG1/8 (Contained in 1-8/190-E and 1-8/228-E (Were withdrawn after it had been discussed in meeting)	1-8/190-E contains a measurement campaign performed in Singapore (IDA) for both laboratory and field experiments. The laboratory tests were made on a UE device with a better sensitivity than the standardized reference receiver. Since the useful signal power at the UE was set to the value defined for the reference sensitivity test, the UWB interference tolerable value is higher than it would be for a UE device with reference receiver sensitivity. The field test indicated much higher UWB interference tolerance (compared to laboratory measurements). There are a number of reasons for this difference: - UE device were not working under worst-case conditions: even the lowest considered WCDMA pilot signal level was still 20dB above the reference sensitivity - The actual UWB interference level into the UE was not directly measured, therefore possible reasons are that

				o Multipath leads to a higher LoS propagation loss between UE and UWB. o UE device antenna gain is lower than assumed. o Polarization mismatch between UWB and UE antennas. - The tests did not consider BER degradation as the degradation criteria (as in laboratory tests) instead only the IMT-2000 base station power increase was used as the measurement indicator. 1-8/228 contains a link budget analysis of the compatibility between UWB and CDMA-2000 spread spectrum mobile stations operating in the 1930-1990 MHz band. The contribution claims that a minimum separation distance of 0.9 m is achieved using FCC mask. However, there are a number of errors in the analysis. The major issue is that the user code channel power has to be used and not the total power in this kind of link budget calculations (15.6 dB difference). Even when based on the user code channel power, the study still lacks a protection criterion and is therefore also flawed from a methodology perspective. Another issue is that the calculation is made with a mixture of standardized (agreed) values and non-agreed values (input from different US operators) The contribution was withdrawn by USA. 1-8/228 also reference some documents (from FCC, Qualcomm and Sprint) regarding UWB impact on CDMA PCS and some misconceptions about basic principles of CDMA that seem to have influenced the FCC decision regarding acceptable UWB emission levels in the PCS band. Some of these are: - PCS receivers could operate at or near the thermal noise floor. (However, due to spreading gain, they actually can operate below noise floor) - Cellular operators must plan their network with a margin (for fading, multipath, etc.) in order to ensure reliable operation. This margin would also allow the existence of UWB.

				(However, CDMA systems are designed to use the spreading gain to combat intrinsic multiple access interference and fading. It is a fundamental lack of understanding of the basic principles of CDMA to assume that this gain can be used to mitigate un-intentional in-band interference (i.e. UWB)). - Small increases in the effective noise floor (e.g. 1-2 dB) would not have significant impact. (However, a 1 dB effective noise floor increase will cause significant (about 9%) coverage degradation for indoor PCS handsets).
10	Radio Navigation Satellite Service (RNSS)		**NTIA Special publication 01-45** Assessment of compatibility between ultrawideband (UWB) systems and global positioning system (GPS) receivers (February 2001)	It has to be noted that US airline and Department of Transportation officials said that NTIA Special publication 01-45 raises serious concerns about potential interference to Global Positioning Systems (GPS) that the Federal Aviation Administration plans to use for all stages of controlled flight, including landings.
11	Fixed Satellite Service (FSS)		Systems considered in **NTIA special publication 01–43**: * Fixed Satellite Service Earth Stations Contributions to ITU-R TG1/8 (Contained in 1-8/109-E and 1-8/210-E	The separation distances for MSS feeder link earth stations are comparable to those obtained in the NTIA special publication 01-43. CEPT analysis: Min distance of about 10 km for interference from UWB transmitter with PRF of 0.001 MHz. (Non dithered and dithered peak emissions) Minimum separation distance of about 600 meters for interference from UWB transmitter with PRF of 1 MHz (Non dithered average emissions) Minimum separation distance of about 600 meters for interference from UWB transmitter with PRF of 1 MHz (Dithered average emissions) Maximum acceptable UWB EIRP at 10m distance = -86.57 dBm/MHz for 1 MHz PRF C/I criterion: -20 dB NTIA Analysis: Minimum separation distance of 12.3 km (for non-dithered emissions with UWB height device ht of 2 m);Minimum separation distance of 13.2 km (for dithered emissions with UWB device ht of 2m)- PRF of 0.001 MHz

				Minimum separation distance of 600 m for interference from average UWB emissions (both non-dithered and dithered) Maximum EIRP to meet protection criteria: -74 dBm/MHz for 1 MHz PRF C/I criterion: -10 dB The Alion's report (US) (doc 109) presented to TG1-8 an analysis on this sharing situation concluding that C-Band reception will increasingly fail due to interference arising from UWB proliferation. In document 210 presented in TG1-8, the FCC reproduced the calculation made by Alion. The interference calculated is the same as the one of the Alion's report, which is also about the same as the one calculated in the European studies. But as the interference criterion retained by FCC is of 0dB, FCC concluded that there is no impact on C-Band receiver.
12	Amateur/Amateur satellite systems (Amateur)			
13	Maritime mobile service including global maritime distress and safety system (Maritime)		Systems considered in **NTIA special publication 01–43**: * Maritime Radionavigation Radar	The NTIA publication considers the lower frequency radar only. Very similar characteristics are assumed for the radar and both studies assume a required I/N ratio of –10 dB. The CEPT study adds a further protection requirement of 6 dB to allow for aggregate interferers. The CEPT study assumes a minimum approach distance of 300m against 200m for the NTIA study. The resulting maximum permitted UWB EIRP for a dithered (noise like) signal then calculates to be similar at –57/–58 dBm/MHz. For aggregate interference the NTIA publication uses 100% activity factor whereas the CEPT studies use the lower 5%. Even so the aggregate interference values in the CEPT study are considerably

				lower than those in the NTIA publication. On examination it was found that the CEPT study is incorrect as the antenna gain had been added twice, the NTIA airborne Aggregate Model had been used which allows an interferer to approach within 15m instead of 300m and no allowance has been made for the 2^0 beamwidth of the antenna. When these corrections are made the two studies give similar results. The new results show that the single interferer is the dominant interfering mechanism. Due to the narrow beamwidth of the radar antenna the additional 6 dB protection for multiple interferers assumed in the CEPT studies is not therefore required.
14	Aeronautical mobile service and radio determination service (Aeronautical)		Systems considered in **NTIA special publication 01–43**: * Distance Measuring Equipment (airborne interrogator and ground transponder) * Air Traffic Control Radar Beacon System (ground interrogator and airborne transponder) * Air Route Surveillance Radar * Airport Surveillance Radar * Radio Frequency Altimeters * Microwave Landing System	
15	Meteorological radar		Systems considered in **NTIA special publication 01–43**: * Next Generation Weather Radar The US administration has released many US inputs concerning meteorological radars.	As an illustration of the differences between CEPT and other studies, aeronautical and meteorological radars were considered in an additional US study presented to TG 1/8 but only in the 2.8 GHz band, in which the FCC power limit is 20 dB below the one in the 5.6 GHz, and with non typical radar parameters less susceptible to interference.

Annex 3: Workplan and schedule for measurement campaigns

1 Objectives of measurement campaigns on UWB interferer

Objectives for the measurement campaign:

- Characterisation of UWB signal generated by devices representative of future applications
- UWB interferer impact on quality of Service of victim receivers
- Allow comparison with and further interpretation of compatibility study results

This UWB interferer measurement campaign is conducted for selected incumbent radio services which are UMTS, GSM1800, Fixed Services, DVB-T and T-DAB.

2 UWB interferer measurement campaigns on victim services

To cover the objectives, three measurement types are defined:

- Conducted measurements:
  - o UWB transmitter connected to victim receiver (e.g loop back test in UMTS)
  - o To verify interference effect on victim receiver performance
  - o To investigate if protection criteria used for AWGN interferers are adequate for UWB interferences
  - o Measurements Conditions and parameters to be defined (e.g BER, BLER, radio link power increase impact)
- Radiated measurements in Anechoic chamber:
  - o Measurement with antennas
  - o To characterize antenna pattern of UWB devices
  - o To verify interference effect on victim receiver performance according to various distance scenario - investigate protection distances
  - o Measurements Conditions and parameters to be defined (e.g BER, BLER, radio link power increase impact)
- In-situ measurements:
  - o To verify interference effect on victim receiver performance in selected real life conditions
  - o To investigate if protection criteria used for AWGN interferers are adequate for UWB interferences
  - o Measurements Conditions and parameters to be defined (e.g BER, BLER, radio link power increase impact)

Initial Schedule	Victim Service	UWB Interferer scenario	Measurement Campaigns			Status
			1. Conducted measurements	**2. Radiated measurements**	**3. in-situ measurements Note 1**	
17th Jan. to 4th Feb. 2005						
	Fixed Service	**Single**	**RegTP** MB-OFDM Pulsed-UWB			**Completed**
	UMTS	**Single**	**FRANCE TELECOM** MB-OFDM, Pulsed-UWB, DS-UWB	**FRANCE TELECOM** cancelled		**Completed**

	GSM1800	**Single**	**FRANCE TELECOM** MB-OFDM, Pulsed-UWB, DS-UWB	**FRANCE TELECOM** cancelled		**Completed**
7th Feb. to 21st Feb. 2005						
	DVB-T	**Single**	**TDF** MB-OFDM, Pulsed-UWB, DS-UWB	**TDF** MB-OFDM, Pulsed-UWB, DS-UWB		**Postponed To April**
	UMTS	**Single**	**Swisscom** MB-OFDM, Pulsed-UWB, DS-UWB			**Postponed to 28th Feb to 11th March**
March'05						
	T-DAB	**Single**	**TDF** MB-OFDM, Pulsed-UWB, DS-UWB	**TDF** MB-OFDM, Pulsed-UWB, DS-UWB		**Postponed To April**
	Fixed Service	**Single**			**ANFR** MB-OFDM, Pulsed-UWB, DS-UWB	**Date to be confirmed**
	FSS C band	**Single**			**ANFR** MB-OFDM, Pulsed-UWB, DS-UWB	**Date to be confirmed**
June'05						
	DVB-T	**Single**			**TDF** MB-OFDM, Pulsed-UWB, DS-UWB	
	T-DAB	**Single**	**TDF** MB-OFDM, Pulsed-UWB, DS-UWB	**TDF** MB-OFDM, Pulsed-UWB, DS-UWB	**TDF** MB-OFDM, Pulsed-UWB, DS-UWB	

Target schedule for measurement reports:

- TG3#7 end of feb'05: Intermediate activity report
- April'05 Measurement report for mobile services and fixed services
- DVB-T and in-situ measurement reports will be provided in a later stage

3 Technical support and equipments availability

In order to support and conduct these UWB interferer measurement campaigns, a measurement ad hoc group has been created and is including several TG3 members.

- UWB transmitters have been provided by industry members . On top of the provision of UWB devices, the providers insure technical support
    - Intel supports the provision of MB-OFDM devices from Wisair and Staccato communication
    - Freescale provides DS-UWB devices
    - STMicroelectronics provides Pulse modulation UWB devices
- RegTP, FTR&D, Swisscom and TDF provide certified laboratories to support the measurements
    - Anechoic chamber
- Measurement equipments and availability:
    - RegTP: frequency and time domain measurement equipments
    - FTR&D: frequency and time domain measurement equipments
    - TDF: frequency and time domain measurement equipments
    - ANFR: mobile vehicle for in-situ measurements
- Provision of victim receivers and radio service infrastructure equipments is supported by services representatives:
    - Broadcasting receivers and service access are available by TDF
    - Availability of victim receivers and availability of radio links in order to provide useful signals for GSM1800, UMTS is secured by France Telecom and Swisscom
    - The provision of FS equipments is insured by RegTP and Marconi
- Resources availability to support the measurement campaigns
    - The members provide resources to perform the measurement activities.

Annex 4: Mitigation and other interference reduction techniques

The following general techniques have been identified (or referred to in the literature) and a preliminary assessment as to their feasibility and practicality to UWB is given below. It should be noted that the relevance of implementing these techniques depends on the final results of the ECC Report.

Mitigation and other interference reduction techniques for UWB Communications				
Technique	**Advantages**	**Disadvantages**	**Comments**	**Preliminary Conclusion**
Creation of an indoor only category of UWB devices	Mitigates interference to outdoor systems.	Requires regulatory enforcement which is difficult in practice. Useful only in scenarios where outdoor use is predominant in interference level	Included in FCC Rules	Not possible to achieve adequate regulatory enforcement
Require a response from an associated device within a defined time, to ensure that UWB will not be active when no data can be transmitted.	Prevents interference from devices transmitting when out of range of other devices.		Included in FCC Rules Does not provide mitigation relative to the compatibility studies (only limits UWB transmissions in excess of the assumptions in the studies)	Believed to be feasible
Restrict outdoor use to mobile category (no infrastructure)	Prevents high activity from fixed access points outdoors	May be difficulties in implementing under EU legislative framework. Might preclude future UWB applications that would not generate significant interference. Useful only in scenarios where outdoor use is predominant in interference level	Included in FCC Rules This may be easier to enforce than indoor only category.	Further study needed

Mitigation and other interference reduction techniques for UWB Communications (continued)				
Technique	**Advantages**	**Disadvantages**	**Comments**	**Preliminary Conclusion**
Sensing and reaction to coexistent RF signals	Would enable UWB devices to avoid generating localised interference.	Difficult to implement and for UWB design Cannot prevent interference to devices that are not transmitting.		
Dynamic notching	Would enable UWB devices to avoid generating localised interference.	Difficult to implement and for UWB design Cannot prevent interference to devices that are not transmitting.		
Static notching	Can limit UWB emissions in critical frequency bands.	Feasibility depends on notch width+depth and number of notches	This may be useful if there are a small number of bands for which a lower UWB PSD is necessary.	
Static Power control		User would have no incentive to reduce power.	User controlled possible (and allowed under R&TTE)	
Dynamic link control	Minimises interference through dynamic control of bit rate and/or power.		Requires further industry assessment. Power control requires further study	
Activity factor restrictions	Would provide regulatory confidence that the activity factor used in compatibility studies would be met in practice	Might restrict UWB applications	Possible maximum activity factor value is linked to the maximum power density that would be agreed for UWB applications Requires further industry assessment Application dependent activity factor limits may be difficult to enforce under R&TTE Directive. Regulatory considerations require further study.	

Mitigation and other interference reduction techniques for UWB Communications (continued)				
Technique	**Advantages**	**Disadvantages**	**Comments**	**Preliminary Conclusion**
Limiting the spectrum available for UWB to a narrower frequency range than 3.1-10.6GHz	May avoid UWB emissions in some critical bands.	May lead different products in Europe and USA. Some applications operating in the allowed band would potentially experience interference Would delay introduction of UWB products in Europe.	The lowest 3 IEEE MB-OFDM channels are mandatory	
Limiting the sale of UWB devices operating in the whole 3.1-10.6GHz band only up to a certain date and then limit to a narrower band		May be difficult to enforce, because the future manufacturers of devices that incorporate UWB devices cannot be identified with certainty.	Similar approach has been adopted in EU for automotive radars operating at 24GHz	
Restricting the authorisation of UWB to devices complying with certain specifications	Would provide regulatory confidence about assumptions in compatibility studies.	May not be consistent with principle of technology neutrality.		

Annex 5: Impact analysis of a -55 dBm/MHz "in-band range" PSD limit for indoor equipment

This annex provides a preliminary assessment of the impact of a -55 dBm/MHz PSD limit in the band 3.1-10.6 GHz for indoor equipment on both radiocommunication services and UWB applications.

The first part presents a "simplified generic mask derived from ECC Report 64", basis for the development of the proposed mask for impact analysis.
Second part introduces the proposed mask for impact analysis and how it was built.
Preliminary impact analysis based on the -55 dBm/MHz mask is provided in appendix 1 to this annex.

This impact analysis was stimulated by studies conducted by one administration suggesting that applying an indoor limitation with a maximum UWB PSD limit of -55 dBm/MHz, in their opinion, can protect outdoor Fixed Service stations when taking into account lower activity factors (i.e. in the order of 1%).

1 Simplified generic mask derived from ECC Report 64

1.1 Principles

Based on ECC Report 64 generic limits for the protection of radiocommunication services, it is proposed to develop for regulatory reference a simple "generic mask", acting possibly as the "regulations by default". As a general principle, this mask should ensure the protection of all radiocommunication services studied in ECC Report 64. Flat limits over ultra large frequency range are to be identified as far as practical instead of having severe notches. The services for which a gap with ECC Report 64 limits occur shall be clearly identified. In that case, adequate regulatory measures should be taken to protect the endangered services.

It is recognized that studies which have been carried out are not addressing all frequency bands and all systems. Some of the systems that have not been studied, in particular military systems, may be highly susceptible to interference from UWB.

Also, as identified in various studies, such generic mask for PSD needs to be accompanied by additional requirement on either PRF values or peak power e.i.r.p. In this regard, limits which appear in some studies for low PRF (eg. below 1 MHz) have not been considered in the definition of mean power limits since it would be covered by such additional limitation in terms of PRF or peak power.

1.2 UWB PSD Limits

The following e.i.r.p. limits measured in 1 MHz bandwidth are proposed here:

	Frequency range (in MHz)	Maximum e.i.r.p. (dBm/MHz)
Range 1	Below 230 MHz	-95
Range 2	230 – 1600 MHz	-90
Range 3	1600 – 2700 MHz	-85
Range 4	2700 – 8500 MHz	-70

Range 5	8500 – 10600 MHz	-65
Range 6	Above 10600 MHz	-95

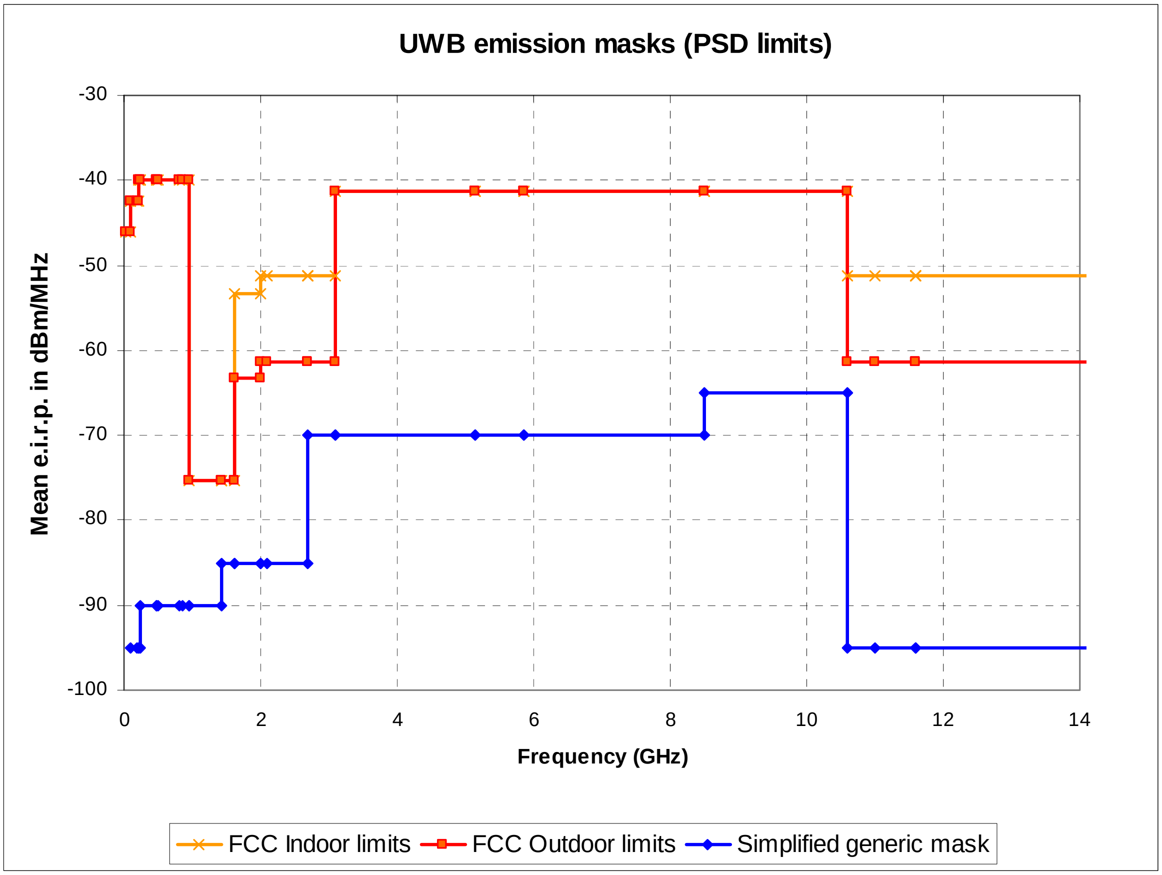
Most constraining services have been identified for the definition of this mask, allowing however an "uncertainty margin" of maximum 2 dB in some cases where the limit had been produced by an aggregate interference analysis.

The low number of frequency bands below 100 MHz studied in ECC Report 64 renders potential limits applicable below 100 MHz little representative of the interference situations that could occur. It should therefore be kept in mind that this exercise took into account only calculated limits above 100 MHz.

The e.i.r.p. limit for 'Range 2' (230 - 1600 MHz) is driven by the EESS and DVB-T studies. The upper frequency boundary set at 1600 MHz allows in particular improving the protection of MSS devices operating in band 1525-1559 MHz.
The limit for 'Range 3' (1600 MHz ≤ f < 2.7 GHz) is based on ECC Report 64 limits (calculated on a single entry basis) for in particular T-DAB, GSM, UMTS which are likely to operate in close proximity to UWB devices. It can be noted that the upper frequency boundary (2700 MHz) allows including passive band 2690-2700 MHz which is covered by RR Article 5.340.
Limits above 2.7 GHz are primarily driven by Radar, Fixed Service (inc. FWA), RLAN, and FSS.
The split at 8.5 GHz is related to the FS allocation and reflects the gain from increasing free space loss attenuation.

As for the limit above 10.6 GHz, which would in practice be applicable to "unwanted UWB emissions", it is proposed to retain, as a conservative assumption the lowest limit proposed for 'Range 1'.

A graphical representation of this "Simplified generic mask derived from ECC Report 64" is presented below.



1.3 Outstanding difficulties

A gap remains however for some services and bands between the calculated ECC Report 64 limits and this proposed “Generic mask derived from ECC Report 64". In that case, adequate regulatory measures should be taken to protect the endangered services.

Such limitations in the protection offered by the generic mask have to be clearly identified, as detailed in the table below:

Service / Applications	Lower bound	Upper bound	Aggregate / Single	Aggregate model / separation distance (m)	Report 64 PSD limit (dBm/MHz)	Proposed “CEPT mask” limit (dBm/MHz)	Margin if "not protected" (dB)	Assessment
FS	3400	4200	Aggregate	Urban (1c)	-71,5	-70	-1,50	within acceptable uncertainty margin?
FS	4400	5000	Aggregate	Urban (1c)	-71,5	-70	-1,50	within acceptable uncertainty margin?
FS	5925	7125	Aggregate	Urban (1c)	-71,5	-70	-1,50	within acceptable uncertainty margin?
FS	10150	10650	Aggregate	Urban (1c)	-66,5	-65	-1,50	within acceptable uncertainty margin?
MSS	1525	1559	Single	20	-98,4	-90	-8,40	Protected with d >= 52,61 m
RAS	All RAS bands		Aggregate	Suburban (1b)	Margin between -15,2 and -33,4 dB			Further analysis required
T-DAB	174	230	Single	0,3	-97	-95	-2,00	Protected with d >= 0,38 m

IMT-2000	1710	1885	Single	0,36	-86,4	-85	-1,40	Protected with d >= 0,42 m
IMT-2000	1885	2025	Single	0,36	-85,9	-85	-0,90	Protected with d >= 0,4 m
FSS	3400	4200	Aggregate	Urban (1c)	-77	-70	-7,00	Further analysis required
FSS	4500	4800	Aggregate	Urban (1c)	-77	-70	-7,00	Further analysis required
FSS	7250	7750	Aggregate	Urban (1c)	-77	-70	-7,00	Further analysis required
Aeronautical	2700	3100	Single	170	-82,6	-70	-12,60	Protected with d >= 725,19 m
Aeronautical	9000	9500	Single	20	-87,5	-65	-22,50	Protected with d >= 266,7 m
Meteo Radar	2700	2900	Aggregate	Suburban (1b)	-71	-70	-1,00	within acceptable uncertainty margin?

The following preliminary analysis is proposed:

- Fixed Service

Check if the 1.5 dB negative margin is within an acceptable uncertainty margin for the FS study.

- MSS

Check under what conditions a protection distance in the order of 50 m can be acceptable.

- RAS

Local solutions should be investigated to prevent UWB operations in a protection area around radio astronomy observatories.

- T-DAB

The calculated protection distance offered by the proposed “Generic mask” seems to be still acceptable (less than 40 cm).

- Meteorological radars

Check the impact of a 1 dB exceeding of protection criteria or the need for a specific separation distance.

- IMT-2000

The calculated protection distance offered by the proposed “Generic mask” seems to be still acceptable (less than 50 cm).

- FSS

Check if the occurrence of the Urban deployment scenario is realistic for FSS terrestrial stations. In the case of Suburban deployment scenario, the proposed generic limit offers sufficient protection.

- Aeronautical

Due to the localization of some radars outside the airport zone, the protection distance in the order of 700 m for band 2.7 – 3.1 GHz and 250 m for band 9 – 9.5 GHz is not acceptable. Further studies are required to ensure the protection of aeronautical services in these bands.

In performing the abovementioned analysis, it should be kept in mind that the notion of protection distance needs to be discussed in conjunction with potential means to enforce it on a regulatory basis. At this stage, such a possibility is more than likely not to be manageable.

2 UWB emission mask for impact analysis

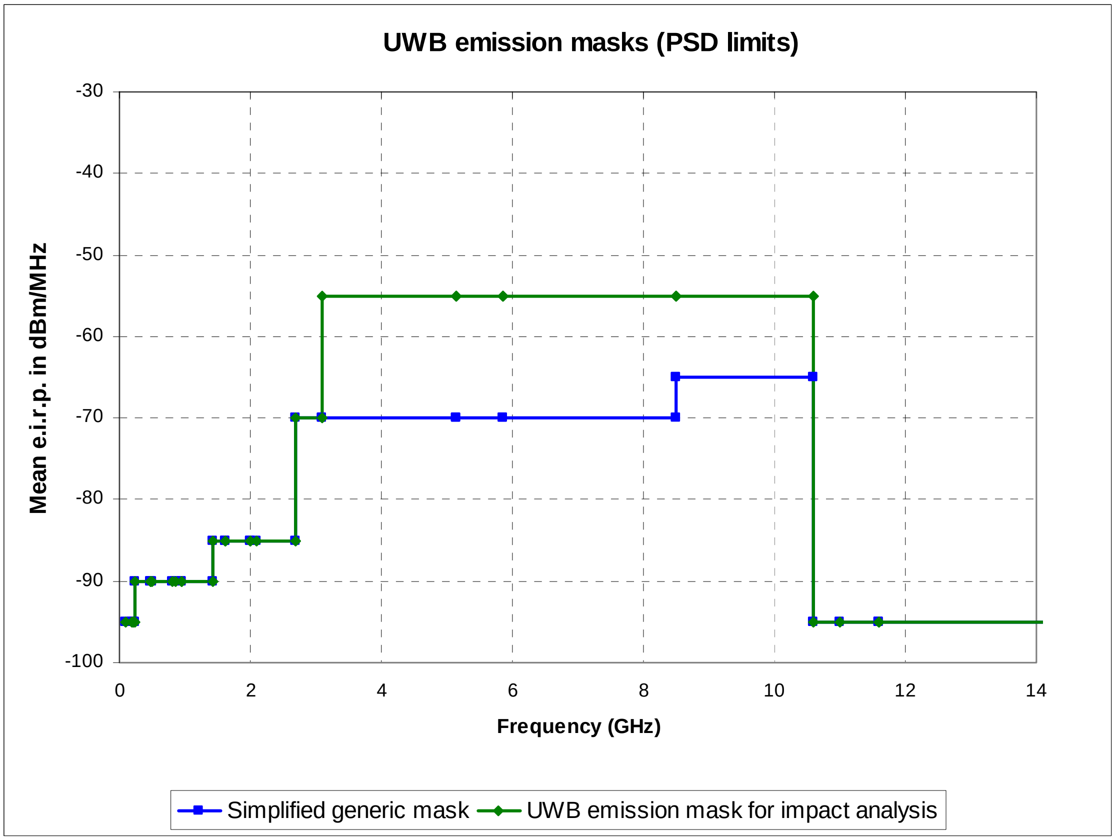
The "simplified generic mask derived from ECC Report 64" together with adequate regulatory measures to be developed - in particular to address the specific case of the Radio Astronomy service - shall ensure the protection of all radiocommunication services.

In the second step for the development of regulatory solutions facilitating the introduction of UWB communication devices, work shall concentrate on "in band" emission limits. Limits from the "Generic mask" apply by default to "Out of band" UWB emissions.

A PSD of -55 dBm/MHz for the 3.1 – 10.6 GHz "in-band range" is proposed to be considered for this impact analysis, <u>assuming in particular restriction to indoor equipment</u>.

	Frequency range (in MHz)	Maximum e.i.r.p. (dBm/MHz)
Range 1	Below 230 MHz	-95
Range 2	230 – 1600 MHz	-90
Range 3	1600 – 2700 MHz	-85
Range 4	2700 – 3100 MHz	-70
Range 5	3100 – 10600 MHz	-55
Range 6	Above 10600 MHz	-95

A graphical representation of these levels is presented below:



It should be noted that this mask is proposed in view of impact analysis on both incumbent services and UWB applications with regard to in-band as well as out-of band UWB emissions. For specific cases, this study might conclude on the need to implement notch filtering in particular frequency bands to ensure protection of the corresponding services at an adequate level.

3 Impact analysis of a -55 dBm/MHz “in-band range” PSD limit for indoor equipment

3.1 *Preliminary assessment of the impact on radiocommunication services*

The table below highlights the gap that appears for some services and bands between the calculated ECC Report 64 limits and this proposed “-55 dBm/MHz “in-band range” PSD limit ":

Service / Applications	Lower bound	Upper bound	Aggregate / Single	Aggregate model / separation distance (m)	Report 64 PSD limit (dBm/ MHz)	Proposed “CEPT mask” limit (dBm/ MHz)	Margin if "not protected" (dB)	Assessment
FS	3400	4200	Aggregate	Urban (1c)	-71,5	-55	-16,50	Further analysis required
FS	4400	5000	Aggregate	Urban (1c)	-71,5	-55	-16,50	Further analysis required
FS	5925	7125	Aggregate	Urban (1c)	-71,5	-55	-16,50	Further analysis required
FS	7125	8500	Aggregate	Urban (1c)	-69	-55	-14,00	Further analysis required
FS	10150	10650	Aggregate	Urban (1c)	-66,5	-55	-11,50	Further analysis required
EESS	5250	5570	Aggregate	Rural (1a)	-21	-55	ok	
EESS	6425	7250	Aggregate	Rural (1a)	-62	-55	-7,00	Further analysis required

EESS	8025	8400	Aggregate	Rural (1a)	*-41,3*	-55	ok	
RAS	3260	3267	Aggregate	Suburban (1b)	-92,9	-55	-37,90	Further analysis required
RAS	3332	3339	Aggregate	Suburban (1b)	-92,9	-55	-37,90	Further analysis required
RAS	3345,8	3352,5	Aggregate	Suburban (1b)	-92,9	-55	-37,90	Further analysis required
RAS	4800	4990	Aggregate	Suburban (1b)	-103,4	-55	-48,40	Further analysis required
RAS	4990	5000	Aggregate	Suburban (1b)	-103,4	-55	-48,40	Further analysis required
RAS	6650	6675,2	Aggregate	Suburban (1b)	-87,9	-55	-32,90	Further analysis required
RLAN	5150	5350	Single	0,36	-68,2	-55	-13,20	Protected with d >= 1,65 m
RLAN	5470	5725	Single	0,36	-68,2	-55	-13,20	Protected with d >= 1,65 m
FSS	3400	4200	Aggregate	Urban (1c)	-77	-55	-22,00	Further analysis required
FSS	4500	4800	Aggregate	Urban (1c)	-77	-55	-22,00	Further analysis required
FSS	5725	7075	Aggregate	Global beam scenario (2bis)	*-41,3*	-55	ok	
FSS	7250	7750	Aggregate	Urban (1c)	-77	-55	-22,00	Further analysis required
FSS	7900	8400	Aggregate	Global beam scenario (2bis)	*-41,3*	-55	ok	
Amateur	3400	3500	Single	10	-55	-55	ok	
Amateur	5650	5850	Single	10	-51	-55	ok	
Amateur	10000	10500	Single	10	-46	-55	ok	
Maritime	9300	9500	Single	300	-48,6	-55	ok	
Aeronautical	4200	4400	Aggregate	Suburban (1b)	-48,7	-55	ok	
Aeronautical	5030	5150	Aggregate	Suburban (1b)	-44,7	-55	ok	
Aeronautical	9000	9500	Single	20	-90,2	-55	-35,20	Protected with d >= 1150,88 m
Meteo Radar	5600	5650	Aggregate	Suburban (1b)	-65	-55	-10,00	Further analysis required
Meteo Radar	9300	9500	Aggregate	Suburban (1b)	-60	-55	-5,00	Further analysis required

3.2 Impact of simple mitigation measures

A preliminary assessment of the impact of simple mitigation measures such as indoor restriction and lower Pro-UWB activity factors (i.e. in the order of 1%) is provided in Appendix 1 to this Annex and includes the initial reactions from representatives of both the incumbent services and the UWB industry.

Appendix 1 - Preliminary impact analysis of a -55 dBm/MHz "in-band range" PSD limit for indoor equipment

This preliminary assessment of the impact of simple mitigation measures such as indoor restriction and lower Pro-UWB activity factors (i.e. in the order of 1%) is based on initial reactions from representatives of both the incumbent services and the UWB industry.

1 Impact on radiocommunication services

1.1 Fixed Service

We should first take in mind that a –55 dBm/MHz PSD limit, even with the other mentioned simple mitigation IS NOT ENOUGH FOR COEXISTENCE with FWA indoor terminals applications (e.g. those defined by IEEE 802.16/WiMAX Forum) and they will still experience blocking situation when a UWB is close by.
Having said that, based on the studies in Report 64, it is easy to derive the impact of the other two simple regulatory provisions on the results in scenarios 1 of Report 64:
1) forbid UWB outdoor applications
will be deprived by the outdoor contribution reducing the aggregate interference by 6.5 dB
2) assume a reduced average activity factor
provided that in Report 64 a average 5% activity factor was used, further reduction of 7 dB on the aggregation is expected.
Conclusions
The proposed UWB PSD reduction and other limitations will have the following impact on FS applications:
A) FWA indoor terminals (e.g. according IEEE 802.16/WiMAX Forum):
no change from Report 64 conclusions; even with reduced PSD, blocking situations, are still expected (at 1m distance, more than 7 dB of fade margin degradation, thus comparable with the typical operating signal level, are expected). ~13,5 dB are still missing for coexistence with respect to Report 64 assumptions (that will become ~20 dB if the more stringent protection criteria, recently defined by ITU-R WP9A, would apply). These FS applications should be better protected by introducing in UWB regulation a DFS-like mechanism with detection threshold that have to be determined.
B) Rural (1a) and sub-urban (1b) scenario situations will possibly be solved
C) Urban (1c) scenario is solved only in upper band above 7,125 GHz, while in the lower band from 3,4 to 7,125 GHz, formally 3 dB are still missing for coexistence (however, in this range, the FWA indoor coexistence problems in point A will be predominant).

1.2 GSO MSS Systems

A preliminary Impact analysis for Feeder Links of GSO MSS Systems in the downlink direction with –55 dBm/MHz mask is provided below.

The following conclusions can be drawn from the results of the compatibility analysis with regard to interference from single UWB emitter with assumed PRF not less than 1 MHz.

Separation distances (Single Entry)

- A minimum separation distance ranging from 4.0 meters to 73 meters, depending on the PRF, is required for interference from average power UWB emissions.

- A minimum separation distance ranging from 4.0 meters to 800 meters, depending on the PRF, is required for interference from peak power non-dithered UWB emissions.
- A minimum separation distance ranging from 73 meters to 800 meters, depending on the PRF, is required for interference from peak power dithered UWB emissions.

1.3 Meteorological radars

1.3.1 Background

There are currently in Europe more than 160 meteorological radars (and about 140 in the 5600-5650 MHz band) that play a crucial role in the immediate meteorological and hydrological alert processes and that roughly represent an investment of more than 400 Meuros.

As for all types of radars, such as meteorological radars, any increase of the noise at the input of the radar receiver directly translates in coverage degradation.

Taking into account an accepted I/N = -10 dB, current coverage of meteorological radars roughly extend up to 200 km.

On this basis, the following table provides for the 5600-5650 MHz band the radar losses in range and coverage versus the UWB interference and noise increase, in the range of figures as given in the compatibility studies.

Noise increase (dB)	**Corresponding I/N produced by UWB (dB)**	**Loss in coverage (km)**	**Loss in coverage (% relative to surface)**
1	-6	22	21%
2	-2.3	42	38%
3	0	59	50%
4	1.8	75	61%
5	3.3	88	69%
6	4.7	100	75%
7	6	111	80%
8	7.3	121	84%
9	8.4	130	88%
10	9.5	137	90%

It clearly shows that any increase of the interference compared to the radar interference criteria would, seriously degrade the performance of the radars (20% loss in coverage for 1 dB noise increase) or make these radars totally unusable for higher interference value.

Also, in the remaining zone were the radar will still be operational, interference increase will have an impact on the precipitation measurements that would be corrupted.

These elements demonstrate that it is not possible to give any allowance to interference produced by UWB compared to the I/N = -10 dB protection criteria and that power limits as given the current Draft ECC Report 64 are necessary to protect meteorological radars.

According to the compatibility studies and the table above relating to the radars operating in the 5600-5650 MHz band, the impact on meteorological radars would be the following:

- **With a UWB limit of -**55 dBm/MHz (noise increase of 1.5 dB) the radar **coverage degradation would be of about 30%.**
- **With a UWB limit of -**51 dBm/MHz (noise increase of 3 dB) the radar **coverage degradation would be of about 50%.**
- **With a UWB limit of** -41 dBm/MHz (noise increase of 10 dB) a **TOTAL loss of the coverage the radar would occur.**

It has to be stressed that meteorological radar networks are designed to provide a complete coverage of territories and that moving one radar will likely imply to move other radars or deploy additional radars in order to keep nominal global coverage, with related costs and operational consequences. Eventually, meteorological radars are designed to operate at low elevation in order to reach the required coverage and being able to perform precipitation and Doppler measurements at the coverage edge. Increasing the elevation of the radar to decrease the potential UWB interference would, by geometrical principle, drastically limit the radar coverage and would hence have the same effect than the UWB interference itself.

1.3.2 Band by band analysis

With regards to meteorological radars, the situation is somehow different in the 3 frequency bands:

2700-2900 MHz

The compatibility studies have concluded on the following necessary maximum power levels to protect meteorological radars :

- for Imaging applications (low density) = –**51 dBm/MHz**
- for Telecommunication (indoor) = **–61 dBm/MHz**
- for Telecommunication (outdoor) = –**71 dBm/MHz**

These levels are roughly 10 dB below the current US regulation.

For imaging application that will likely be limited in number, the maximum power level is derived from a single entry scenario and relates to in-band transmission of UWB devices that are expected to have their needed bandwidth covering the 2700-2900 MHz band. It is not assumed that such a level would constrain Imaging UBW operation.

For Telecommunications applications, the situation is different since the core band is assumed to be 3-10 GHz and hence the transmission in the 2700-2900 MHz relates to out-of-band emissions. Therefore, the above maximum power levels (-61 and –71 dBm/MHz) would not impact the transmission capabilities of Telecommunication UWB devices but would only imply more efficient filtering. Since UWB would already have, even under the US regulation, to protect other services in bands at the vicinity of the 2700-2900 MHz band at even much lower power density levels (down to –85 dBm/MHz), it is not assumed that such limit would constrain Telecommunication UWB.

5600-5650 MHz

The compatibility studies have concluded on the following necessary maximum power levels to protect meteorological radars :

- for Imaging applications (low density) = –**51 dBm/MHz**
- for Telecommunication (indoor) = –**65 dBm/MHz**

These levels are respectively 10 dB and 24 dB below the current US regulation. In particular for Telecommunication application, it is not expected that such level of gap could be filled by any mitigation technique.

In addition, it has to be noted that, following last WRC03 conclusions and related ECC decision, meteorological radars in this band, as well as all radar types in the 5470-5750 MHz band, have to share the band with RLAN application under specific regulation such as power limits, power control and Dynamic Frequency Selection (DFS).

The RLAN community has already raised its concerns with potential co-frequency operation with UWB devices, in particular concerning the implementation of DFS. Indeed, by nature, UWB transmission are likely to be seen by RLAN as "radar pulse like" transmissions that could hence disturb or even totally block the DFS implementation and efficiency to protect radars.

Apart from the impact on RLAN, this also presents a high level of risk to jeopardise the DFS feature that is the only solution to protect radars and by consequence to severely increase interference probability from RLAN to radars. Also, it cannot be neglected that, under political pressure, this situation could at the end lead to a withdrawal of the mandatory status of DFS in the 5 GHz band and would finally make that meteorological radars, and other radars would experience interference from both UWB and RLAN.

9300-9500 MHz

The compatibility studies have concluded on the following necessary maximum power levels to protect meteorological radars :

- for Imaging applications (low density) = –**54 dBm/MHz**
- for Telecommunication (indoor) = –**61 dBm/MHz**

These levels are respectively 13 dB and 20 dB below the current US regulation. Also, in particular for Telecommunication application, it is not expected that such level of gap could be filled by any mitigation technique.

The abovementioned limits for Telecommunication UWB devices is based on the aggregate scenario for suburban case. Meteorological radars in the 9300-9500 MHz are currently seen as the adequate band to improve the coverage of the radar networks deployed in the 2.8 and 5.6 GHz bands in a number of areas where precipitation detection are not satisfactory or even not manageable, due in particular to the relief.

It can hence be assumed that meteorological radars in this band would be more predominantly deployed in remote or rural areas. This could hence give a potential for relaxation of the maximum power level and, according to compatibility studies, the difference between suburban scenario and rural scenario is roughly 7 dB that means that a power density limit of –54 dBm/MHz could be adequate to protect meteorological radars, assuming a typical rural deployment.

It also interesting to note that this level corresponds to the level for Imaging that is based on single entry analysis and will hence ensure protection from 1 single UWB device used for either Imaging or Telecommunications applications.

On the other hand, it has to be stressed that there are also transportable Meteorological radars in the 9300-9500 MHz that are used on particular occasions to perform detailed meteorological and hydrological surveys. There might be situations where those radars will be located close to cities and hence would be able to operate in suburban areas. It is however expected that interference occurring in such a situation (up to I/N = -3 dB for a –54 dBm/MHz UWB limit) would be handled on a case by case basis, recognising that, by nature, these radars would be able to be relocated.

1.4 EESS

An Impact on EESS (passive) in the bands 6425-7075 MHz and 7075-7250 MHz has to be further developed.

1.5 RAS

A preliminary impact analysis on RAS is presented, based on spectrum mask presented in Table 1 below:

Table 1

"–55 dBm/MHz" spectrum mask

	Frequency range (in MHz)	Maximum e.i.r.p. (dBm/MHz)
Range 1	Below 230 MHz	-95
Range 2	230 – 1600 MHz	-90
Range 3	1600 – 2700 MHz	-85
Range 4	2700 – 3100 MHz	-70
Range 5	3100 – 10600 MHz	-55
Range 6	Above 10600 MHz	-95

Table 2 gives the spectrum mask from Table 1 given in levels above the detrimental interference levels given in Recommendation ITU-R RA.769 as a function of frequency.

Table 3 gives the reduction of RAS channel capacity as a function of frequency when for UWB devices the spectrum mask given in Table 1.

Table 2

Spectrum mask levels above ITU-R RA.769 levels as function of density ρ of UWB devices per km^2 transmitting towards a radio astronomy antenna

Radio astronomy frequency band (MHz)	Spectrum mask[8] (dBm/MHz)	Spectrum mask level above ITU-R RA.769 (dB)		
		Rural (1a)	Suburban (1b)	Dense urban (1c)
		ρ = 5 per km^2	ρ = 50 per km^2	ρ = 500 per km^2
608 – 614 [5]	-90	23.2 [4]	33.2 [4]	43.2 [4]
1330.0 – 1400.0 [5]	-90	5.4 [3], 21.4 [4]	15.4 [3], 31.4 [4]	25.4 [3], 41.4 [4]
1400.0 – 1427.0 [6]	-90	5.4 [3], 21.4 [4]	15.4 [3], 31.4 [4]	25.4 [3], 41.4 [4]
1610.6 – 1613.8 [5]	-85	5.6 [3]	15.6 [3]	25.6 [3]

1660.0 – 1670.0 [5]	-85	4.8 [3], 23.8 [4]	14.8 [3], 33.8 [4]	24.8 [3], 43.8 [4]
1718.8 – 1722.2 [5]	-85	5.2 [3]	15.2 [3]	25.2 [3]
2655.0 – 2690.0 [5]	-85	15.0 [4]	25.0 [4]	35.0 [4]
2690.0 – 2700.0 [6]	-85	15.0 [4]	25.0 [4]	35.0 [4]
3260.0 – 3267.0 [5]	-55	27.9 [3]	37.9 [3]	47.9 [3]
3332.0 – 3339.0 [5]	-55	27.9 [3]	37.9 [3]	47.9 [3]
3345.8 – 3352.5 [5]	-55	27.9 [3]	37.9 [3]	47.9 [3]
4800.0 – 4990.0 [5]	-55	27.4 [3], 38.4 [4]	37.4 [3], 48.4 [4]	47.4 [3], 58.4 [4]
4990.0 – 5000.0 [5]	-55	38.4 [4]	48.4 [4]	58.4 [4]
6650.0 – 6675.2 [5]	-55	22.9 [3]	32.9 [3]	42.9 [3]

Notes to the table: [3]: spectral line observations (narrow band)
[4]: continuum observations (broadband)
[5]: RR No. **5.149** applies
[6]: RR No. **5.340** applies
[8]: "–55 dBm/MHz" spectrum mask

Table 3

Reduction of RAS channel capacity as function of density ρ of UWB devices per km^2 transmitting towards a radio astronomy antenna

Radio astronomy frequency band (MHz)	Spectrum mask[8] (dBm/MHz)	Relative RAS channel capacity		
		Rural (1a)	Suburban (1b)	Dense urban (1c)
		$\rho = 5$ per km^2	$\rho = 50$ per km^2	$\rho = 500$ per km^2
608 – 614 [5]	-90	0.003 [4]	0.000 [4]	0.000 [4]
1330.0 – 1400.0 [5]	-90	0.887 [3], 0.613 [4]	0.080 [3], 0.019 [4]	0.001 [3], 0.000 [4]
1400.0 – 1427.0 [6]	-90	0.887 [3], 0.613 [4]	0.080 [3], 0.019 [4]	0.001 [3], 0.000 [4]
1610.6 – 1613.8 [5]	-85	0.876 [3]	0.075 [3]	0.001 [3]
1660.0 – 1670.0 [5]	-85	0.914 [3], 0.002 [4]	0.100 [3], 0.000 [4]	0.001 [3], 0.000 [4]
1718.8 – 1722.2 [5]	-85	0.898 [3]	0.085 [3]	0.001 [3]
2655.0 – 2690.0 [5]	-85	0.091 [4]	0.001 [4]	0.000 [4]
2690.0 – 2700.0 [6]	-85	0.091 [4]	0.001 [4]	0.000 [4]
3260.0 – 3267.0 [5]	-55	0.000 [3]	0.000 [3]	0.000 [3]
3332.0 – 3339.0 [5]	-55	0.000 [3]	0.000 [3]	0.000 [3]
3345.8 – 3352.5 [5]	-55	0.000 [3]	0.000 [3]	0.000 [3]
4800.0 – 4990.0 [5]	-55	0.000 [3], 0.000 [4]	0.000 [3], 0.000 [4]	0.000 [3], 0.000 [4]
4990.0 – 5000.0 [5]	-55	0.000 [4]	0.000 [4]	0.000 [4]
6650.0 – 6675.2 [5]	-55	0.003 [3]	0.000 [3]	0.000 [3]

Notes to the table: [3]: spectral line observations (narrow band)
[4]: continuum observations (broadband)
[5]: RR No. **5.149** applies
[6]: RR No. **5.340** applies
[8]: "–55 dBm/MHz" spectrum mask

Recommendation ITU-R SM.1633 explains that "*interference exceeding the protection criteria for radio astronomy by 10 dB implies that no service can be provided to radio astronomy*".

Based on the above conclusions, the introduction of a "–55 dBm/MHz" spectrum mask given in Table 1, implies that the ability for a radio astronomy station to provide service is lost in the frequency range 0.6 - 10.6 GHz.

1.6 RLAN

The analysis for RLANs in the 5 GHz range is based on the single interferer methodology in ECC Report 64. The UWB power spectral density (PSD) is determined for a spatial separation between the RLAN terminal and the UWB device. Increasing the UWB PSD from –68.2 to –55 dBm/MHz increases the required separation distance from 36 cm to 1.65 m for the same signal degradation in the RLAN system.

Dynamic Frequency Selection (DFS) implemented in the RLAN systems in the bands 5150-5350 and 5470-5725 GHz were introduced as mandatory mitigation measure to protect the co-primary Radiolocation Services by the WRC-03 and ECC/DEC(04)08, respectively. Similar mitigation measures are also now considered in relation with proposed FWA systems (WiMAX) in the adjacent ISM band 5725-5875 MHz. A rough estimation of the link budget in ECC Report 64 have shown, that if the UWB PSD is increased to –55 dBm/MHz, the safe detection of radar signals by the DFS mechanism of the RLANs is endangered seriously or even impossible in the presence of UWB close to the RLANs.

1.7 FSS

Preliminary results, in the case of indoor restriction and the use of an activity factor of 1%, shows that -55dBm/MHz in the FSS bands seems to adequately protect the FSS receiving earth stations in rural and sub-urban cases. However, the assumptions made for this assessment have to be further verified and confirmed, and relevant regulatory decisions have to ensure the applicability of such conditions (ensure the indoor restriction and ensure such a low activity factor by applying, for example, coding scheme for video streaming…). Moreover, the -55dBm/MHz psd value does not protect FSS receiving earth stations in urban case, even if, for this particular case, FSS operators could consider a degree of burden sharing, by increasing the exclusion zone around FSS earth stations. "
See document TG3#6_42R0 and TG3#7_09R0.

1.8 Aeronautical

Due to the localization of some radars outside the airport zone, a protection distance in the order of 1150 m for band 9 – 9.5 GHz is not acceptable. Further studies are required to ensure the protection of aeronautical services in this band.

1.9 Future mobile systems

Agenda Item 1.4 of the WRC-07 addresses the developments of future mobile systems (e.g. IMT-2000 and systems beyond). Currently, candidate bands are being studied within ECC PT1 and ITU-R WP8F and it is highly expected that bands in the range above 3.1 and below 6 GHz become identified bands for IMT-2000 and systems beyond IMT-2000.

Referring to the IMT-2000 studies performed in the adjacent band about 2.6 GHz in the ECC Report 64, which resulted in the UWB PSD limit of –85 dBm/MHz, the proposed limit –55 dBm/MHz would exceed the limit required for IMT-2000 by 30 dB. Even if a higher free space path loss between the UWB device and the IMT-2000 victim terminal in the range of 4-10dB were considered, the limit of -55dBm/MHz would be 20-26dB too high. Although the exact characteristics of systems beyond IMT-2000 are not yet known yet, it is likely that at least some important operation modes will be similarly susceptible to interference from UWB. Therefore, the proposed UWB limit of -55dBm/MHz could make the bands unusable for some important operation modes of systems beyond IMT-2000.

2 Impact on UWB applications

The analysis below was provided by representatives of the UWB industry.

This section shows the degradation of range (performance) for UWB devices under different propagation conditions when emitting at PSD limit: -55 dBm/MHz compared to 41.3 dBm/MHz.
It covers UWB communications equipment.

1st study (theoretical) :

Following propagation models were selected:

1. NLOS residential environments with a path loss exponent 3.5.
2. NLOS office/laboratory with a path loss exponent 2.5.
3. Dual-slope model with a break-point (BP) of 3 meters and a path loss exponent of 3.0 beyond 3 meters.

For reference, free space and propagation models from IEEE (CM) were also added.

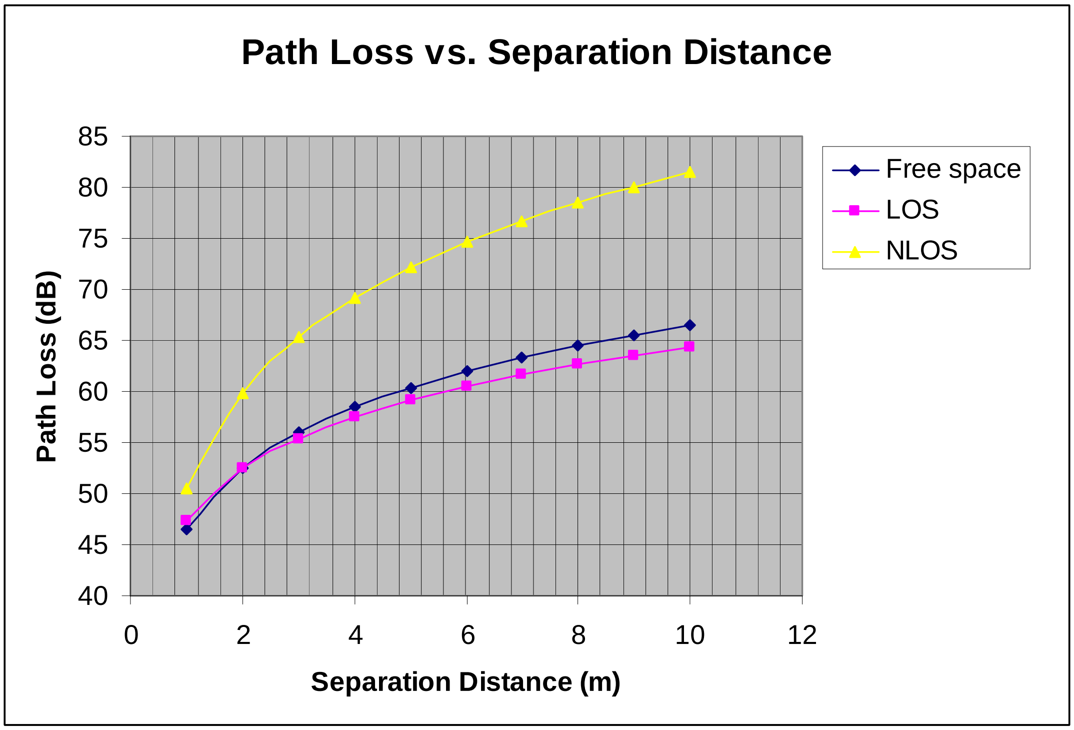
Impact of -55 dBm/MHz limit for various propagation channels

Range*	Free-space	IEEE Model (CM1)	IEEE Model (CM2)	Residential (3.5 exp.)	Office/lab (2.5 exp)	Dual-slope (3m BP)
110 Mbps (-41.3 dBm/MHz)	20.5 m	11.4 m	10.7 m	4.5 m	8.3 m	8.6 m
110 Mbps (-55 dBm/MHz)	4.1 m	2.3 m	2.1 m	2.2 m	3.1 m	3.7 m
200 Mbps (-41.3 dBm/MHz)	14.1m	6.9 m	6.3 m	3.7 m	6.3 m	6.7 m
200 Mbps (-55 dBm/MHz)	2.8 m	1.4 m	1.3 m	1.8 m	2.3 m	2.8 m
480 Mbps (-41.3 dBm/MHz)	7.8 m	2.9 m	2.6 m	2.6 m	3.9 m	4.5 m
480 Mbps (-55 dBm/MHz)	1.6 m	0.6 m	0.5 m	1.3 m	1.4 m	1.6 m

The above models are theoretical and based upon a limited number of measurements which were available at the time the models were developed.

2nd study (using more realistic path loss):

One of the more extensive recent campaigns was done by AT&T[13], which included measurements in over 300,000 channels in 23 different homes. The graph below compares the average path loss model which best fit the measurement data for ranges from 1-10 meters.



Average path loss vs. separation distance for NLOS and LOS based upon AT&T measurements

Here are the implications of the above graphic and associated real measurements:

1. NLOS average path loss can experience from 3 – 10 dB more loss compared to free space even for short separation distances of 1-4 meters.
2. If products want to address the majority of locations in the homes in this study, some margin needs to be added to account for the random log-normal shadowing of at least 4.4 dB for the NLOS locations (corresponding to just one standard deviation from the mean).
3. As a result, expected margins for reliable device operation should be at least 7.7 to 14.4 dB relative to free space propagation.

The following table shows the impact of these link margins on range for different data rates and PSD limits.

Impact of -55 dBm/MHz PSD with realistic margins based upon home measurements

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13 S. Ghassemzadeh, R. Jana, C. W. Rice, W. Turin, and V. Tarokh, "Measurement and Modeling of an Ultra-Wide Bandwidth Indoor Channel," *IEEE Trans. Commun.*, Vol. 52, No. 10, Oct. 2004, pp. 1786-1796.

Range*	Free-space	FS+ 7.7 dB Margin	FS + 14.4 dB Margin
110 Mbps (-41.3 dBm/MHz)	20.5 m	8.7 m	3.9 m
110 Mbps (-55 dBm/MHz)	4.1 m	1.7 m	0.8 m
200 Mbps (-41.3 dBm/MHz)	14.1m	6 m	2.7 m
200 Mbps (-55 dBm/MHz)	2.8 m	1.2 m	0.5 m
480 Mbps (-41.3 dBm/MHz)	7.8 m	3.3 m	1.5 m
480 Mbps (-55 dBm/MHz)	1.6 m	0.6 m	0.3 m

Conclusions from the above table:

There is a factor 5 range reduction using -55 dBm/MHz compared to -41.3 dBm/MHz PSD.

Communications over a NLOS channel is extremely challenging at the -55 dBm/MHz PSD limit. These results also do not account for additional losses due to multipath propagation. Although communications over a LOS channel may be feasible at the low PSD limits, this restriction will have a significant impact on consumer usability and applications for which UWB technology will be competitive.

Effect on applications:

Applications (home or office) have been characterized by describing both the anticipated operating range as well as moderately high throughput requirements. These are representative cases, and need to be validated with a more extensive body of use cases, as some members of the UWB proponents see a need for additional range in some cases.

Home applications

Type of application performed by the link	Average link range	File size/ streaming throughput - Mb	MAC Overhead	Instantaneous PHY Link rate
Wireless Monitor (w/compression 1Mb)	1m	8	1.15	480
HDD/External Storage (remote backups)	2m	16000	1.15	480
Scanner	2m	5.7	1.15	480
Printer	2m	9.5	1.15	480
PDA/handheld game	1m	800	1.15	480
MP3 Download (4MB/song-4min/song,128k encoding)	1m	800	1.15	480
Digital Camera Download (50% of a 64MB memory card)	1m	256	1.15	480
Camcorder Download (50% of a 24GB DV file)	1m	96000	1.15	480
Television (HD MPEG2)	2m	24	1.15	480
Home theatre speakers (384kb-1.5Mb/s)	5m	1.5	1.15	200
Game Controller (8kb)	3m	0.008	1.93	480
Personal Video Recorder	2m	10	1.15	480
Cellular Handsets	1m	256	1.15	480
PC Web Cameras	1m	1.6	1.15	480
Flash Card Readers	1m	256	1.15	480
Input Devices	1m	0.008	1.82	480
Cell phone headset	1m	0.32	1.93	480

Office applications

Type of application performed by the link	Average link range	File size/ streaming throughput in Mb	MAC Overhead	Instantaneous PHY Link rate
HDD/External Storage (remote backups)	2m	16000	1.15	480
Scanner	2m	1040	1.15	480
Printer	2m	560	1.15	480
PDA	1m	800	1.15	480
Wireless Video Projector for conference room (1Mb)	3m	1	1.15	200
Wireless Monitor	1m	8	1.15	480
Cell Phone	1m	256	1.15	480
Cell Phone Earpiece	1m	0.32	1.93	480

At -55 dBm/MHz PSD, all applications operating in excess of 2 m would be lost entirely, e.g. home applications like home theatre, game console; e.g. office application like video projectors

At -55dBm/Mhz PSD, applications operating at 2 m would be in jeopardy by having little to no margin for error, e.g. home applications like compressed video applications; e.g. office application like scanners, hard drives and printers which will be sensitive to placement.

Moreover, the current NLOS models do not take into account any type of customer behaviors like enclosing televisions and other CE stack components into entertainment centers, cabinets and racks that can be closed, like making sure to have clear line of sight.
Same applies to PC's in offices that can be enclosed in desk.

Conclusion:

At a -55dBm/MHz level, it is the opinion of UWB proponents that the technology would not be commercially viable. It is our opinion that a PSD level of -41.3 dBm/MHz is in many instances below the design limits of the systems envisioned but is sufficiently close so as to be considered possible. The number of unknowns present in the channel characteristics and in the consumer usage patterns makes it inadvisable to reduce the PSD below -41.3 dBm/MHz. We strongly advise TG3 concentrating on mitigation factors investigation and reconsidering conservative assumptions adopted in previous compatibility studies.
These areas have not yet been considered by TG3, and therefore it is premature to simply adopt a very low PSD limit without consideration of this new approach to regulate UWB technology.

The analysis below was provided by a representative of an incumbent service:

The impact of a PSD mask of –85dBm in the range 1.6GHz to 2.7GHz on UWB devices for communications applications will be small. The implementations of both the technologies being developed in IEEE 802.15.3a already can achieve this performance (or very nearly so), without taking any measures to protect radio services in this frequency range.

It therefore appears that UWB devices above 6GHz are feasible in a reasonable timescale. One company already offers UWB devices for operation above 6GHz, and several semiconductor companies have foundry processes that are capable of producing comparable devices up to at least 6GHz.

Annex 6: Future work on the development of an UWB regulatory framework

This annex has been developed by the UWB industry.

Introduction

For the robust operation of UWB communication and measurement applications and for a much needed globally compatible *UWB Regulatory Framework in Europe*, it is requested to develop a regulatory framework which would allow UWB communication and measurement applications to operate with an effective isotropic radiated power (EIRP) spectral density (PSD) limited to –41.3 dBm/MHz in the frequency range 3.1 to 10.6 GHz in Europe.
It is proposed to accommodate the recognized needs for protection of radiocommunication services from possibly harmful interference from UWB applications *by introducing certain differentiating i) regulatory, ii) operational and iii) technical (device level) measures*.
ECC TG3 should conduct further compatibility and measurement studies considering this differentiated approach, *and adopt adequate assumptions in term of deployment, propagation models, activity factors and aggregation.*
This regulatory framework would provide an UWB application/deployment differentiated approach compared to the "generic approach" conducted in previous compatibility studies. These areas have not yet been considered by TG3, and therefore it is premature to simply adopt a very low PSD limit without consideration of this new approach to regulate UWB technology.

Procedurally, after ECC TG3 has defined the PSD limits (mask) – based on a set of regulatory and operational criteria – it is proposed that CEPT/ECC (TG3) cooperates with ETSI to define and standardize mitigating measures at the detailed technical level (physical device), should such a need still arise.

The proposed approach would provide the regulatory framework and subsequent technical standards needed for an economically viable market introduction of UWB radio applications, while providing effective measures for mitigating possibly harmful interference to radiocommunication services.

3 UWB Application categories

Several major UWB communication application types have been identified:

- Devices supporting a low data rate (LDR: few kb/s to ~ few Mb/s) or localization and tracking (LT: ranging accuracy of ~1 m over a range up to several tens of meters) or a combination of both LDR and LT (LDR-LT).
- Devices supporting a high data rate (HDR: 50 to 500 Mb/s) for high speed file transfer and video applications.
- Devices supporting a very high data rate (V-HDR: >500 Mb/s) for high speed large file transfer and high capacity video applications.

For future work, a clear differentiation by UWB application and deployment is recommended:

- High and Very High Data Rate WPAN applications mainly deployed in indoor environment or on handheld devices,
- Low Data Rate and LT applications deployed indoor and outdoor

This document, proposes a way to progress towards the above goals. By splitting the classes of UWB regulation by device category, and proposing regulatory, operational and technical means of limiting the harmful interference of UWB systems, it will allow the timely introduction of these systems. If in due course, the regulation that is derived from these specifications is found to be conservative then some of the constraints on UWB systems might be relaxed.

High data rate WPAN applications:

It is proposed to develop a regulatory and standardization framework with the following domains:

- Regulatory domain
- Operational domain
- Technical domain (at device level)

Adequate assumptions for further compatibility and measurement studies will be adopted taking into account the impact of each measure adopted in the various domains in order to limit harmful interference from UWB applications on radiocommunication services.

Regulatory domain:

In a first instance, limit initial studies to the frequency range of 3.1 to 5 GHz

In order to allow HDR devices to operate with an effective isotropic radiated power (EIRP) spectral density (PSD) limited to –41.3 dBm/MHz it's proposed that the 'in-band' frequency range under consideration could be reduced from the current 3.1-10.6 GHz to a range of 3.1-5 GHz, and out of band emissions would be defined below 3.1 GHz and above 5 GHz.
This limitation would reduce the number of potentially affected victim services, to four current services:

- Fixed services,
- Fixed satellite services,
- Radio astronomy services,
- Aeronautical services.

This range is based upon the current operational range of devices developed by the majority of UWB proponents, and for which it is envisaged to implement features compliant with the proposed regulatory measures in order to complement regulatory rules being considered up to now (e.g FCC limits).

Limiting the scope for immediate studies to the frequency range from 3.1 to 5 GHz will ensure the completion of these initial studies in a timely manner.

Extension to 10.6 GHz could be considered at a later time.

Introduce an Indoor deployment limitation

In addition to the defined PSD limits, regulatory measures should include application and deployment specific constraints, and for High and Very High Data rate WPAN applications, a deployment limitation to indoor environments should be specified, by precise measures such as:

- No outdoor infrastructure for High and Very High Data rate WPAN systems

This would further reduce the impact on potentially affected victims by limiting outdoor activity to infrequent peer to peer exchanges between handheld devices.

Operational domain:

In this category, are system level solutions providing operational and interoperability functions based on realistic deployment and coexistence. Certain alternate techniques at a system's operational level will be considered, since the potential for effective mitigation is rather sizable at these levels. The most viable (based on complexity and cost estimation) measures are:

- Radio access schemes (TDMA): Within such network cells, *only one UWB device is allowed to transmit at any given time*. This relatively simple measure effectively limits signal aggregation within a piconet or cell area of typically up to a few 100's m^2.
- The "*10 seconds rule*" (Transmission stops after [10sec] if no response to ARQ): In this case, any device that is unable to establish a connection with an associated receiver in a piconet (or network cell or subnet) within 10 seconds should cease to transmit until a later time period.
- Introduction of limits on UWB device activity, according to UWB device classification (very high bit rate, high bit rate, low bit rate)

This will reduce the level of aggregated UWB signals and the interference risk to incumbent services.

Technical domain (physical device):

Typical solutions would reduce UWB device emissions, while keeping the overall system performance compliant with the application needs and use cases (throughput, coverage, QoS).

These requirements include generic mitigation techniques that require radio technology dependant solutions and could impact the MAC and physical layers. The most viable (based on complexity and cost estimation) are:

- Transmission Power Control (TPC): Limit transmitted power to the minimum required to meet the requirements of the associated application.
- Coordinated and uncoordinated quiet periods: Periods of no UWB transmissions are provided on a regular basis to allow other services to have full access to the spectrum.
- Definition of application specific requirements such as compression rates (video streaming, multimedia content transfer, etc…) in order to reduce the air traffic rate.

These measures would reduce the level of aggregated UWB signals and would further reduce the interference risk with incumbent services.

Additionally, dedicated mitigation techniques could be proposed when no other solution has proven to be suitable, and eventually, the investigation of techniques such as static frequency shaping should be carried on, mainly in the case of coexistence with future indoor fixed and mobile services.

Due to the increased system complexity required to support these features, a viable technical approach could be to support these measures only by capable devices (defined as masters), and not supported by all UWB devices. This would imply that these devices should coordinate the activities of slave devices to comply with these requirements.

The definition of such requirements should be mandated by regulatory rules, but the technical feasibility studies should be conducted within standardization (or "harmonized standardization") bodies.

Revision of compatibility studies:

This differentiated approach, modifies the compatibility study assumptions for propagation models, activity factors and aggregation.

The major areas of revision for new compatibility studies:

- Path loss models: The work in TG3 employed path loss models which emphasized conservatism and do not necessarily reflect restrictions on devices to primarily operate indoor. It is possible to select alternative path loss models which accurately reflect the interference environment.
- Activity factors: TG3 reached conclusion on activity factor estimates after the close of Report 64. These estimates should be incorporated into existing simulations. Simulations could then use common assumptions.
- Mitigation factors: The effects of UWB upon victim services were calculated without incorporation of potential mitigation techniques. Existing simulations for the 4 victim services would be recomputed with a base set of mitigation techniques as a starting point. These would include elimination of fixed outdoor infrastructure, a 10 second rule on beaconing without association, radio access schemes (TDMA), coordinated and uncoordinated quiet periods, and activity based on device classifications.
- Single Entry Assumptions: A 100% activity is assumed in all Single Entry calculations. These assumptions could be revisited with a recognition that devices will not be operational 100% of the time.

Low Data Rate and LT applications:

In order to allow LDR-LT UWB devices to operate with an effective isotropic radiated power (EIRP) spectral density (PSD) limited to –41.3 dBm/MHz in the frequency range 3.1 to 10.6 GHz in Europe, it is proposed to develop a regulatory and standardization framework with the following domains:

- Regulatory domain
- Operational domain
- Technical domain (at device level)

Adequate assumptions for further compatibility studies will be adopted taking into account the impact of each measure adopted in the various domains in order to limit harmful interference from UWB applications on radiocommunication services.

Regulatory domain:

It is proposed that regulatory measures should include a deployment differentiation between a lower band (3.1 to 5 GHz) and an upper band (6 to 10.6 GHz). These two different approaches are defined here below:

- Use of the lower band between 3.1 and 5 GHz for the deployment of indoor and outdoor LDR-LT devices compliant with operational modes allowing the protection of specific incumbent services deployed in this frequency range.
- Use of the upper band between 6 and 10.6 GHz for the deployment of indoor and outdoor LDR-LT devices compliant with operational modes allowing the protection of specific incumbent services deployed in this frequency range.
- No emission between 5 and 6 GHz.

Operational domain:

In this category, are system level solutions providing operational and interoperability functions based on realistic deployment and coexistence. Certain alternate techniques at a system's operational level will be considered, since the potential for effective mitigation is rather sizable at these levels. The most viable (based on complexity and cost estimation) measures are:

- Radio access schemes (TDMA): Within such network cells, *only one UWB device is allowed to transmit at any given time*. This relatively simple measure effectively limits signal aggregation within a piconet or cell area of typically up to a few 100's m^2.
- The "*10 seconds rule*" (Transmission stops after [10sec] if no response to ARQ): In this case, any device that is unable to establish a connection with an associated receiver in a piconet (or network cell or subnet) within 10 seconds should cease to transmit until a later time period.
- Data rate limitation: Introduction of limits on UWB device activity, according to the class of devices (access point, nodes).
- Duty cycle limitation: Introduction of limits on UWB device activity, according to the frequency range where the UWB is operating

While the first three measures (TDMA access, "10 second rules" and data rate limitation) are generic mitigation techniques, the last one, duty cycle limitations would be specific for each frequency range.

Technical domain (physical device):

Typical solutions would reduce UWB device emissions, while keeping the overall system performance compliant with the application needs and use cases (throughput, coverage, QoS).

These requirements include generic mitigation techniques that require radio technology dependant solutions and could impact the MAC and physical layers. The most viable (based on complexity and cost estimation) are:

- Transmission Power Control (TPC): Limit transmitted power to the minimum required to meet the requirements of the associated application.
-

This measure would reduce the level of aggregated UWB signals and would further reduce the interference risk with incumbent services.

The definition of such requirements should be mandated by regulatory rules, but the technical feasibility studies should be conducted within standardization (or "harmonized standardization") bodies.

Revision of compatibility studies:

This differentiated approach, modifies the compatibility study assumptions for propagation models, activity factors and aggregation.

The major areas of revision for new compatibility studies:

- Activity factors: TG3 should adopt specific activity factors considering the limitation of duty cycle and data rate.

- LDR-LT device density: The limited range of application envisaged for LDR-LT implies to revise the density assumptions in line with new deployment scenario.

Conclusion:

These recommendations propose a base on which to implement a regulatory framework taking into account UWB application requirements and proposing the investigation of specific UWB deployment limitations in order to reduce UWB interference with incumbent radio services.

It is believed, the directions for future work proposed here will allow the development of a regulation framework for UWB that fulfils the following criteria:

- Reduce interference risk to acceptable levels, although this cannot be zero.
- Allow the applications that will exploit UWB to be introduced under conditions that the market will adopt.
- Not impose or pretend to know the best technology, allowing innovation.

Allow improvements to occur with manufacturing and market experience, together with acceptable levels of financial return on investments.

While *regulatory domain measures* have to be clearly considered by CEPT, the availability of technical features (e.g, by ETSI) required to support the measures defined by operational and technical domains is a prerequisite for conducting such a regulatory framework. . Thus, there is a need to:

- First establish a *Regulatory Framework* (ECC TG3) based on agreed technical and operational assumptions (regulatory domain and operational domain measures);
- Define technical mitigation techniques within a *Standardisation Framework* (ETSI) to insure equipment compliance under this regulation (operational domain and technical domain measures).

Annex 7: EC Mandate on UWB

MANDATE TO CEPT TO HARMONISE RADIO SPECTRUM USE FOR ULTRA-WIDEBAND SYSTEMS IN THE EUROPEAN UNION
FINAL VERSION

Title

A 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.

Purpose

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

Justification

UWB technology may provide a host of applications of benefit for the implementation of various EU policies. However, its characteristic broad underlay over spectrum already used by other radio services may also have an impact on the proper operation of radio services of significance for the successful implementation of EU policies. It is therefore important to establish conditions of the use of radio spectrum for UWB which will allow UWB to be introduced on the market as commercial opportunities arise, while providing adequate protection to other radio services.

Furthermore, economies of scale and consequent benefits to the consumer will only accrue if an effective single market for these applications is set in place by harmonising spectrum usage rules across the EU. This approach will also address the fact that the expected mobility of UWB devices would likely render the enforcement of divergent national regulations impracticable.

Considering the potential impact of UWB regulation on a high number of EU policies and initiatives, this Commission mandate aims to ensure that the technical work already underway or planned by CEPT will fulfil EU policy requirements, as well as to formally align spectrum access harmonisation activities with standardisation work being carried out by ETSI in response to Commission Mandate M/329.

Order and Schedule

1. CEPT is hereby mandated to undertake all relevant work to identify harmonised conditions of use of radio spectrum for ultra-wideband applications in the European Union. A high degree of consideration shall be given to the interests of all parties involved, including the existing services in the bands which could be employed for ultra-wideband applications. At the same time, this must be balanced with the overall requirement of avoiding undue regulatory delays in the development and introduction in the European Union of new technologies, such as UWB.

To do so, the technical feasibility of coexistence of UWB applications with existing and planned radio services shall be explored in detail. The near-totality of UWB applications are expected to be operated without requirement for an individual right to use radio spectrum ("licence-exempted") and on a "no protection, no harmful interference" basis. In order to compute "safe" operating parameters for UWB in the European Union, future individual and aggregation effects of UWB devices should be fully considered and operational mitigation techniques explored.

At the same time, usage and power level constraints proposed in the light of all the possible factors affecting the degree of harmful interference from UWB to other services ought to remain proportionate, taking into account that many sources of radio "white noise" already exist, in particular in indoor environments.

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 UWB. However, the protection of other radio users should be ensured, by considering the European specificities in spectrum use compared to other regions of the world.

This mandate is intended to provide a general framework for the development of a common European position on UWB, and to consider all possible UWB types of applications (i.e. communications, imaging, surveillance, etc.), except automotive short-range radar, for which a separate Commission mandate has already been issued to CEPT (see RSCOM 03-37).

In scheduling the work, CEPT is requested to take into account the state of progress in the development of UWB standards and the fact that sharing studies have been focussed until now on communication applications operating between 1 and 6 GHz. It is therefore expected that under this Mandate CEPT will finalise its activities in this area and in this range at first, while addressing other possibilities, both concerning other applications and other frequency ranges. Depending on developments of UWB technology, more mandates may be required subsequently.

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

- undertake all the necessary technical compatibility work between UWB systems and potentially affected radio services required to develop a harmonised regulation for the use of radio spectrum for UWB in the European Union; including
    - scheduling and prioritising activities under this mandate to reflect the work already undertaken in this area; justifying this selection on the basis of clear criteria, notably industry demand and potential impact of UWB applications on EU policies;
    - determining the frequency range(s) it wishes to focus upon first, and justifying this selection on the basis of clear criteria; studying the possible use of additional frequency ranges in the future;
- identify the technical parameters of UWB systems to be included in the overall harmonised regulatory approach; for this, work in close collaboration with ETSI, in its development of harmonised standards for UWB pursuant to Commission Mandate M/329; in this context, consider where design guidelines for existing and new radio standards could improve suitability of spectrum for underlay by UWB devices;

- identify the conditions of use of radio spectrum by UWB required to protect other radio services from harmful interference[14], including the potential impact of UWB out-of-band emissions on other services. Give due consideration to appropriate measurements techniques for UWB emission, as well as to the use of mitigation techniques compliant with the application of EC law;

- consider the existing and developing regulatory environment, in particular on-going ITU activities, and the extent of convergence which is feasible with non-EU regulation. The application across the EU of ITU RR article 4.4, but also the implications of UWB emissions in frequency bands covered by ITU RR footnote 5.340, should also be studied;

- report on actual or planned real-life testing within the European Union; consider the possible benefits of experimental rights to use radio spectrum (or licences) for UWB applications[15];

- consider the designation of one or more harmonised frequency band(s) for generic or specific UWB uses; the choice of particular technical conditions of use applicable to UWB in this/these band(s) shall be duly justified. Alternatively, technical “options” shall be provided for discussion and approval by the Radio Spectrum Committee.

- consider 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 services.

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
July 15th 2004	First Report from CEPT to the Commission	Description of initial work undertaken under this Mandate and schedule for future work.
Nov 15th 2004	Interim Report from CEPT to the Commission	Description of first phase of work finalised under this Mandate and orientation for second phase.
April 2005	Final Report from CEPT to the Commission	Description of work undertaken and results achieved under this Mandate. Suggestions for further work.

[14] As defined in ITU RR 1.169

[15] In this and other relevant areas of the Mandate, the Commission will encourage CEPT to make use of on-going activities and know-how of EU RTD projects on UWB.

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.

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, where relevant, take the utmost account of Community law applicable.

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[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.

Annex 8: Statements

Statement made by the UWB industry on ECC Report 64 and proposal for an alternate regulatory framework approach.

Most results on the generic UWB PSD limits (i.e., the maximum effective isotropic radiated power of UWB devices measured in dBm/MHz) reported in the CEPT/TG3 studies on UWB radio compatibility with various radiocommunication services, as summarized in Fig. 8-1 of Draft ECC Report 64, are drastically lower than the FCC/Part 15 limit of –41.3 dBm/MHz within the frequency range 3.1 GHz to 10.6 GHz, where the industry expects the large majority of UWB communication and measurement devices to operate.
Based on the broad experience gained during the last few years (a) by the participation in relevant UWB standardization bodies and (b) from the development of first generation UWB devices, the industry's viewpoint is that the applications listed in Section 2 of Draft ECC Report 64 can only be realized provided that the UWB link's power budget is adequate to develop both technically and economically viable product and application solutions.
Type 1 applications (Communications and Measurement Systems for Consumer and Business, etc.), with at least 110 Mb/s at 10 m per the IEEE 802.15.3a standard requirements can only be achieved with an emitted UWB signal power that is equivalent to an effective isotropic radiated power (EIRP) spectral density near –41.3 dBm/MHz.
UWB emission limits below this level would prevent the development of an economical viable European UWB radio ecosystem.
Given the significant discrepancy between the approach taken towards the coexistence studies as reported in Draft ECC Report 64 and the consensus opinion within the Industry, we recommend that all interested parties shall consider novel and more open approaches to protect adequately (but not excessively or exclusively) incumbent radiocommunication services, by adopting a more forward looking approach towards coexistence issues, based on realistic deployment scenarios for both UWB devices and incumbent services. A proposal for an alternate regulatory framework approach is proposed to start investigations of regulatory limitations that would allow reduction of UWB interference to incumbent radio services.

Statement made by some administrations on the proposed UWB emission mask and the associated impact analysis

Sweden proposed, in order to guide the ECC/EC in the Decision on future UWB-regulation in a balanced way, a framework based on three options considering different UWB-emission masks plus consequences/impact primarily based on the outcome of the compatibility study performed in ECC Report 64.
In particular, Sweden pointed out the need of flexibility concerning the proposed "impact-analysis" model in terms of breakpoint in frequency and emission levels in the band 3,1-10,6 GHz where the preference is a breakpoint of 6 GHz with an UWB-emission level sufficiently stringent (-70 dBm/MHz) in order to protect radiocommunication services, in particular existing indoor systems such as FS(FWA), RLANs which deployment is likely to be in close proximity to UWB communication devices and possible future4G-system in the range 3,1-6 GHz.

Considering the tight time schedule and the need of further studies, in particular the investigation of the impact of various UWB- mitigation techniques, Sweden is of the opinion that any proposed mask at this stage should be viewed as a time-limited interim solution pending ongoing activities such as WRC-07 AI 1.4.
Concerning the long-term solution, the Swedish preference for UWB-applications is significantly higher frequency bands compared to the currently considered range up to 10.6 GHz.

France highlighted the specific case of the frequency band 5.15 – 5.85 GHz. The UWB community has already mentioned that this band would likely not be used by UWB in view of the difficulty of coexistence between UWB and RLAN. This could be translated in the regulation by imposing a sufficient stringent value (-70 dBm/MHz) in this band that would on the one hand solve the UWB community concern with regard to RLAN and, on the other hand, would facilitate the work of ECC, by already excluding a frequency band in which several non-compatibility scenario have been reported.