Integrated Project - EUWB

Contract No 215669

Deliverable

D9.2c

Regulation and standardisation plan (final version)

Contractual data:	**M40**
Actual data:	**M40**
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Work package:	**WP9**
Security:	**PU**
Nature:	**Report**
Version:	**1.0**
Total number of pages:	**45**

Abstract

The present document provides the updated regulation and standardisation plan for the work items on which the different WPs and project member have worked on.

It is the final version and reflects the status of the standardisation of application of applications using the Ultra Wide Band technology. The further activities in regulation and standardisation will be planned based on this living report.

Keywords

UWB, standardisation, regulation, ETSI, CEPT, APT, FCC, ITU

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Abbreviations

APT	Asian Pacific Telecommunity
CEPT	Committee on European Postal Regulations
DAA	Detect And Avoid
EC	European Commission
ECC	European Communication Committee
EIRP	Equivalent isotropically radiated power
ERO	European Radiocommunication Office
EUWB	CoExisting Short Range Radio by Advanced Ultra-WideBand Radio Technology
FCC	Federal Communication Commission
IDA	Infocomm Devlopment Authorithy
ITU	International Telecommunication Union
LBT	Listen Before Talk
LDC	Low Duty Cycle
LDR	Low Data Rate
MB-OFDM	Multi-Band OFDM
OFDM	Orthogonal Frequency Division Multiplexing
RSC	Radio Spectrum Committee
SRDoc	System Reference Document
UWB	Ultra-Wideband
UWB-RT	Ultra-Wideband Radio Technology
WGFM	Working Group Frequency Management (sub group of CEPT ECC)
WGSE	Working Group Spectrum Engineering (sub group of CEPT ECC)
WiMAX	Worldwide Interoperability for Microwave Access
WiMAX UL	WiMAX Uplink

1 Executive summary

This regulation and standardisation plan is created based on the status report (D9.1).

It reflects the regulation and standardisation situation in July 2012 on a world wide basis.

It is structured according to the applications and research areas covered in EUWB. It was updated on a regular basis on inputs from the EUWB WPs and running external regulatory and standardisation activities.

The further activities in regulation and standardisation after closing of the EUWB project will be based on this report.

The fulfilled actions for standardisation and regulation of the four EUWB application platforms and the Cognitive Radio principle as listed below are described:

1. "UWB in the Public transport", e.g. airborne UWB applications (WP8a). EADS (AIRBUS):
2. "UWB in the automotive Environment", (WP8b), BOSCH
3. "UWB in the Home Entertainment" (WP8c), PHILIPS:
4. "UWB in Heterogeneous Access Networks" (WP6), TELEFONICA
5. "Cognitive Radio and Coexistence" (WP2), CNET

Further on the status of the activities will be stated out.

This is: for all above mentioned items the necessary actions are addressed in the relevant European boards for frequency allocation and or standardisation.

The process is described in Annex I "Description of work" in the grant agreement of the EUWB project (vers. 17+, Fig. 26, page 63).

It has to be mentioned that the regulatory activities on "UWB onboard aircraft" are not finished yet.

It is not up to the project to define or enforce regulatory processes in national administrations or international regulation authorities (FCC, APT, CEPT).

2 Definitions

The use of "shall", "should", "must", "will" and "may" shall observe the following rules:

- The word SHALL in the text denotes a mandatory requirement. Departure from such a requirement is not permissible without formal agreement.
- The word SHOULD in the text denotes a recommendation or advice on implementing such a requirement of the document. Such recommendations or advices are expected to be followed unless good reasons are stated for not doing so.
- The word MUST in the text is used for legislative or regulatory requirements (e.g. Safety) and shall be complied with. It is not used to express a requirement.
- The word WILL in the text denotes a provision or service or an intention in connection with a requirement of this document.
- The word MAY in the text denotes a permissible practice or action. It does not express a requirement.

3 Introduction

The introduction of a new radio technology, especially when it is a wide band technology which works as an underlay radio application has to take into account the existing regulatory frame works and frequency allocations in the different regions of the world (ITU Region 1 – 3).

Inside EUWB the different WPs are working on different aspects leading to deliverables which must fulfil at the end of the project regulatory and standardisation requirements which are the precondition for a possible market launch of UWB devices.

With priority the European relevant requirements are taken into account having in mind the different requirements in other countries outside Europe.

Besides scientific studies which guides industry partners to gain competitiveness with their UWB applications the results are four application platforms and one medium access principle which have the request to be regulated and/or standardised:

1. "UWB in the Public transport", e.g. airborne UWB applications (WP8a). EADS (AIRBUS):
2. "UWB in the automotive Environment", (WP8b), BOSCH
3. "UWB in the Home Entertainment" (WP8c), PHILIPS:
4. "UWB in Heterogeneous Access Networks" (WP6), TELEFONICA
5. "Cognitive Radio and Coexistence" (WP2), CNET

Beside the application platforms (1-4) which lead to demonstrators, the work package on "Cognitive Radio and Coexistence" (5, WP2) enable the paradigm shift for UWB communications, supporting the transition from the conventional concept of underlay radio to a context-aware Cognitive Radio (CR) approach. A cognitive UWB-Radio shall be capable of interacting with the surrounding wireless environment, taking autonomous and intelligent decisions and adapting its operating behaviour to coexist with various (heterogeneous) networks, in order to minimise the mutual interference.

Here the mechanisms and parameter have been proposed, considered by the regulatory bodies (CEPT) and standardised in a harmonised standard by ETSI.

These 5 items are based on inputs coming from other work packages and are the major areas on which regulatory and standardisation activities have to be applied.

4 Planning for the application platforms

4.1 Global planning considering

All UWB applications in Europe which have a need for standardisation are handled in ETSI Technical Committee TC ERM.

Inside TC ERM a Task Group (TG UWB) deals especial with applications using UWB technology.

The chairman of TG UWB is coming from EUWB partner Bosch. This leads to the fact that all relevant UWB application standardisation have been controlled by the EUWB partner BOSCH.

As one positive effect it can be mentioned, that this construction will be kept alive after the closing of EUWB.

Furthermore BOSCH was and will be constantly present in the relevant CEPT panels like WGSE with its subgroups and WGFW with its subgroups to promote these work items coming from present and future stakeholders using the UWB technology.

This offers a certain influence capability of the overall planning inside and between the European boards responsible for the standardisation and regulation.

Status of work in ETSI TG UWB (July 2011)

4.1.1 "UWB in the automotive Environment", (WP8b), BOSCH and "UWB in the Home Entertainment" (WP8c), PHILIPS

Both applications are summarised and described in one System Reference Document (SRDoc). ETSI TR 102 495-7.

"Locations tracking and sensor applications for automotive and transportation environments operating in the frequency bands from 3.1 GHz to 4.8 GHz and 6 GHz to 8.5 GHz".

Planning milestones for this SRDoc:

- Start of activities in ETSI: November 2007
- Amended with the inputs from EUWB and release for publication in Dec2008
- New WI for standardisation in TG31C: February 2009

  Work done: Creation of an updated version of TR 102 495-7. Technical characteristics for SRD equipment using Ultra Wide Band Sensor technology (UWB); System Reference Document as in TR 102 495-7 V1.1.1 was updated in order to harmonise power spectral density values with the ongoing ECC investigations and the updated EC regulation.
- SRDoc approved by ETSI ERM for publication (PU) in November 2009
- Approval of requested WI for a Harmonised Standard (EN 302 882) November 09

  Content: Creation of new EN for location tracking and sensor applications for automotive and transportation environment (LTT). Based on TR 102 495-7 and the relevant parts of ECC and EC Decisions (ECC DEC (06)04, ECC DEC(06)12 and 2007/131/EC).
- Beginning of work on HS in TG UWB in 1 Q 2010 (in cooperation with CEPT SE24 and FM47)
- Approval of preliminary draft standard in technical body (TG UWB) depends on frequency allocation done by WGFW and ECC expected in 2nd Q 2010
- approval for Public Enquiry (PE) expected for 4th Q 2010
- Resolution meeting out of PE in TG UWB in 2nd Q 2011
- Depending on 1 step (or 2 step) approach for harmonisation start national vote in Europe in 3rd Q 2011
- Depending on the national vote result: publication of the HS in the Official Journal (OJ) of the European commission end of 2011, which is the allowance for selling products.

Note: delay of approx. 6 month in the compatibility/coexisting studies to be done by CEPT.

Up to now this will not have a direct impact on the R&D project milestones.

4.1.2 UWB in the Public transport, e.g. airborne UWB applications (WP8a). EADS (AIRBUS)

Compared to the EUWB applications in 4.1.1, these applications need additional effort for acceptance by CEPT.

The existing generic regulation framework on UWB applications excludes explicitly the usage of UWB devices on board aircrafts (ECC/DEC (06)04).

It is decided by CEPT that additional compatibility studies or an ECC report will be required.

This will be done by WGSE subgroup SE24 and the support of EUWB WP8a is strongly recommended.

A planning based on the already existing experience with a similar situation with UWB devices in rail and road vehicles, which have been excluded before too, may look like the following.

New work item (WI) generated by ETSI TG31A	December 2008.
Preliminary draft SRDoc generated by TG31A ETSI TR 102 834 V0.0.4 (2008-12)	December 2008
In parallel draft SRDoc to CEPT WGSE January 2009 and WGFW for information	February 2009
Approval of the WI in the technical committee ETSI ERM	March 2009
Decision of WGFM for an impact study (to be done in WGSE)	May 2009
Approval of the draft SRDoc for publication (PU) in ETSI ERM	November2009
Start of compatibility studies in CEPT WGSE	1Q/2010
First results of the impact study for WGFM	4Q/2011
Amendment on existing UWB regulation	2Q/2012

In parallel EUROCAE, responsible for "Environmental Conditions and Test Procedures for Airborne Equipment," has to be involved for their related investigations.

4.1.3 "UWB in Heterogeneous Access Networks" (WP6), TELEFONICA

Studies in EUWB have shown that these applications are similar to the regulated generic applications in Europe (ECC/DEC (06)04) and it is unlikely that standardisation in ETSI and a regulation in CEPT is furthermore necessary.

The existing regulation allows the usage of mobile/cell phones with an UWB interface in a nomadic outdoor scenario.

Covered by ETSI EN 302 065.

No further actions necessary.

Target of EUWB successfully fulfilled.

4.1.4 Cognitive Radio and Coexistence

These standardisation activities are not directly under the responsibility of EUWB partners.

EUWB is involved and contributed in ETSI technical committee RRS which deals with Reconfigurable Radio Systems.

Activities in ETSI RRS have started in 3 Q of 2008 and EUWB partner CREATE net has constantly cooperated with the related WG2 dealing with SDR and CR.

EUWB participates on ITU-R WP 1A/B meetings for monitoring purposes. The working parties are still employing with definitions for SDR and CR.

World wide acting network and service provider are intensively engaged in this Agenda Item (AI) for the World Radio Conference in 2012 (WRC12).

AI 1.19 to consider regulatory measures and their relevance, in order to enable the introduction of software-defined radio and cognitive radio systems, based on the results of ITU-R studies, in accordance with Resolution 956 (WRC-07)

ITU-R SG1 is on the opinion that SRD/CR as a spectrum access mechanism do not need to be considered in the Radio Regulations.

It can be assumed that this AI will be closed on the WRC12 (Jan/Feb 2012).

5 Regulation in Europe

5.1 Actual overview for regulatory and standardisation framework:

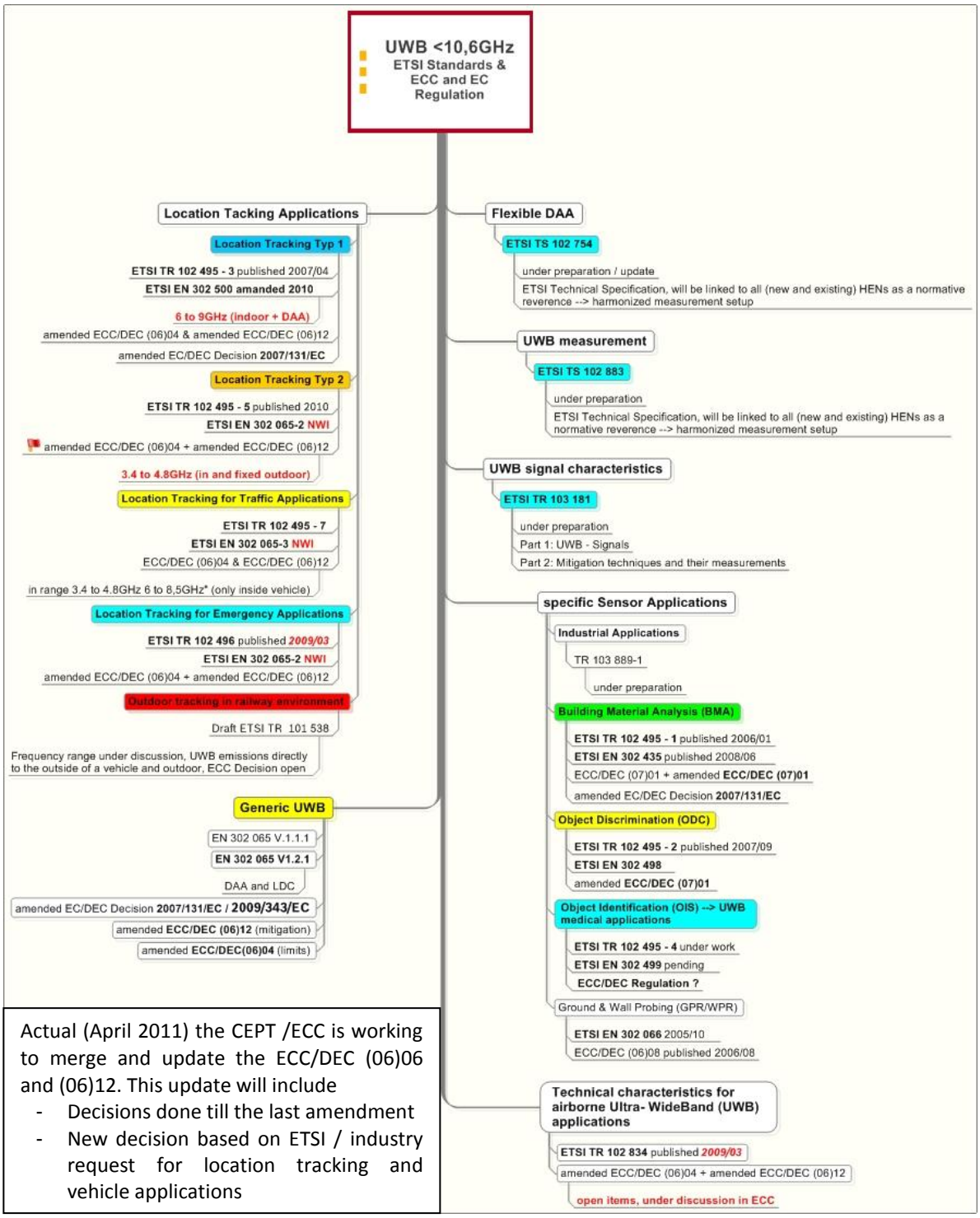

Figure 1: Actual overview for regulatory and standardisation framework

5.2 Generic UWB regulation

UWB definition in CEPT and ECC for the frequency range below 10GHz:

During normal operation the allocated bandwidth must be greater than 50MHz. Based on this definition followed UWB signals are possible: pulsed, OFDM modulated, frequency hopper / stepper, pseudo noise coded, frequency modulated.

Summary regulation (status April 2011)

- Minimum Bandwidth of UWB > 50MHz
- Main operational band with -41.3dBm/MHz mean e.i.r.p. is 6.0GHz to 8.5GHz
  - No mitigation defined/needed in this band
  - Only indoor usage
  - LDC allowed in car as alternative to TPC, see chapter X.X
- Restricted operation possible in the band 3.1GHz to 4.8GHz
  - Low Duty Cycle operation in the band 3.1GHz to 4.8GHz with -41.3dBm/MHz
  - Detect and Avoid operation in 3.1GHz to 4.8GHz with -41.3dBm/MHz

5.2.1 ECC Decisions on generic UWB devices

Decision ECC/DEC/(06)04 on the harmonised conditions for devices using UWB technology in bands below 10.6 GHz was adopted by the ECC at its meeting March 2006.

This ECC Decision was primarily intended to respond to the market demand for UWB indoor and handheld devices providing communication applications. Some categories of UWB devices characterised by predominantly outdoor usage and which are listed below were however explicitly excluded from the scope of this regulation as they could present a significant risk of interference to radio services deployed outdoor:

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

It was agreed that further technical studies would still be needed in several areas in order to finalise generic regulatory solutions for UWB operation in Europe, in particular concerning maximum mean e.i.r.p. spectral densities in the bands 2.7 – 3.8 GHz and 8.5 – 9 GHz, Detect And Avoid (DAA) and Low Duty Cycle (LDC) mitigation techniques and UWB installations in road and rail vehicles.

As requested by the ECC meeting July 2006, a report on the regulatory and enforcement implications of a possible harmonised transition measure (phased approach) applicable to frequency band 4.2 – 4.8 GHz was also developed. Such a phased approach would mean that the first generation (1G) of UWB devices operating in the 4.2 – 4.8 GHz frequency band with a maximum mean e.i.r.p. spectral density of –41.3 dBm/MHz without additional mitigation is introduced earlier in Europe, and after a cut-off date (31 December 2010) it will gradually be replaced with the second generation (2G) of UWB devices implementing a mandatory requirement for additional mitigation like DAA, LDC or equivalent methods.

Decision ECC/DEC/(06)04 was finally amended July 2007 so as to reflect the outcome of these further studies on UWB.

Decision ECC/DEC/(06)12 on the harmonised conditions for devices using Ultra-Wideband (UWB) technology with Low Duty Cycle (LDC) in the frequency band 3.4 – 4.8 GHz was adopted by the ECC at its meeting December 2006 and has not been amended so far.

Current "generic regulation for UWB devices" from CEPT consisting of Decisions ECC/DEC/(06)04 and ECC/DEC/(06)12 has been proposed to evolve into the following:

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

Based on further investigations in the EU project WALTER and EUWB and a detailed discussion of the open issues in ECC TG3 group a new regulation including the additional mitigation techniques like DAA and LDC has been issued be the ECC as ECC Decision ECC/DEC/(06)12 amended 31 October 2008 and the corresponding EC decision 2009/343/EC. These new EC decision has been the bases for the development of the new ETSI harmonised standard EN 302 065 1.2.1 including the needed conformance test setups and procedure for the conformance test of UWB devices using DAA or LDC techniques. In this version of the regulation the use of LDC is now allowed in the complete band 3.1GHz to 4.8GHz as alternative to the active DAA techniques.

5.2.2 Review of regulatory provisions for generic UWB devices

Beyond the core market demand for communication applications and cable replacement technology, recent work within CEPT has shown the interest from industry for operating various types of applications (e.g. location-tracking, sensor technologies…) under the generic UWB regulation.

CEPT/ECC TG3 has undertaken in this context a detailed review of regulatory provisions for generic UWB devices that addresses all type of devices or installations including those categories of installations that were originally excluded from the scope of Decision ECC/DEC/(06)04.

The amendments that have been recently agreed for Decision ECC/DEC/(06)04 and those that are planned for ECC/DEC/(06)12 as well as their implications for the related Commission Decision of 21 February 2007 (2007/131/EC) are detailed in Attachment 1 to this document.

This analysis considers the applicability of the spectrum mask for generic UWB devices, and of the requirements for DAA and LDC mitigation techniques for each of the following categories:

- All applications (except installations listed below)
- Installations in road and rail vehicles
- Fixed outdoor installations
- Installations in flying models, aircraft and other aviation

5.2.3 Impact of CEPT technical studies on Commission Decision of 21/02 2007 (2007/131/EC)

5.2.3.1 Progress status

The CEPT technical studies distinguish clearly the cases of installations in road and rail vehicles, fixed outdoor installations and installations in flying models, aircraft and other aviation.

The table below provides a progress status of the CEPT complementary technical studies that are likely to impact Commission Decision on generic UWB (2007/131/EC):

Categories \	Power level	LDC operation	DAA operation
All applications except…	Existing provisions (2007/131/EC): Spectrum mask Complementary studies : Power level in the bands 2.7 – 3.4 GHz, 3.4 – 3.8 GHz and 8.5 – 9 GHz Status / Target : **Completed**	Existing provisions (2007/131/EC): LDC operation in the band 3.4 – 4.8 GHz Complementary studies : LDC operation in the Band 3.1 – 3.4 GHz Status / Target : **Completed and included in the new EC decision 2009/343/EC**	Existing provisions (2007/131/EC): *Not explicitly included* Complementary studies : DAA operation in the bands 3.1 – 3.4 GHz, 3.4 – 4.8 GHz[(1)] and 8.5 – 9 GHz Status / Target : **Completed and included in the new EC decision 2009/343/EC**
Installations in road and rail vehicles	Existing provisions (2007/131/EC): *Not included* Complementary studies : Power level in the bands 3.1 – 4.8 GHz and 6 – 9.0 GHz for operation in vehicles Power control requirements for UWB devices Completed Status / Target : **Completed and included in the new EC decision 2009/343/EC**	Existing provisions (2007/131/EC): *Not included* Complementary studies : Requirements for LDC operation in vehicles Status / Target : **Completed and included in the new EC decision 2009/343/EC**	Existing provisions (2007/131/EC): *Not included* Complementary studies : Requirements for DAA operation in vehicles Status / Target : **Completed and included in the new EC decision 2009/343/EC**
Fixed outdoor installations	Existing provisions (2007/131/EC): *Not included* Complementary studies : Power level in the bands 4.2 – 4.8 GHz and 6 – 8.5 GHz for operation at fixed outdoor location Status / Target : **Ongoing investigation in ECC SE24**	Existing provisions (2007/131/EC): *Not included* Complementary studies : Requirements for LDC operation at fixed outdoor location Status / Target : **Ongoing investigation in ECC SE24**	Existing provisions (2007/131/EC): *Not included* Complementary studies : Requirements for DAA operation at fixed outdoor location Status / Target : **Ongoing investigation in ECC SE24**
Installations in flying models, aircraft and other aviation	Existing provisions (2007/131/EC): *Not included in the scope of the EC Decision / subject to appropriate sector regulation* Complementary studies : ETSI SRdoc has been developed and investigations in the SE24 groups are ongoing		
[(1)] Technical studies are limited to the band 3.4 – 3.8 GHz as no other bands are being used for BWA systems as DAA target.			

Table 1: **Impact of ongoing CEPT technical studies**

5.2.3.2 Schedule of work: summary

The main open points in the running ECC SE24 discussion on the update of the UWB regulation for specific applications have been finalised in 2008 and 2009 and are now included in the new EC decision 2009/343/EC(DAA, LDC, UWB onboard of vehicles).

The open points of discussion are still the fixed outdoor installation of UWB in the band 3.1GHz to 4.8Ghz and the corresponding needed additional mitigation factors and procedures. Furthermore, the operation of UWB onboard of aircrafts is under discussion and additional investigation will be performed in the scope of SE24 and the ETSI activities toward the standardisation in that domain.

Based on requests from the industrie

- for Location Tracking applications (Generic outdoor and emergency) in the range 3.4 to 4.8GHz and (ETSI SRDoc 102495-5)
- for vehicle usage in the ranges 3.4 to 4.8 and 6 to 8.5GHz (ETSI SRDoc 102495-7)
- for UWB usage inside the aircraft (ETSI SRDoc 102823)

leads to following situation / studies in ECC:

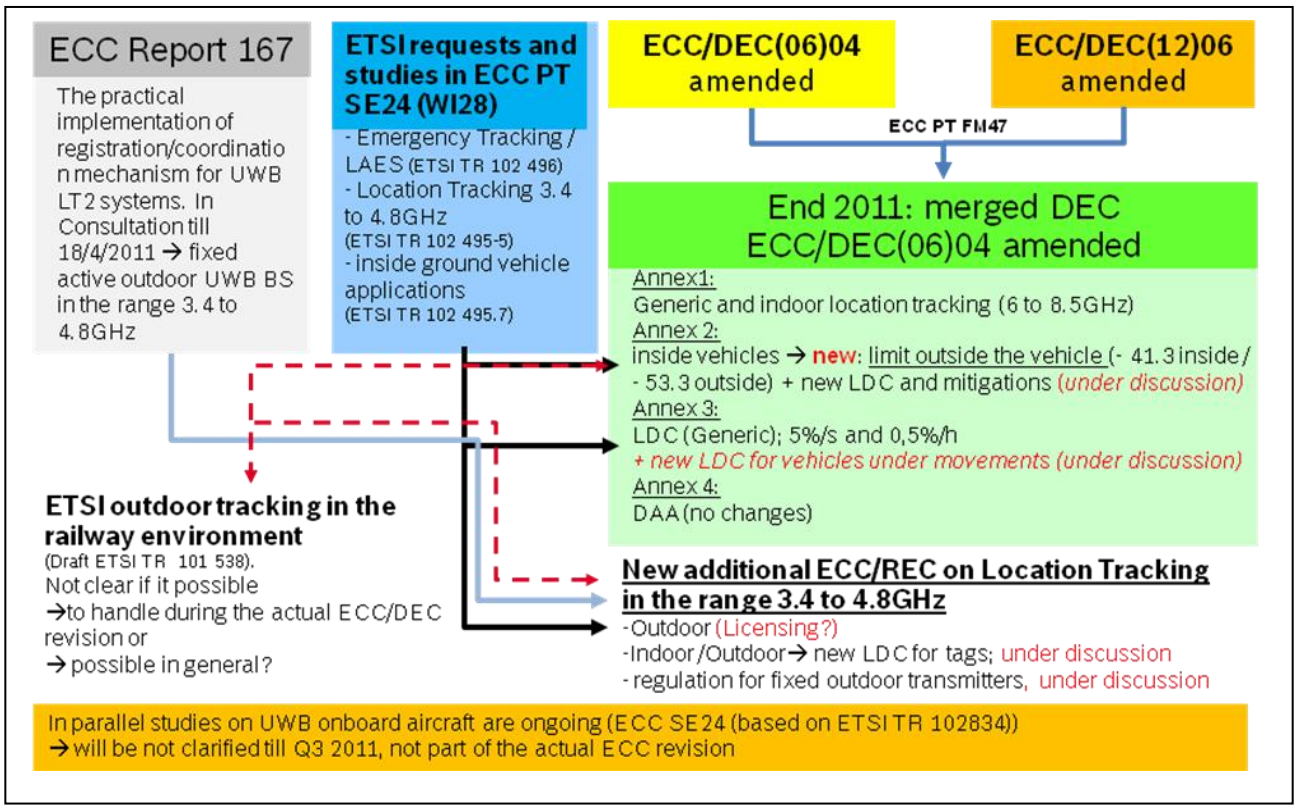

Figure 2: Actual status of studies

Actual Status:

- ECC report 167 was consulted during the ECC Project team FM47 meeting (27th to 28th of April 2011), approval and publication during the next ECC FM meeting (16th to 20th of May 2011)
- A draft version of the merged new ECC Decision was generated during the ECC Project team FM47 meeting (27th to 28th of April 2011). It is expected that the draft decision will send to public consultation after the next ECC FM meeting.
- In parallel two ECC Recommendations were generated during the ECC Project team FM47 meeting (27th to 28th of April 2011) for
    - Location Tracking application in the range 3.1 to 4.8GHz
    - Location Tracking applications foremergency situations

  The new ECC Recommendations will in addition also send to public consultation after the next ECC FM meeting.
- The new study report from working group SE on specific UWB (Work Item 28) was send to public consolation after the ECC SE meeting (2nd to 5th of May)
- The finalisation of the ECC regulatory framework is planned for September 2011

- After this finalisation ETSI can update and finalise their work on the harmonised standards afterwards.

- The compatibility studies for UWB onboard aircrafts are still ongoing in ECC SE project team 24.

- The EC DEC on UWB will also be updated after publication of the ECC Decision

- During their meeting in May 2011, the CEPT/ ECC working group spectrum engineering (SE) approved a work item to study the duty cycle mitigation again. Reason: during the LDC studies for Location Tracking till April 2011 it could possible, that changes of the LDC mitigation could increase the protection of radio services. Main focus is the radar band: 3.1 to 3.4GHz. These studies are planned to finalised in 2012 and depending on the results. They will be than included in a future ECC / DEC amendment.

6 Specific UWB regulation

6.1 Location Tracking Application

The first harmonised ETSI standard in the ECC region for UWB was the EN 302500. This standard handled indoor location tracking systems with active tags / nomadic devices and passive (UWB) fixed indoor base stations. These "so called" Location Tracking Typ1 devices are regulated under the same ECC and EC decision than Generic UWB devices in the range 6 to 8.5GHz.

Details of this applications and technical requirements can be found in the ETSI documents.

Actual in the ECC additional is working on to define in addition the requirements for Location Tracking applications in the range 3.4 to 4.8GHz.

Here following differentiations were made:

1. Generic Location Tracking, "Type 2" with the possibility to have fixed outdoor active UWB transmitters. (details: ETSI TR 102 435-5)

2. And Location Tracking devices for ad hoc systems in an emergency situation (LAES) (details: ETSI TR 102 496)

The final regulation and the decisions / recommendations in the ECC are expected end of the summer 2011. The plan is to generate two different, very specific ECC Recommendations. The basis for the specific ECC framework is the results of the ECC studies, which are described in

- Draft ECC report for specific UWB: Finalised, but actual in approval and publication process in the ECC. Finalisation is expected Summer 2011

- ECC report 169, possibility for site licensing of outdoor location tracking systems (type 2) and LAES systems.

6.2 Vehicle applications

Since the approval of ECC/DEC(06)04 and (06)12 there is the possibility to use UWB devices also inside a ground based vehicle. For this usage following two requirements were defined (for the range 3.1. to 4.8 and 6 to 8.5GHz)

1. In case of devices installed in road and rail vehicles, operation is subject to the implementation of Transmit Power Control (TPC) with a range of 12 dB with respect to the maximum permitted radiated power. If no TPC is implemented, the maximum mean e.i.r.p. spectral density is -53.3 dBm/MHz.

2. in case of **LDC UWB** devices installed in road and rail vehicles, no additional mitigation is required as the LDC mitigation technique is recognised to offer a protection level that is at least equivalent to Transmit Power Control (TPC);

Based on this decision ETSI prepared a SRDoc (TR 102 495-7) with a request to optimise the UWB regulation for ground vehicle use. This revision will be included in the merged and updated new ECC decision.

6.3 General considerations for additional applications

CEPT Report 10 and 34 provides a summary of general principles for the development of regulations for specific UWB applications and benefits of using UWB technology for this type of applications.

A number of difficulties of technical, regulatory and enforcement nature associated with the multiplication of specific UWB applications are underlined. It is concluded in particular that strong justification is needed for developing specific UWB regulations, which can be envisaged only for "niche applications". It was also argued that the notion of "undesired emissions", which is inherent to most specific UWB applications considered initially by CEPT, could to some extent justify that these applications cannot fit within the generic regulation. Key differences in the principles behind the generic UWB regulation and specific regulations for Ground- and Wall- Probing Radar (GPR/WPR) imaging systems and Building Material Analysis (BMA) devices are presented below:

- The generic UWB regulation defines a spectrum mask applicable to a stand-alone radio device. For a communication application, the maximum e.i.r.p. density and frequency band will typically govern the maximum operating range for a given data rate. For a sensor-like application (e.g. movement detection, location-tracking…), it will typically govern the maximum operating range for a given resolution/accuracy
- The "undesired emissions" from a specific UWB application are highly dependent on the operational conditions and are only meaningful when coupled with the material being investigated. Their reduction is a specific design task for the manufacturers and may e.g. necessitate appropriate shielding of the device. It does not necessarily affect the performance of the application.

Requirements from the industry for specific UWB applications ought obviously to be considered for applications with clear benefits from using UWB technology that cannot fit under the generic Decision on UWB. The use of UWB technology in accurate imaging applications is expected to be the main application for which a specific UWB regulation could be developed because of physical reasons (e.g. lower frequencies with higher levels are needed due to reflections of clutter and the needed penetration depth).

Recognising the benefits offered by UWB technology in providing "accuracy in imaging applications", ECC developed and approved the following Decisions:

- ECC Decision of 1 December 2006 on the conditions for use of the radio spectrum by Ground- and Wall- Probing Radar (GPR/WPR) imaging systems (ECC/DEC/(06)08)
- ECC Decision of 30 March 2007 on Building Material Analysis (BMA) devices using UWB technology (ECC/DEC/(07)01)

6.3.1 Imaging applications using UWB-RT: definition

CEPT Report 10 defines imaging applications as applications for the purpose of detecting or obtaining the images of objects buried into the ground or contained within a ''wall'', or of determining the physical properties within the ground or a ''wall''; the ''wall'' being a concrete structure, the side of a bridge, the wall of a mine or another physical structure that is dense enough and thick enough to absorb the majority of the signal transmitted by the imaging system.

The following definitions have been used in the ECC Decisions on GPR/WPR imaging systems and BMA devices:

Decision ECC/DEC/(06)08:

- Ground probing radar (GPR) imaging system. A field disturbance sensor that is designed to operate only when in contact with, or within one meter of, the ground for the purpose of detecting or obtaining the images of buried objects or determining the physical properties within the ground. The energy from the GPR is intentionally directed down into the ground for this purpose.

- Wall probing radar (WPR) imaging system. A field disturbance sensor that is designed to detect the location of objects contained within a "wall" or to determine the physical properties within the "wall". The "wall" is a concrete structure, the side of a bridge, the wall of a mine or another physical structure that is dense enough and thick enough to absorb the majority of the signal transmitted by the imaging system;

The application under this regulation is related to following documents from the European Telecommunications Standards Institute (ETSI):

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

and the corresponding Harmonised European Standard

- EN 302 066 for GPR/WPR Radar applications which includes the technical characteristics and test methods for such equipment.

GPR/WPR radar applications are not intended for communications purposes. Their intended usage excludes radiation into the free space and this should be avoided (e.g. a function which deactivates the equipment when normal use is interrupted).

Decision ECC/DEC/(07)01 :

Building Material Analysis (BMA) devices are defined as field perturbation sensors that are designed to detect the location of objects within a building structure or to determine the physical properties of a building material

The main focus of the BMA application is to:
Detecting and determining the position and depth of:

- electric cables and wires (low-voltage and three-phase cables);
- metal of all types such as copper, aluminium, iron or steel;
- metal tubes such as gas or water pipes;
- plastic tubes used for floor heating;
- steel armour in concrete;
- wood (studs);
- cavities;
- tendon cables behind meshes of rebar;
- rebars, pipes, conduits etc. deep in concrete

Determining the water and salt content of:

- concrete and light construction structures;
- historic buildings;
- concrete structures like bridges

Inspection and quality assessment of:

- floors, decks, slabs and balconies;
- tunnels;
- relative concrete condition for renovation planning

Details of these BMA devices / application can be found in the related ETSI document:

ETSI TR 102 495-1 V1.1.1 (2006-01); *Radio spectrum Matters (ERM); Short Range Devices (SRD); Technical characteristics for SRD equipment using Ultra Wide Band Sensor technology (UWB); System Reference Document Part 1: Building material analysis and classification applications operating in the frequency band from 2,2 GHz to 8 GHz*

The studies in ECC came to the decision that following frequency regulation for the BMA application would be possible to protect the radio service

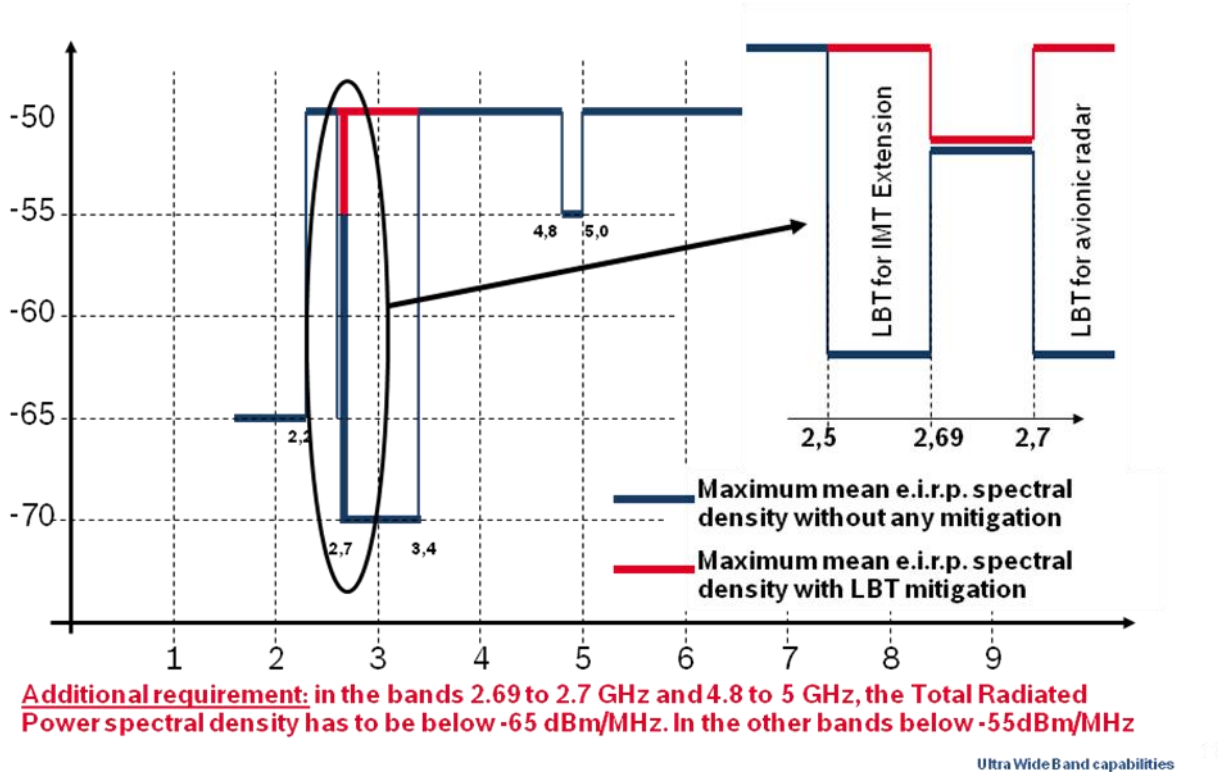

Figure 3: Spectral mask for Building Material Analyses equipment based on UWB

The emissions of the device have to be measured in a „realistic" scenario. For this the "representative wall was defined and with this "wall" the emissions out of the scenario can be measured (both sides of the wall)

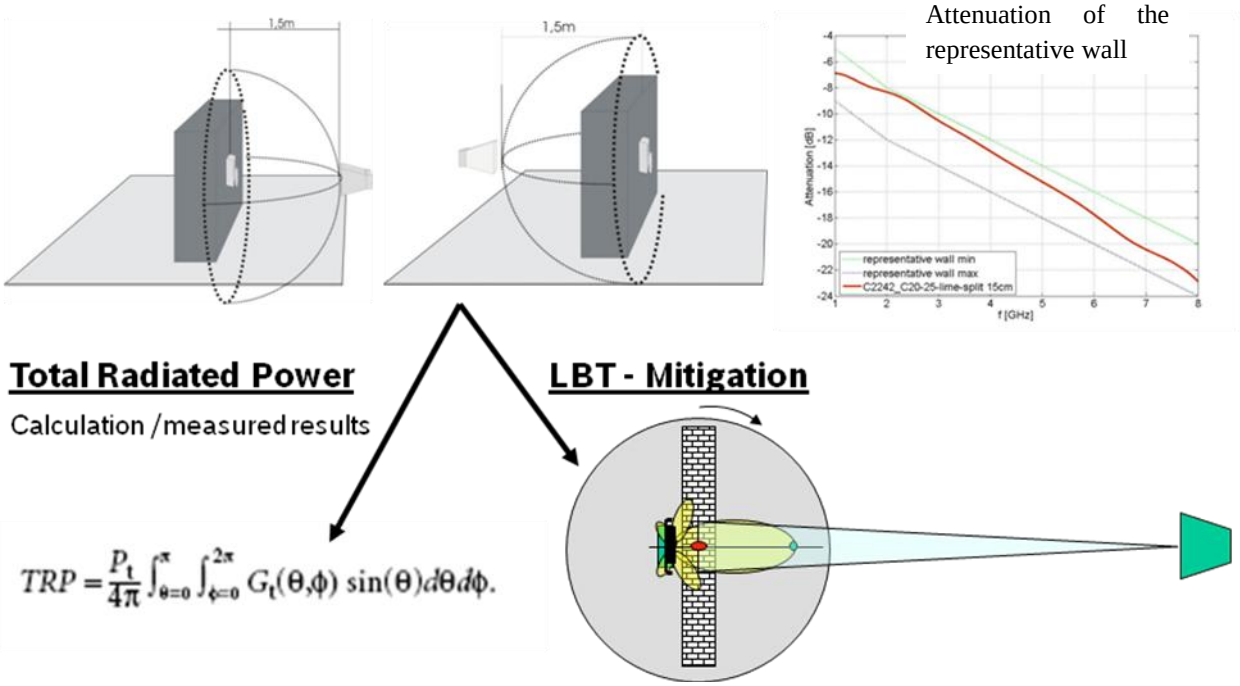

Figure 4: Measurement setup for the conformance testing of a BMA device

In addition to the scenario measurement two additional mitigation techniques were developed to protect the radio services:

- *Total Radiated Power → details see chapter 7.3.2*
- *Listen Before Talk → very comparable to DAA → details see chapter 7.2.2*

The whole conformance test procedure of a BMA device is described in:

ETSI EN 302 435-1 V1.3.1 (2009-12); *Radio spectrum Matters (ERM); Short Range Devices (SRD); Technical characteristics for SRD equipment using Ultra WideBand technology (UWB); Building Material Analysis and Classification equipment applications operating in the frequency band from 2,2 GHz to 8,5 GHz; Part 1: Technical characteristics and test methods*

6.3.2 Additional specific regulation for UWB applications

During the work in ECC on specific application, the ECC/DEC (07)01 was amended with a second type of application. In this type, the application includes so called ODC / Object Discrimination and Characterisation Applications:

Following ODC devices, two types of applications were distinguished in the ECC compatibility studies:

- Application A: Proximity Sensing of Human tissue , quasi fixed applications

- Application B: "Break through" protection and direct contact avoidance for building work, non fixed applications.

Application A is intended for:

- detection of small objects like a finger or other extremities in the presence of obstacles (e.g. wood), positioned close to a hazard like a saw blade;
- applications typically for consumer market, like safety devices for power tools or dangerous machines;
- usage in close proximity to potentially hazard area (0 to 40 cm).

Application B will be used for high end drilling and percussion drilling machines. It is planned to mount it directly to the tool. A parallel usage is possible. The UWB sensor application monitors the drilling process and controls the drilling machine also depending on the inhomogenities in the material. The user will be warned acoustically or optically in case of a collision with unexpected objects inside the material (e.g. gas- water pipes or electric cables) may happen. The UWB application may be active synchronously to the operation of the drilling machine which will be supported by this application.

Details of these ODC devices can be found in the related ETSI document:

ETSI TR 102 495-2 V1.2.1 (2007-09); *Radio spectrum Matters (ERM); Short Range Devices (SRD); Technical characteristics for SRD equipment using Ultra Wide Band Sensor technology (UWB); System Reference Document; Part 2: Object Discrimination and Characterisation (ODC) applications for power tool devices operating in the frequency band of 2,2 GHz to 8,5 GHz*

The compatibility studies for these applications have resulted in a different spectral mask than BMA. Details can be found in ECC report 123 and in the table below.

Frequency range [GHz]	**Fixed installations (Application A)**		**Non fixed installations (Application B)**
	Maximum mean e.i.r.p spectral density	**Maximum mean e.i.r.p spectral density in the horizontal plane (-20 to 30° elevation)**	**Maximum mean e.i.r.p. spectral density**
Below 1.73	-85 dBm/MHz		-85 dBm/MHz
1.73 to 2.2	-65 dBm/MHz	-70 dBm /MHz	-70 dBm/MHz
2.2 to 2.5	-50 dBm/MHz		-50 dBm/MHz
2.5 to 2.69	-65 dBm/MHz Note 1	-70dBm/MHz	-65 dBm/MHz Note 1 & Note 2
2.69 to 2.7	-55 dBm/MHz	-75 dBm/MHz	-70 dBm/MHz Note 3
2.7 to 2.9	-50 dBm/MHz	-70 dBm/MHz	-70 dBm/MHz
2.9 to 3.4	-50 dBm/MHz	-70 dBm/MHz	-70 dBm/MHz Note 1
3.4 to 3.8	-50 dBm/MHz	-70 dBm/MHz	-50 dBm/MHz Note 2 & Note 3
3.8 to 4.8	-50 dBm/MHz		-50 dBm/MHz
4.8 to 5	-55 dBm/MHz	- 75 dBm/MHz	-55 dBm/MHz Note 2 & Note 3

5 to 5.25	-50 dBm/MHz		-50 dBm/MHz
5.25 to 5.35	-50 dBm/MHz	- 60 dBm/MHz	-60 dBm/MHz
5.35 to 5.6	-50 dBm/MHz		-50 dBm/MHz
5.6 to 5.65	-50 dBm/MHz	-65 dBm/MHz	-65 dBm/MHz
5.65 to 5.725	-50 dBm/MHz	-60 dBm/MHz	-60 dBm/MHz
5.725 to 8.5	-50 dBm/MHz		-50 dBm/MHz
8.5 to 10.6	-65 dBm/MHz		-65 dBm/MHz
Above 10.6	-85 dBm/MHz		-85 dBm/MHz
Note 1: devices using a Listen Before Talk (LBT) mechanism, as described in the harmonised standard EN 302 498-2, which meet the technical requirements defined within Appendix 1 to this Annex, are permitted to operate in frequency ranges 2.5 to 2.69 and 2.9 to 3.4 GHz with a maximum mean e.i.r.p. spectral density of –50 dBm/MHz.			
Note 2: to protect the radio services, non fixed installations (application B) must fulfil the following requirement for Total Radiated Power: a) In the frequency ranges 2.5 to 2.69 GHz and 4.8 to 5 GHz, the Total Radiated Power spectral density has to be 10dB below the max e.i.r.p. spectral density b) In the frequency ranges 3.4 to 3.8 GHz, the Total Radiated Power spectral density has to be 5dB below the max e.i.r.p. spectral density			
Note 3: Limitation of the Duty Cycle to 10% per second			

Table 2: Spectral mask as defined in ECC report 123

In addition to the existing mitigation techniques for BMA and Generic devices following additional mitigation techniques for the ODC applications were defined

- Radiation pattern, here the emissions levels are different over the elevation angle.

Based on these new emissions levels over elevations following measurement concepts were develop for ODC applications.

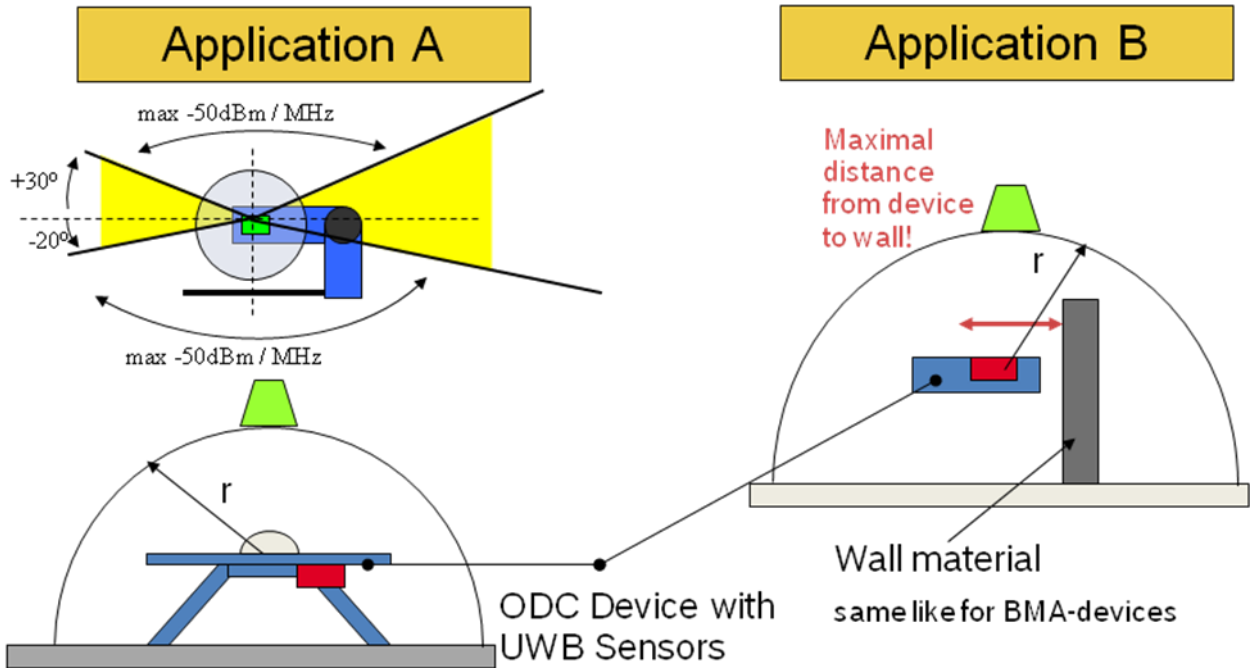

Figure 5: Measurement Setup for ODC applications

7 Mitigation techniques and methods

7.1 Introduction

In this section an overview over the mitigation techniques considered in the European regulation will be presented. The mitigation techniques lead to an additional level of protection towards the potential victim systems.

Examples for mitigation techniques used in the European including the corresponding ETSI harmonised standards are:

- Detect and Avoid (ETSI EN 302 065 1.2.1), DAA
- Low Duty Cycle (ETSI EN 302 065 1.2.1), LDC
- Total radiated power (ETSI EN 302 435 1.1.1)
- Listen before talk (ETSI EN 302 435 1.1.1)

The mitigation techniques and mechanisms can be split into passive mitigation techniques (e.g. LDC, TRP) and active mitigation techniques (e.g. DAA, LBT)

Additional mitigation techniques need to be considered for specific environments and applications. This will also lead to specific measurement setup required for these applications to cover the specific environmental considerations (see ODC, BMA).

7.2 Active mitigation techniques

7.2.1 Detect and Avoid, DAA

The most powerful and flexible active mitigation is the flexible “detect-and-avoid” technique introduced in the generic UWB regulation and standardisation. The basic specification and definition of the DAA mechanisms have been developed in an ETSI Special Task Force (STF 350) in the year 2008 in close cooperation with the EU projects EUWB [2] and WALTER [10]. The results of the ST work have been documented in the ETSI Technical Specification TS 102 754 1.1.1 [11] and the ETSI Technical Report TR 102 762 1.1.1. [12]. The two documents are the bases for the ETSI harmonised standard EN 302 065 1.2.1 [13] covering generic UWB devices in the frequency range between 3.1GHz to 4.8 GHz and 6.0GHz to 9.0 GHz.

The developed flexible DAA approach can be extended to different services to be protected. In the EU regulation three different services have been considered up to now:

- S-Band radar systems in the band 3.1GHz to 3.4GHz
- Broad Band Wireless Access Systems in the band 3.4GHz to 3.8GHz and
- X-Band radar systems in the band 8.5GHz to 9.0GHz

The flexible DAA approach is based on the estimation of the isolation between the potential UWB interferer and the victim system. Based on the estimated isolation the UWB device can chose an appropriate operational mode (TX power reduction, Beam forming, LDC, etc.) to guarantee the operation of the victim without harmful interference. In order to be able to define efficient estimation

methods and thresholds a detailed knowledge of the potential victim systems and the needed protection criterions is needed.

The estimation needs to be updated in a regular periodicity in order to allow new victim system to enter the relevant spectrum without interference.

The basic approach of the flexible DAA mitigation techniques can be extended to other systems by adopting appropriate sets of parameter to protect these systems. The following "Listen-Before-Talk" (LBT) mitigation technique can be seen as a specific case of the flexible DAA approach.

The flexible DAA parameters defined in [13] are given in Table 3 to

.

Parameter	Symbol	Zone 1 (see note 2)	Zone 2 (see note 2)
Minimum Initial channel availability Check time	$T_{avail\_time\_min}$	14 s	
Maximum Detect and Avoid time	T_{avoid_max}	150 s	
Detection probability		99 % (see note 1)	
Detection probability in Continuous detection operation during UWB radio device operation		97 % (see note 1)	
Signal detection threshold (Peak Detector)	D_{thresh}	D_{thresh_1} = -38 dBm	
Avoidance Level (UWB maximum mean Tx Power density)		-70 dBm/MHz	-41,3 dBm/MHz
Default Avoidance Bandwidth		3,1 GHz to 3,4 GHz (300 MHz)	
Possible Avoidance Options		All	
NOTE 1: 5 consecutive tests shall be performed for each radar signal. If the radar signal was detected all 5 times the UWB DAA radio device will have passed the test. If the radar signal was not detected one time, the test shall be repeated another 10 times with the same radar signal. If the radar signal was detected all 10 times the UWB DAA radio device will have passed the test. NOTE 2: Zone definition see [12][11].			

Table 3: Band 3,1 GHz to 3,4 GHz: Radiolocation systems Detect and avoid parameter set

Parameter		Zone 1 (see note 3)	Zone 2 (see note 3)	Zone 3 (see note 3)
Minimum Initial channel availability Check time	$T_{avail\_time\_min}$	5,1 s		
Detection Probability for initial detect operation after UWB radio device power on		99 % (see note)		
Signal detection threshold (UL)	$D_{thresh(UL)}$	D_{thresh_1} = -38 dBm	D_{thresh_2} = -61 dBm	
Avoidance Level (UWB Maximum mean Tx Power density)		-80 dBm/MHz in the frequency range from 3,4 GHz to 3,8 GHz and	-65 dBm/MHz	-41,3 dBm/MHz
Default Avoidance Bandwidth		3,4 GHz to 3,6 GHz, 3,6 GHz to 3,8 GHz (see note 2)		
Possible Avoidance Options		All		
NOTE 1: 5 consecutive tests shall be performed for each BWA signal. If the BWA signal was detected all 5 times the UWB DAA radio device will have passed the test. If the BWA signal was not detected one time, the test shall be repeated another 10 times with the same BWA signal. If the BWA signal was detected all 10 times the UWB DAA radio device will have passed the test. NOTE 2: The phrase "*default avoidance bandwidth*" means that if the victim was detected in the range 3,4 GHz to 3,6 GHz the "complete "*default avoidance bandwidth*" is 3,4 GHz to 3,6 GHz and if the victim was detected in the range 3,6 GHz to 3,8 GHz the "complete "*default avoidance bandwidth*" is 3,6 GHz to 3,8 GHz. NOTE 3: Zone definition see [12][11]				

Table 4: BWA Detect and avoid parameter set

Parameter		Zone 1 (see note 2)	Zone 2 (see note 2)
Minimum Initial channel availability Check time	$T_{avail\_time\_min}$	14 s	
Maximum Detect and Avoid time	T_{avoid_max}	150 s	
Detection probability		99 % (see note 1)	
Detection probability in Continuous detection operation during UWB radio device operation		97 % (see note 1)	
Signal detection threshold (Peak Detector)	D_{thresh}	D_{thresh_1} = -61 dBm	
Avoidance Level (UWB maximum mean Tx Power density)		-65 dBm/MHz	-41,3 dBm/MHz
Default Avoidance Bandwidth		8,5 GHz to 9,0 GHz (500 MHz)	
Possible Avoidance Options		All	
NOTE 1: 5 consecutive tests shall be performed for each radar signal. If the radar signal was detected all 5 times the UWB DAA radio device will have passed the test. If the radar signal was not detected one time, the test shall be repeated another 10 times with the same radar signal. If the radar signal was detected all 10 times the UWB DAA radio device will have passed the test. NOTE 2: Zone definition see [12][11].			

Table 5: Band 8,5 GHz to 9,0 GHz: Radiolocation systems Detect and avoid parameter set

7.2.2 Listen before talk, LBT

This mitigation technique is used in the ECC and EC for the BMA and ODC devices. Details of this mitigation is descripted in the harmonised ETSI Standards for these devices (EN 302435 and EN 302489)

With this mitigation a protection distance to active radio service devices can be fulfilled. For this reason a threshold level for radio service was specified, with will be detect in the BMA or ODC.

7.2.2.1 *Technical requirements of the "Listen Before Talk" mechanism (BMA and ODC)*

Technical requirements of the "Listen Before Talk" mechanism for Material Sensing devices (BMA and ODC): Peak power threshold values for the "Listen Before Talk" (LBT) mechanism to ensure the protection of the listed potential victim services are defined in the table below.

Frequency range	Radio service to be detected	Peak power threshold value	Mandatory for
1.215 - 1.4 GHz	Radiodetermination Service	+8 dBm/MHz	BMA
1.61 - 1.66 GHz	Mobile Satellite service	-43 dBm/MHz	BMA
2.5-2.69 GHz	Land Mobile service	-50 dBm/MHz	BMA and ODC
2.7 - 3.4 GHz	Radiodetermination Service	-7 dBm/MHz	BMA and ODC

Table 6: LBT parameter for BMA and ODC

Note: Additional requirements for Radar detection: Continuously listening and automatic switch-off within 10ms for the related frequency range if the threshold value is exceeded. A silent time of at least 12s while listening continuously is necessary before the transmitter can be switched on again. This silent time during which only the LBT receiver is active has to be ensured even after the device is switched off by the functions described in Annex 1, the proximity sensor and manual operation.

7.2.2.2 *Principle function of the LBT mitigation for BMA and ODC devices*

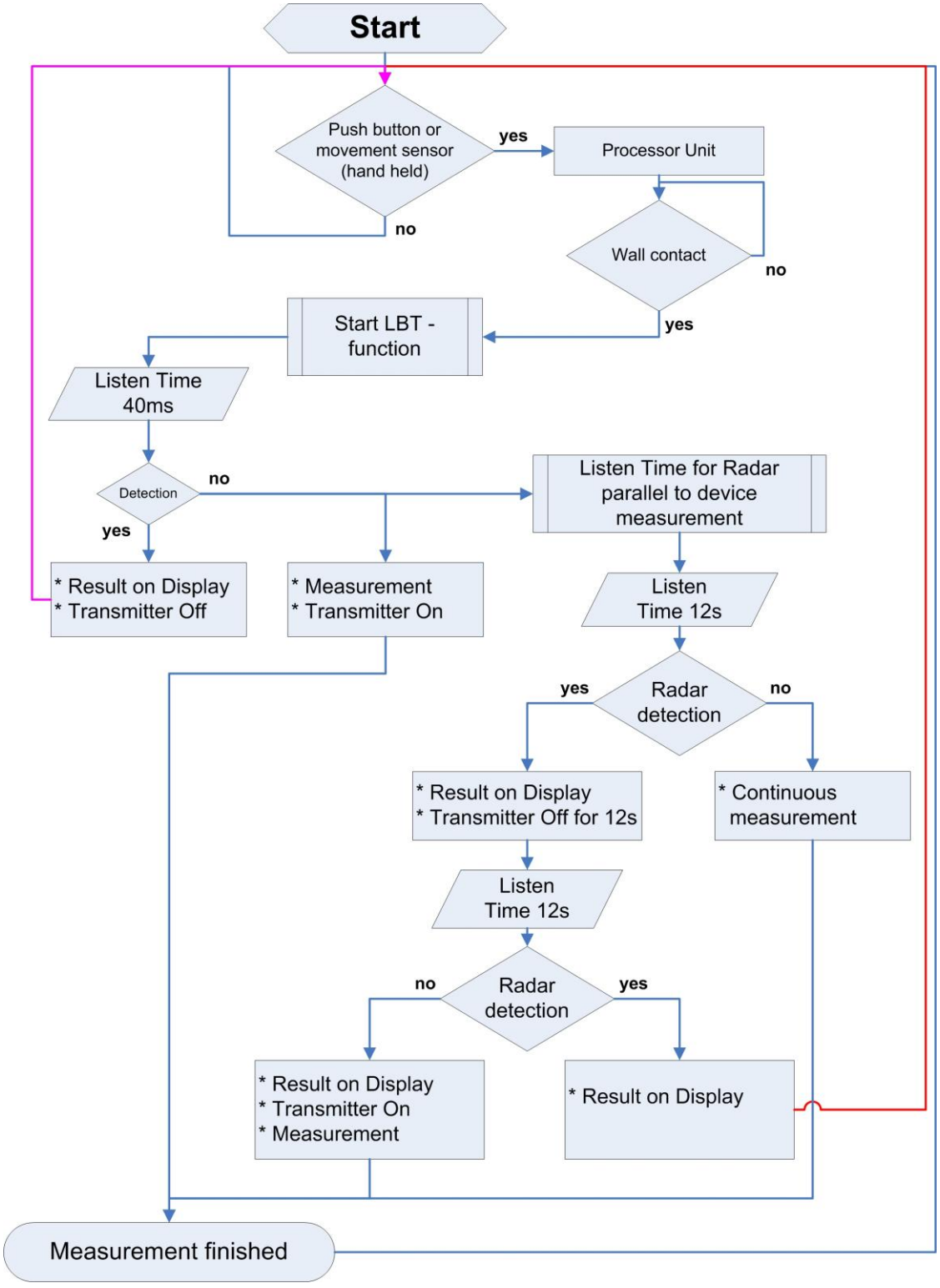

Figure 6: Principle flow of the LBT mitigation technique

7.2.3 Transmit power control, TPC

This mitigation technique is based on the principle that the UWB should use the lowest required power level for the intended use. If necessary the UWB transmitter can increase the power up to a level that the connection / communication is possible.

This mitigation is used for UWB in ground vehicle applications in the ranges 3.1 to 4.8GHz and 6 to 8.5GHz.

In this application the TPC mitigation has a required dynamic range of 12dB. The starting e.i.r.p level is -53.3 dBm/MHz with the possibility to increase the level up to -41.3dBm/MHz.

7.3 Passive mitigation techniques

7.3.1 Low Duty Cycle, LDC

This LDC should not be confused with the ratio of the pulse length to the pulse repetition period of a pulsed system; this is often also used as Duty Cycle definition. Here it is meant as ratio of the transmitter-on time to the sum of transmitter-on and transmitter-off times ($DC=TX_{on}/(TX_{on}+TX_{off})$).

One example

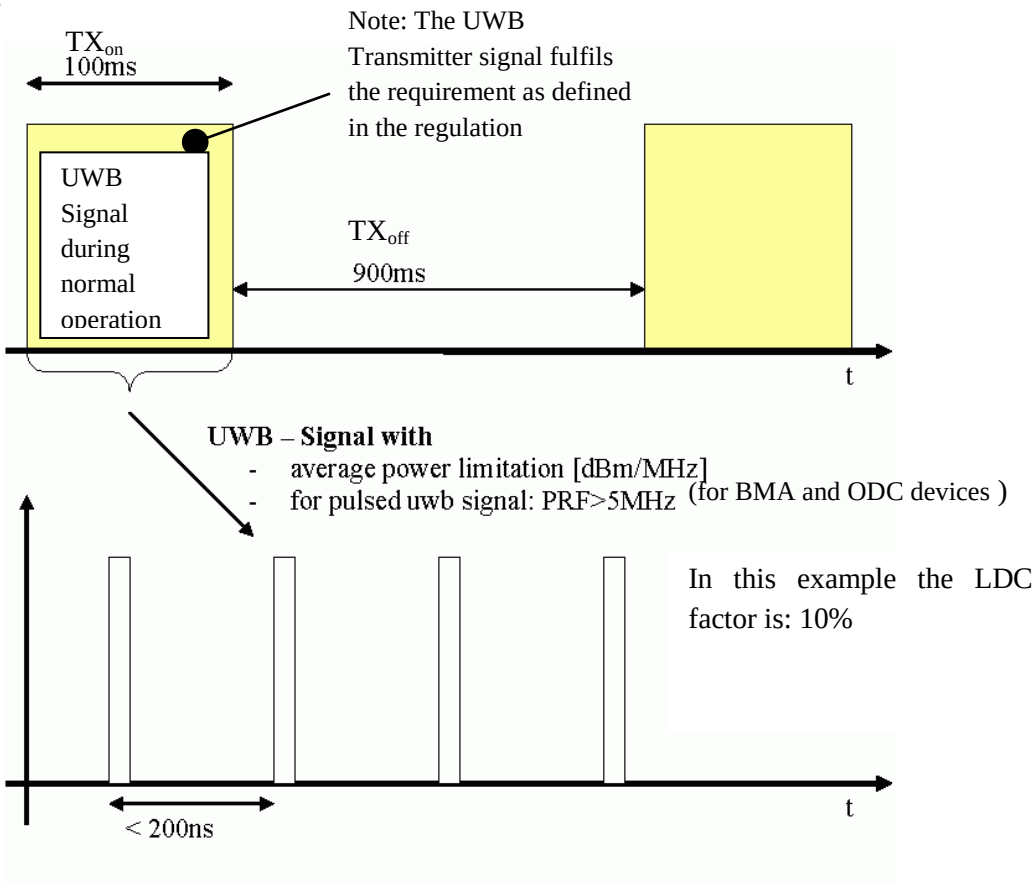

Figure 7: Duty cycle definition on the example of a pulsed UWB system

For aggregated scenarios there is a mitigation of 10dB expected; for single entry scenarios the mitigation factor is depending on the victim service to be protected.

In the following sections some examples for LDC limits already defined or under discussion in the EU regulation will be presented.

7.3.1.1 *Generic LDC rule in ECC*

LDC Parameter in actual EC regulation as part of the HEN 302 065 V1.2.1:

T_{on} max = 5 ms
T_{off} mean ≥ 38 ms (averaged over 1 sec)
Σ T_{off} > 950 ms per second → Σ T_{on} of 50ms per second = 5%/s

Long-term limit
Σ T_{on} < 18 s per hour → equal to 0.5% per hour

7.3.1.2 *Draft specific LDC for Location Tracking Applications in the range 3.1 to 4.8GHz*

Additional requirements in the band 3.1 to 4.8 GHz for location tracking devices (tags/nomadic and active base stations) are under discussion.

Working title in ECC: LT2 (location tracking type 2). Final Decision for this regulation summer 2011)

T_{on} max = 25 ms
T_{off} mean ≥ 38 ms (averaged over 1 sec)
Σ T_{off} > 950 ms per second → Σ T_{on} of 50ms per second = 5%/s

Mid-term limit
Σ T_{on} < 900 ms per minute → equal to 1.5% per minute (Note 1)

Note 1: the duty cycle should also be limited to 1.5% per minute or equipment should implement alternative mitigation technique that provides at least equivalent protection.

7.3.1.3 *Draft specific LDC for ground vehicle applications*

Additional requirements in the band 3.4 to 4.8 GHz and 6 to 8.5GHz for ground vehicle UWB devices.

Working title in ECC: LTT (location tracking in traffic applications). Final Decision for this regulation summer 2011)

T_{on} max = 5 ms
T_{off} mean ≥ 38 ms (averaged over 1 sec)
Σ Toff > 950 ms per second → Σ T_{on} of 50ms per second = 5%/s

Long-term limit
Σ T_{on} < 18 s per hour → equal to 0.5% per hour (Note 1)

Note 1: in case of UWB devices installed in road and rail vehicles, within the band 3.4 – 4.8 GHz, this requirement does not apply for operation with vehicle speed above 40 km/h. For vehicle speeds between 20 km/h and 40 km/h a gradual implementation of the long-term duty cycle limit from 18 seconds to 180 seconds per hour would be required.

7.3.2 Total radiated power, TRP

The total radiated power mitigation techniques give the possibility to define an overall radiated power limit of a UWB device without scarifying the needed e.i.r.p. power in the intended direction. The idea is to limit the potential interference influence towards the surrounding in the directions where the UWB device does not indent to operate. The mitigation technique is being defined for UWB BMA devices where the indented operation direction of the UBW device is clearly defined as to be in the direction of a wall or floor. In this indented direction of radiation additional attenuation factors are present and thus a higher e.i.r.p. power can allowed. In the all other direction the TX power should be limited in order to protect the potential victims in the surrounding. This protection is being implemented by defining a limit for the TRP.

Short Explanation:
An isotropic radiator with -55 dBm e.i.r.p (0dBi) → has a input power of -55dBm
An antenna with -55dBm e.i.r.p and with a TRP value of -65dBm (Directivity of 10dB)
has an input power of -65dBm because of a directivity of 10 dB.

→ An antenna with a TRP – Limit of e.g. -65dBm has the same input power as a comparable isotropic radiator with -65dBm

The max e.i.r.p can be higher: this depends on the Directivity / Pattern of the antenna (e.g. 10dB directivity lead to a max e.i.r.p of -55dBm).

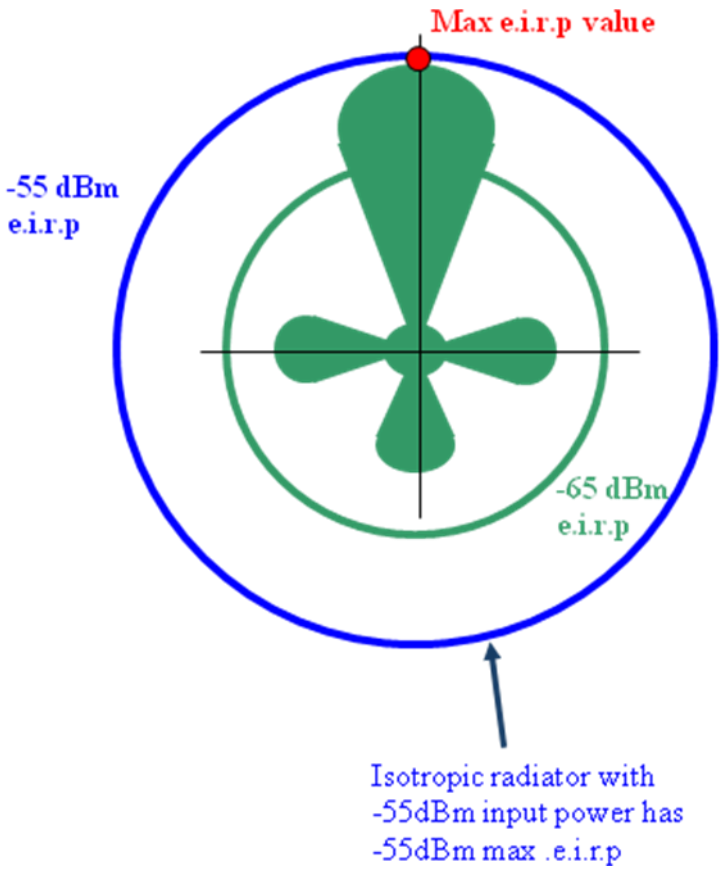

Figure 8: Total Radiated Power principle

7.4 Other mitigation techniques and factors

In addition to the presented mitigation techniques additional method and factors have to be considered when looking at specific UWB applications. Here the intended operational environment is of major importance since additional shielding effects and the possibility of controlling the environment can be taken into account. An example would be the UWB transmission of HD video pictures in an operational room with shielding. In this environment no DAA is required since no BWA devices will be in the close vicinity and the potential interference towards radar systems can be neglect due to the shielding of the operational room. The indented use of the UWB device need to be take into account when investigating the potential interference towards victim systems. Especially in controlled environments like industrial areas, hospitals or offices the interference potential towards several victim services is much lower than under the assumption of a consumer use case.

8 Conclusion

8.1 Conclusion on generic UWB regulation

Taking into account the current trends of future UWB market devices, CEPT has undertaken several complementary studies, involving industry stakeholders, in order to finalise the work on generic UWB. Most of these studies have been completed by March 2008.

In the year 2008 and 2009 the DAA regulation has been put in place resulting in the newest version of the ETSI Standard EN302 065 1.2.1 which officially available.

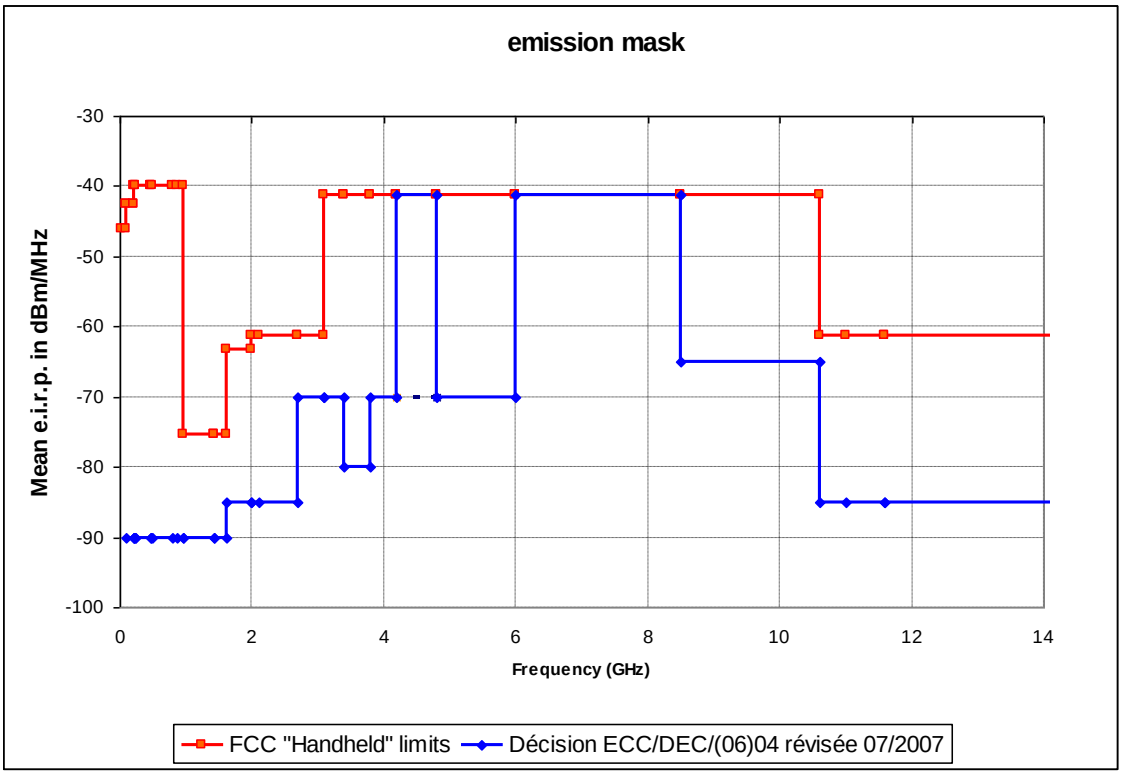

Figure 9: European spectrum mask compared to FCC regulation

The European regulation is being considered in several countries as the bases for the future regulation in the domain of UWB. The main parameters of the EU regulation are depicted in Table 7.

Frequency band	Power spectral density (e.i.r.p.) without DAA	Power spectral density (e.i.r.p.) with DAA	Power spectral density (e.i.r.p.) with LDC
< 1.6 GHz	–90 dBm/MHz	–90 dBm/MHz	–90 dBm/MHz
1.6 - 2.7 GHz	-85 dBm/MHz	-85 dBm/MHz	-85 dBm/MHz
2.7 – 3.1 GHz	-70 dBm/MHz	-70 dBm/MHz	-70 dBm/MHz
3.1 - 3.4 GHz	-70 dBm/MHz	-41.3 dBm/MHz	-41.3 dBm/MHz
3.4 - 3.8 GHz	-80 dBm/MHz	-41.3 dBm/MHz	-41.3 dBm/MHz
3.8 - 4.2 GHz	–70 dBm/MHz	-41.3 dBm/MHz	-41.3 dBm/MHz
4.2 - 4.8 GHz	*–70 dBm/MHz*	*-41.3 dBm/MHz*	*-41.3 dBm/MHz*
4.8 - 6 GHz	–70 dBm/MHz	–70 dBm/MHz	–70 dBm/MHz
6 - 8.5 GHz	–41,3 dBm/MHz	–41,3 dBm/MHz	–41,3 dBm/MHz
8.5 - 10.6 GHz	–65 dBm/MHz	- 41.3 dBm/MHz	- 65 dBm/MHz
> 10.6 GHz	–85 dBm/MHz	- 85 dBm/MHz	- 85 dBm/MHz

Table 7: European PSD including DAA and LDC

As an overall summary and intermediate conclusion a close collaboration with all players in the UWB field will be of importance to come to a better regulatory environment in the different regions. Especially the inclusion of specific environments with additional mitigation factors and the increase of the TX power in the upper band will only be possible if several players join forces. Here the European EUWB project and the included partners could be good starting point. Potentially the creation of a world wide UWB interest group covering the different technologies could be a good way forward. This interest group would have the main goal of coordinating the inputs towards the different regulatory activities and the support during the development of harmonised standards like in ETSI. Some partners in the EUWB project already expressed their interest in participating in such an interest group.

9 Regulation and standardisation outside Europe

9.1 Regulation and standardisation in USA (FCC)

In USA the FCC approved UWB emission mask since 2002. The following figure gives the emission mask for communications devices in an indoor environment. For generic UWB devices a maximum mean EIRP of -41.3 dBm/MHz and a peak power of 0dBm measured in 50MHZ is authorised between 3.1 GHz and 10.6 GHz.

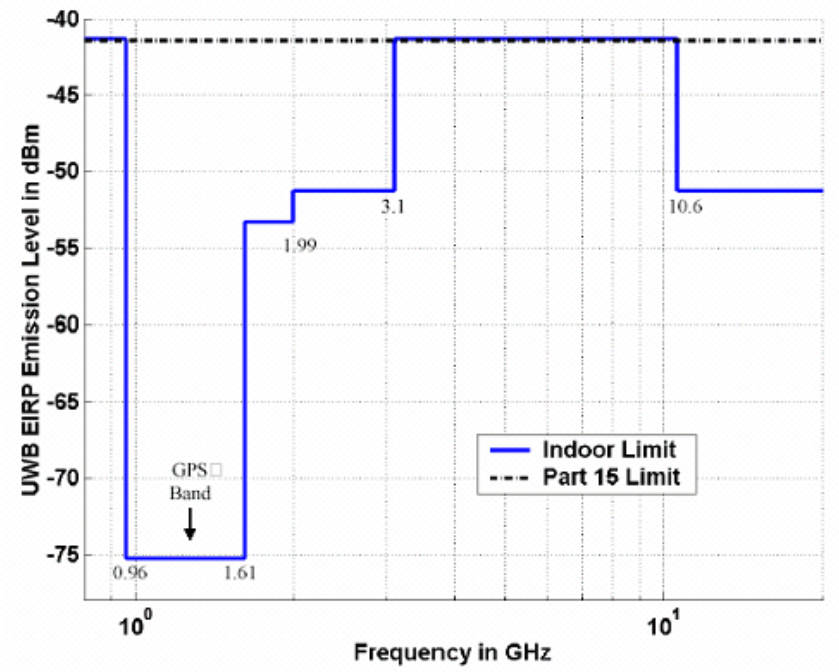

Figure 10: FCC transmission mask

A revision of the FCC UWB regulation is under discussion (including the revision of all the different type and sub-types of applications, like: medical, wall probing,…).

A time schedule is not defined today

Today's procedure: Industry request will handle on waiver basis.

→ e.g. "any point in time" rule for an UWB device leads to an inefficient spectrum usage, because emission < 500 MHz are not allowed.

*FCC definition of UWB : An intentional radiator that, at **any point in time**, has a fractional bandwidth equal to or greater than 0.20 or has a UWB bandwidth equal to or greater than 500 MHz, regardless of the fractional bandwidth.*

9.2 Canada

Industry Canada:

RSS220; Devices Using Ultra-Wideband (UWB) Technology

Indoor Communication, Measurement, Location Sensing and Tracking Devices; equal to handheld devices rule / limits

Frequency	e.i.r.p. in a resolution bandwidth of 1 MHz
0.960 – 1.610 GHz	-75.3 dBm
1.61 - 4.75 GHz	-70.0 dBm
4.75 - 10.6 GHz	-41.3 dBm
Above 10.6 GHz	-51.3 dBm

Definition: An UWB device is an intentional radiator that has either a -10 dB bandwidth1 of at least 500 MHz or a -10 dB fractional bandwidth2 greater than 0.2.

9.3 South America and Middle America

A general regulation framework for UWB in South America is not in place yet but most of the countries allow the use of UWB devices based on an individual certification process.

Here the FCC and the ETSI rules are seen as the references for an intended product certification.

For each country an individual certification process is needed which is comparable to most of the Asian states.

The American Organisation CITEL started in 2010 a Work Item to prepare a UWB harmonised regulation suggestion for all American countries (ITU Region 2).

A new status can be expected for Dec 2011.

9.4 China and Hong Kong

In China the MII (Ministry of Information and Industry – combined into Ministry of Industry and Information Technology of the People's Republic of China) has issued a public call for comments on the draft UWB regulation from May, 28th, 2008 to September, 30th, 2008

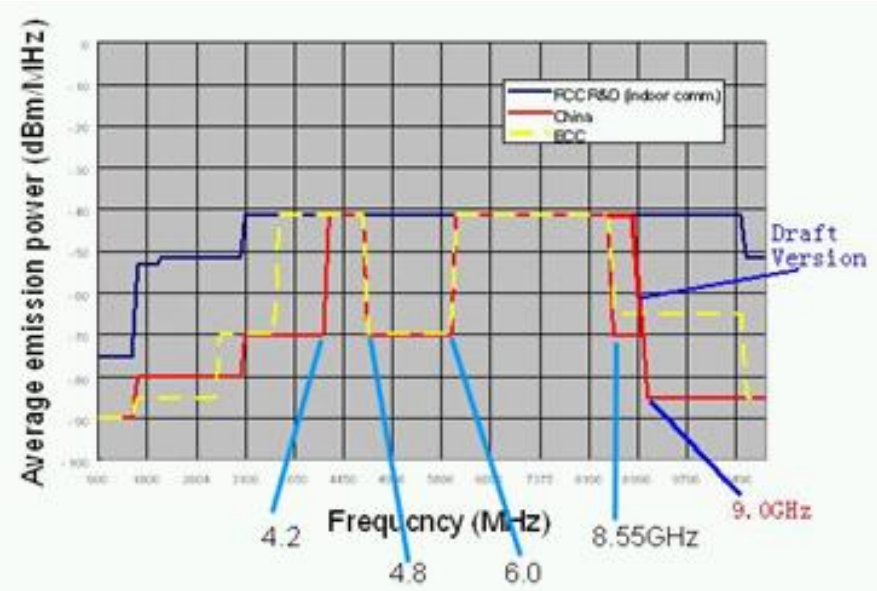

Figure 11: China /Hong Kong transmission mask

- The UWB in band transmission is restricted to the frequency range of 4.2~4.8GHz and 6.0~9.0GHz;
- Device using UWB technology which has UWB transmission in 4.2~4.8GHz is restricted to be used indoor.
- Device using UWB technology which has UWB transmission in 6.0~9.0GHz can be used both in door and outdoor.
- Any UWB radiation from the device using UWB technology (including in band transmission and out of band emission) should meet the requirement list in the table above.

In **Hong Kong** the "Office of Telecommunications Authority" OFTA (http://ww.ofta.gov.hk/) is responsible for the UWB regulation. A so called class license is under discussion in Hong Kong for UWB devices mainly operating indoor.

No final UWB regulation exists up to now.

The regulation is planned to be reevaluated in 2011 on:

$3.4 < f \leq 4.8$ (devices using DAA) with -41.3 dBm/MHz

$6.0 < f \leq 8.5$: with -41.3dBm/MHz

9.5 Japan

In 2010 the phased approach has been extended to 31st of December 2013. No final conclusion related to the definition of DAA has been reached between the UWB industry and the potential victim service operators. Thus the band 4.2GHz to 4.8GHz is open without additional mitigation techniques until the end of 2013.

The band 3.4 – 4.2GHz is licensed for satellite (downlink) communication operators, and requires DAA. Satellite links are rapidly replaced with fibers, and regulation is planned to be reviewed

The band 6.0 – 7.25GHz is licensed to EESS and TV news gathering use, and its use is restricted.

The inputs from the EUWB consortium and other UWB player have asked for an increase of power in the upper band (7.25 GHz to 10,6GHz) and the opening of the band 6GHz to 7,25GHz.

$3.4 < f \leq 4.8$ (devices using DAA)	-41.3 dBm/MHz
$3.4 < f \leq 4.2$ (without DAA)	-70 dBm/MHz
$4.2 < f \leq 4.8$	-41.3 dBm/MHz
$7.25 < f \leq 10.25$	-41.3 dBm/MHz

9.6 Korea

UWB regulation done by MIC (Ministry of Information and Communication Republic of Korea) in July, 2006.

The DAA definition discussion is ongoing and in addition the opening of the band 6GHz to 7,25GHz.Time schedule is open

$3.4 < f \leq 4.2$ (devices using DAA)	-41.3 dBm/MHz
$3.4 < f \leq 4.2$ (without DAA)	-70 dBm/MHz
$4.2 < f \leq 4.8$	-41.3 dBm/MHz
$7.25 < f \leq 10.25$	-41.3 dBm/MHz

References

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[6] ECC(08)023_Annex12_Final report to EC on UWB; Emmanuel Faussurier; ANFR, chairman of ECC TG3

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[8] FCC regulation Part 15 – Radio Frequency Devices; Subpart F- Ultra Wide band Operation; Section 15.501 ff

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Acknowledgement

The EUWB consortium would like to acknowledge the support of the European Commission partly funding the EUWB project under Grant Agreement FP7-ICT-215669 [1],[2].

Annex

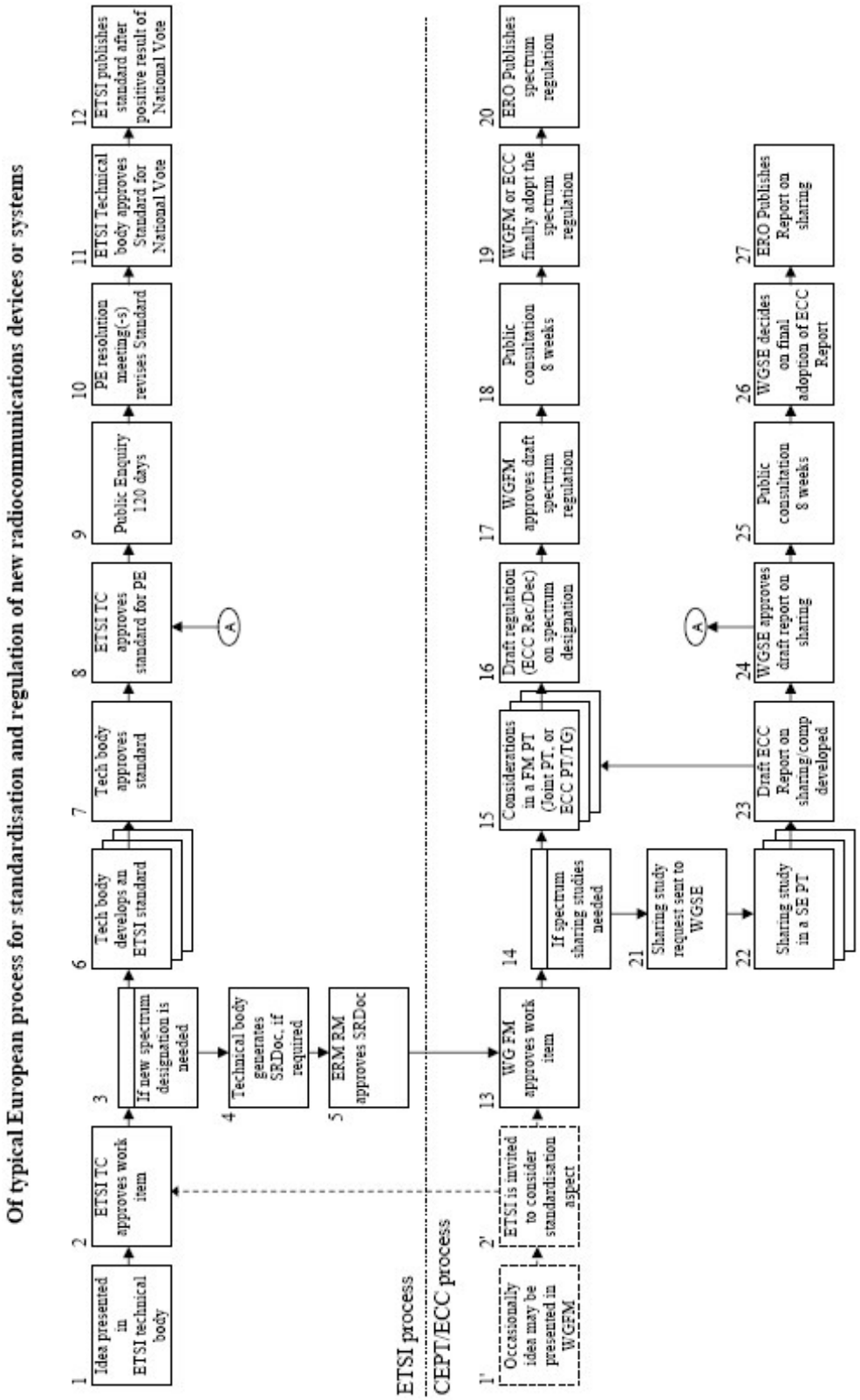

Figure 12: European standardisation process

(working process between ETSI and CEPT)

10 active, non published WIs found, displaying 1 to 10

Work Item Identification	Version	Status
ERM TGUWB		
Doc. Nb. TR103 181-1 Ref. DTR/ERM-TGUWB-007-1	0.0.1	*Working draft (2010-03-10)*
Doc. Nb. TR103 181-2 Ref. DTR/ERM-TGUWB-007-2	0.0.1	*Working draft (2010-03-10)*
Doc. Nb. TS102 883 Ref. DTS/ERM-TGUWB-011	0.0.1 0.0.2 0.0.3	*Working draft (2010-04-20)* Early draft (2010-12-14) Early draft (2011-03-10)
Industrial SRD Doc. Nb. TR102 889-1 Ref. DTR/ERM-TGUWB-012	--	Start of work (2009-11-20)
SRD equipment using Ultra Wide Band technology (UWB) for communications purposes Doc. Nb. EN302 065-1 Ref. REN/ERM-TGUWB-016	0.0.1	Early draft (2011-07-20)
HEN for UWB Location Tracking Doc. Nb. EN302 065-2 Ref. DEN/ERM-TGUWB-017	0.0.1	Early draft (2011-07-19)
HEN for UWB road and rail vehicles Doc. Nb. EN302 065-3 Ref. DEN/ERM-TGUWB-018	--	Start of work (2010-11-08)
DAA mitigation techniques for UWB technologies Doc. Nb. TS Ref. RTS/ERM-TGUWB-019	1.2.2	Early draft (2011-02-15)
UWB location tracking in the railroad environment Doc. Nb. TR101 538 Ref. DTR/ERM-TGUWB-020 Show more drafts >>	0.0.5 0.0.6 0.0.7 0.0.8	Early draft (2010-11-09) Stable draft (2010-11-18) Stable draft (2010-11-23) Early draft (2011-04-04)
UWB location tracking devices in the railroad environment Doc. Nb. TS Ref. DTS/ERM-TGUWB-020	--	TB adoption of WI (2011-06-28)

Figure 13: Status of Standardisation in ETSI ERM TGUWB