



**Short Range Devices (SRD) using Ultra Wide Band (UWB);
Technical Report
Part 1: UWB signal characteristics
and overview CEPT/ECC and EC regulation**

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Foreword

This Technical Report (TR) has been produced by ETSI Technical Committee Electromagnetic compatibility and Radio spectrum Matters (ERM).

The present document is part 1 of a multi-part deliverable covering UWB signal characteristics and related mitigation techniques, as identified below:

- Part 1: "UWB signal characteristics and overview CEPT&ECC and EC regulation";
- Part 2: "UWB mitigation techniques";
- Part 3: "World wide UWB regulation".

Modal verbs terminology

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Introduction

Ultra Wide Band (UWB) radio technology enables a new generation of location tracking systems and sensor devices as well as high-speed data devices for short range communication purposes.

It opens new markets with a variety of innovative applications.

UWB devices may form an integral part of other portable electronic equipment such as future generation cellular phones or laptops equipped with UWB enabled short range air interfaces.

In addition, UWB devices with an operating bandwidth of several hundreds of MHz up to several GHz allow tens of centimetre-level accuracy real time localization and positioning even in the presence of severe multipath effects caused by walls, furniture or any other harsh radio propagation environments.

It is a viable positioning and sensor technology that meets industrial requirements in the following markets:

- 1) Healthcare
- 2) Workplace/Smart Office
- 3) Public buildings
- 4) Security
- 5) Defence training
- 6) Entertainment
- 7) Logistics, warehouses
- 8) Manufacturing assembly lines
- 9) Road and rail vehicles sensor networks
- 10) Public transportation
- 11) Level Gauging
- 12) Professional ground- and wall probing

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1 Scope

The present document summarize the available information about the typical transmission signal characteristics used by Ultra Wideband (UWB) devices, including the references to the relevant standards and CEPT/ECC and EC regulation framework.

Different frequency ranges have been identified or are under study for applications based on UWB technology:

Table 1: Overview UWB application in CEPT/ECC, EC and ETSI (with related Harmonised Standards)

Application	Frequency Ranges [GHz]	ETSI Standard	Remark
Generic, non-specific	3,1 to 4,8 6 to 9	ETSI EN 302 065-1 [i.23]	Former ETSI EN 302 065
Location Tracking below 10 GHz	3,1 to 4,8 6 to 9	ETSI EN 302 065-2 [i.24]	Location Tracking Type 2 (LT 2)
Location tracking called Type 1	6 to 9		Former ETSI EN 302 500 [i.62]
Location tracking called Type 2	3,1 to 4,8		
Location Application for emergency Services (LAES)	3,4 to 4,8		
Location Tracking for automotive & transportation environment (LTT)	3,1 to 4,8 6 to 8,5	ETSI EN 302 065-3 [i.25]	
Building Material Analysis (BMA)	2,2 to 8,5	ETSI EN 302 435 [i.19]	In the future covered by ETSI EN 302 065-4 [i.63]
Object Discrimination and Characterization (ODC)	2,2 to 8,5	ETSI EN 302 498 [i.21]	In the future covered by ETSI EN 302 065-4 [i.63]
Professional Ground- and Wall Probing Radars	0,030 to 12,4	ETSI EN 302 066 [i.20]	ETSI EG 202 730 [i.42]
Short Range Radar 24 GHz	21,65 to 26,65	ETSI EN 302 288	In progress, alternative option to use 24 GHz to 29 GHz frequency range
Long Range Radar 77 GHz	76 to 77	ETSI EN 301 091	Not listed as UWB but devices use signals with BW > 500 MHz
Short Range Radar 79 GHz	77 to 81	ETSI EN 302 264	
Tank Level Probing Radar (TLPR)	4,5 to 7 8,5 to 10,6 24,05 to 27 57 to 64 75 to 85	ETSI EN 302 372 [i.27]	
Level Probing Radars (LPR)	6,0 to 8,5 24,05 to 26,5 57 to 64 75 to 85	ETSI EN 302 729 [i.26]	

2 References

2.1 Normative references

References are either specific (identified by date of publication and/or edition number or version number) or non-specific. For specific references, only the cited version applies. For non-specific references, the latest version of the reference document (including any amendments) applies.

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The following referenced documents are not necessary for the application of the present document but they assist the user with regard to a particular subject area.

- [i.1] EU Commission Decision 2009/343/EC 21 April 2009 amending Decision 2007/131/EC on allowing the use of the radio spectrum for equipment using ultra-wideband technology in a harmonised manner in the Community.
- [i.2] EU Commission Decision 2007/131/EC of 21 February 2007 on allowing the use of the radio spectrum for equipment using ultra-wideband technology in a harmonized manner in the Community.
- [i.3] ECC/DEC/(06)04: "ECC Decision of 24 March 2006 on the harmonized conditions for devices using Ultra-Wideband (UWB) technology in bands below 10,6 GHz", amended 9 December 2011.
- [i.4] ECC/DEC/(07)01: "ECC Decision of 30 March 2007 on Building Material Analysis (BMA) devices using UWB technology".
- [i.5] ECC Report 064: "The protection requirements of radiocommunications systems below 10,6 GHz from generic UWB applications", Helsinki, February 2005.
- [i.6] ECC Report 120: "Technical requirements for UWB DAA (Detect and Avoid) devices to ensure the protection of radiolocation services in the bands 3,1 - 3,4 GHz and 8,5 - 9 GHz and BWA terminals in the band 3,4 - 4,2 GHz", Kristiansand, June 2008.
- [i.7] ECC Report 123: "The impact of object discrimination and characterization (ODC) applications using ultra-wideband (UWB) technology on radio services", Vilnius, September 2008.
- [i.8] ECC Report 170: "Specific UWB applications in the bands 3,4 - 4,8 GHz and 6 - 8,5 GHz Location Tracking Applications for Emergency Services (LAES), location tracking applications type 2 (LT2) and location tracking and sensor Applications for automotive and transportation environments (LTA)", Tallinn, October, 2011.
- [i.9] CEPT Report 10: "Report from CEPT to the European Commission in response to the Mandate on UWB Specific Applications", Final Report on July 2006.

- [i.10] CEPT Report 9: "Report from CEPT to the European Commission in response to the Mandate on Harmonise radio spectrum use for Ultra-Wideband Systems in the European Union", Final Report on 28 October 2005.
- [i.11] CEPT Report 45: "Report from CEPT to the European Commission in response to the Fifth Mandate to CEPT on ultra-wideband technology to clarify the technical parameters in view of a potential update of Commission Decision 2007/131/EC", Final Report on 28 October 2005.
- [i.12] ETSI TS 102 883 (V1.1.1): "Electromagnetic compatibility and Radio spectrum Matters (ERM); Short Range Devices (SRD) using Ultra Wide Band (UWB); Measurement Techniques".
- [i.13] ETSI TS 103 060 (V1.1.1): "Electromagnetic compatibility and Radio spectrum Matters (ERM); Short Range Devices (SRD); Method for a harmonized definition of Duty Cycle Template (DCT) transmission as a passive mitigation technique used by short range devices and related conformance test methods".
- [i.14] ETSI TS 102 754 (V1.3,1): "Electromagnetic compatibility and Radio spectrum Matters (ERM); Short Range Devices (SRD); Technical characteristics of Detect And Avoid (DAA) mitigation techniques for SRD equipment using Ultra Wideband (UWB) technology".
- [i.15] ETSI TR 103 181-2 (V1.1.1): "Electromagnetic compatibility and Radio spectrum Matters (ERM); Short Range Devices (SRD) using Ultra Wide Band (UWB); Transmission characteristics; Part 2: UWB mitigation techniques".
- [i.16] ETSI TR 103 086 (V1.1.1): "Electromagnetic compatibility and Radio spectrum Matters (ERM); Short Range Devices (SRD); Conformance test procedure for the exterior limit tests in EN 302065-3 UWB applications in the ground based vehicle environment".
- [i.17] ETSI TR 102 495-1 (V1.1.1): "Electromagnetic compatibility and 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".
- [i.18] ETSI TR 102 495-2 (V1.2.1): "Electromagnetic compatibility and 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 Characterization (ODC) applications for power tool devices operating in the frequency band of 2,2 GHz to 8,5 GHz".
- [i.19] ETSI EN 302 435, Part 1 and 2 (V.1.3,1): "Electromagnetic compatibility and 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".
- [i.20] ETSI EN 302 066, Part 1 and 2 (V.1.3,1): "Electromagnetic compatibility and Radio spectrum Matters (ERM); Ground- and Wall- Probing Radar applications (GPR/WPR) imaging systems".
- [i.21] ETSI EN 302 498, Part 1 and 2 (V.1.1.1): "Electromagnetic compatibility and Radio spectrum Matters (ERM); Short Range Devices (SRD); Technical characteristics for SRD equipment using Ultra WideBand technology (UWB); Object Discrimination and Characterization Applications for power tool devices operating in the frequency band from 2,2 GHz to 8,5 GHz".
- [i.22] ETSI EN 300 328 (V.1.8.1): "Electromagnetic compatibility and Radio spectrum Matters (ERM); Wideband transmission systems; Data transmission equipment operating in the 2,4 GHz ISM band and using wide band modulation techniques; Harmonized EN covering the essential requirements of article 3.2 of the R&TTE Directive".
- [i.23] ETSI EN 302 065-1 (V.1.3,1): "Electromagnetic compatibility and Radio spectrum Matters (ERM); Short Range Devices (SRD) using Ultra Wide Band technology (UWB); Harmonized EN covering the essential requirements of article 3.2 of the R&TTE Directive; Part 1: Requirements for Generic UWB applications".

- [i.24] ETSI EN 302 065-2 (V.1.1.1): "Electromagnetic compatibility and Radio spectrum Matters (ERM); Short Range Devices (SRD) using Ultra Wide Band technology (UWB); Harmonized EN covering the essential requirements of article 3.2 of the R&TTE Directive; Part 2: Requirements for UWB location tracking".
- [i.25] ETSI EN 302 065-3 (V.1.1.1): "Electromagnetic compatibility and Radio spectrum Matters (ERM); Short Range Devices (SRD) using Ultra Wide Band technology (UWB); Harmonized EN covering the essential requirements of article 3.2 of the R&TTE Directive; Part 3: Requirements for UWB devices for road and rail vehicles".
- [i.26] ETSI EN 302 729, Part 1 and 2 (V1.1.2): "Electromagnetic compatibility and Radio spectrum Matters (ERM); Short Range Devices (SRD); Level Probing Radar (LPR) equipment operating in the frequency ranges 6 GHz to 8,5 GHz, 24,05 GHz to 26,5 GHz, 57 GHz to 64 GHz, 75 GHz to 85 GHz".
- [i.27] ETSI EN 302 372, Part 1 and 2 (V1.2.1): "Electromagnetic compatibility and Radio spectrum Matters (ERM); Short Range Devices (SRD); Equipment for Detection and Movement; Tanks Level Probing Radar (TLPR) operating in the frequency bands 5,8 GHz, 10 GHz, 25 GHz, 61 GHz and 77 GHz".
- [i.28] Recommendation ITU-R P.526-10: "Propagation by diffraction".
- [i.29] Recommendation ITU-R P 679-1: "Propagation data required for the design of broadcasting-satellite systems".
- [i.30] Recommendation ITU-R RA 769-2: "Protection criteria used for radio astronomical measurements".
- [i.31] ECC TG3#18-18R0: "Flexible DAA mechanism based on "isolation criteria" between victim service and UWB devices", ECC TG3 Meeting 18, Mainz, March 2007.
- [i.32] JRC: "Report on Radio Frequency Compatibility Measurements between UWB LDC Devices and Mobile WiMAX (IEEE 802.16e-2005) BWA Systems", July 26-27, 2010.
- [i.33] Wimax Forum: "Mobile WiMAX - Part 1: A Technical Overview and Performance Evaluation", August, 2006.
- [i.34] L. K. Brunson et Alt: "Assessment of compatibility between Ultra WideBand devices and selected federal systems", NTIA special publication, January 2001.
- [i.35] Ching-Ping Wang and Wen-Jiao Liao: "Propagation of Ultra Wideband Signals in Automotive Environment", National Taiwan University of Science and Technology, Taiwan.
- [i.36] Joaquim Fortuny-Guasch: "UWB screening attenuation measurements of cars", study by IPSC of JRC and ETSI TG31C on the measurements of the screening attenuation of cars in the frequency range between 0,85GHz and 11GHz, IPSC, October 2006.20.
- [i.37] EC DEC on UWB (2014/702/EU): "Commission Implementing Decision of 7 October 2014 amending Decision 2007/131/EC on allowing the use of the radio spectrum for equipment using ultra-wideband technology in a harmonised manner in the Community".
- [i.38] ECC/REC(11)10: "Location tracking application for emergency and disaster situations", November 2011.
- [i.39] ECC/REC(11)09: "UWB Location Tracking Systems TYPE 2 (LT2)", November 2011.
- [i.40] ECC Report 167: "Practical implementation of registration/coordination mechanism for UWB LT2 systems", May 2011.
- [i.41] ECC/DEC(12)03: "ECC Decision of 2 November 2012 on the harmonised conditions for UWB applications onboard aircraft".
- [i.42] ETSI EG 202 730: "Electromagnetic compatibility and Radio spectrum Matters (ERM); Code of Practice in respect of the control, use and application of Ground Probing Radar (GPR) and Wall Probing Radar (WPR) systems and equipment".

- [i.43] ECC/DEC(06)08: "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".
- [i.44] ECC/DEC(11)02: "ECC Decision of 11 March 2011 on industrial Level Probing Radars (LPR) operating in frequency bands 6 - 8,5 GHz, 24.05 - 26.5 GHz, 57 - 64 GHz and 75 - 85 GHz".
- [i.45] ERC REC 70-03 Annex 6, final version: "Relating to the Use of Short Range Devices (SRD)" Tromsø 1997. Subsequent amendments 07 February 2014.
- NOTE: Available on EFIS database www.efis.dk.
- [i.46] ETSI TR 101 994-1 (V1.1.1): "Electromagnetic compatibility and Radio spectrum Matters (ERM); Short Range Devices (SRD); Technical characteristics for SRD equipment using Ultra Wide Band technology (UWB) Part 1: Communications applications".
- [i.47] ETSI TR 101 994-2: "Electromagnetic compatibility and Radio spectrum Matters (ERM); Short Range Devices (SRD); Technical characteristics for SRD equipment using Ultra Wide Band technology (UWB); Part 2: Ground- and Wall- Probing Radar applications; System Reference Document".
- [i.48] ETSI TR 102 495-3: "Electromagnetic compatibility and Radio spectrum Matters (ERM); System Reference Document; Short Range Devices (SRD); Technical Characteristics for SRD equipment using Ultra-Wideband Sensor Technology (UWB); Part 3: Location tracking applications type 1 operating in the frequency band from 6 GHz to 8,5 GHz for indoor, portable and mobile outdoor applications".
- [i.49] ETSI TR 102 495-5: "Electromagnetic compatibility and Radio spectrum Matters (ERM); System Reference Document; Short Range Devices (SRD); Technical characteristics for SRD equipment using Ultra Wide Band Sensor technology (UWB); Part 5: Location tracking applications type 2 operating in the frequency bands from 3,4 GHz to 4,8 GHz and from 6 GHz to 8,5 GHz for person and object tracking and industrial applications".
- [i.50] ETSI TR 102 495-7: "Electromagnetic compatibility and Radio spectrum Matters (ERM); System Reference Document; Short Range Devices (SRD); Technical characteristics for SRD equipment using Ultra Wide Band Sensor technology (UWB); Part 7: Location 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".
- [i.51] ETSI TR 102 496: "Electromagnetic compatibility and Radio spectrum Matters (ERM); System Reference Document; Short Range Devices (SRD); Technical characteristics for Location tracking Applications for Emergency Services (LAES) in disaster situations operating within the frequency range from 3,4 GHz to 4,8 GHz".
- [i.52] ETSI TR 101 538: "Electromagnetic compatibility and Radio spectrum Matters (ERM); Short Range Devices (SRD); UWB location tracking devices in the railroad environment".
- [i.53] ETSI TS 103 085: "Electromagnetic compatibility and Radio spectrum Matters (ERM); Short Range Devices (SRD) using Ultra Wide Band (UWB) for Location and Tracking railroad applications; RF conformance testing".
- [i.54] CEPT Report 34: "Report B from CEPT to European Commission in response to the Mandate 4 on Ultra-Wideband (UWB)".
- [i.55] ETSI TR 102 347: "Electromagnetic compatibility and Radio spectrum Matters (ERM); Short Range Devices (SRD); Equipment for Detecting Movement; Radio equipment operating around e.g. 5,8 GHz, 10 GHz, 25 GHz, 61 GHz, 77 GHz; System Reference Document for Tank Level Probing Radar (TLPR)".
- [i.56] ETSI TR 102 601: "Electromagnetic compatibility and Radio spectrum Matters (ERM); System reference document; Short Range Devices (SRD); Equipment for Detecting Movement using Ultra Wide Band (UWB) radar sensing technology; Level Probing Radar (LPR) - sensor equipment operating in the frequency bands 6 GHz to 8,5 GHz; 24,05 GHz to 26,5 GHz; 57 GHz to 64 GHz and 75 GHz to 85 GHz".

- [i.57] ECC Report 139: "Impact of Level Probing Radars (LPR), using Ultra-Wideband Technology on Radiocommunications Services".
- [i.58] ECC Report 175: "Co-existence study considering UWB applications inside aircraft and existing radio services in the frequency bands from 3,1 GHz to 4,8 GHz and from 6.0 GHz to 8,5 GHz".
- [i.59] ETSI TR 102 834: "Electromagnetic compatibility and Radio spectrum Matters (ERM); System Reference Document; Technical Characteristics for airborne Ultra-WideBand (UWB) applications operating in the frequency bands from 3,1 GHz to 4,8 GHz and 6 GHz to 8,5 GHz".
- [i.60] ECMA-368: "High Rate Ultra Wideband PHY and MAC Standard", ECMA international, 3rd Edition, Geneva, December 2008.
- [i.61] EU Commission Decision 2013/752/EU implementing Decision of 11 December 2013 amending Decision 2006/771/EC on harmonisation of the radio spectrum for use by short-range devices and repealing Decision 2005/928/EC.
- [i.62] ETSI EN 302 500 parts 1 and 2 (V1.2.1): "Electromagnetic compatibility and Radio spectrum Matters (ERM); Short Range Devices (SRD) using Ultra WideBand (UWB) technology; Location Tracking equipment operating in the frequency range from 6 GHz to 8,5 GHz".
- [i.63] ETSI EN 302 065-4: "Electromagnetic compatibility and Radio spectrum Matters (ERM); Short Range Devices (SRD) using Ultra Wide Band technology (UWB); Harmonized EN covering the essential requirements of article 3.2 of the R&TTE Directive; Part 4; Material Sensing devices using UWB technology below 10,6 GHz".
- [i.64] IEEE™ 802.15.4f-2012: "IEEE Standard for Local and metropolitan area networks - Part 15.4: Low Rate Wireless Personal Area Networks (LR-WPANS)".
- [i.65] ETSI EN 303 883: "Electromagnetic compatibility and Radio spectrum Matters (ERM); Short Range Devices (SRD) using Ultra Wide Band (UWB); Measurement Techniques".

3 Symbols and abbreviations

3.1 Symbols

For the purposes of the present document, the following symbols apply:

dB _i	antenna gain relative to isotropic radiator in decibel
dB _m	Absolute power level expressed in decibels relative to 1 mW
EP	Energy per pulse
f	frequency
f ₀	start frequency
f _E	stop frequency
Δf	step width
GHz	Giga Hertz
kb	Boltzmann constant
mW	Milliwatt
MHz	Mega Hertz
n	number of hops
N ₀	Noise floor
R ₀	predefined antenna impedance
T	Temperature
T _c	Chip period
t ₀	Start time
t _E	Stop time
Δt _{hopp}	time for one step
Δt _{on}	time transmission on (one step)
T _p	pulse period
T _{txa}	Transmitter active time
T _{txi}	Transmitter idle time

V0 Peak Voltage Amplitude

3.2 Abbreviations

For the purposes of the present document, the following abbreviations apply:

ABL	Anchor Based Location
AFL	Anchor Free Location
APC	Automatic Power Control
BMA	Building Material Analyses
BPSK	Binary Phase Shift Keying
BW	Band Width
CEPT	Commission Européenne des Postes et Télécommunications
DAA	Detect and Avoid
DC	Duty Cycle
DEC	Decision
e.i.r.p.	equivalent isotropic radiated power
EC	European Commission
ECC	European Communication Comity
ECMA	European Computer Manufacturers Association
EESS	Earth Exploration Satellite Services
EN	European Norm
FH	Frequency Hopping
FMCW	Frequency Modulated Continuous Wave
FS	Fixed Services
FSK	Frequency Shift Keying
FSS	Fixed Satellite services
GPR	Ground Probing Radar
IF	Intermediate Frequency
LAES	Location Application for emergency Services
LAN	Local Area Network
LBT	Listen before talk
LDC	Low Duty Cycle
LPR	Level Probing Radar
LT	Location Tracking
LTT	Location Tracking for automotive and environment
MB	Multi Band
MSS	Mobile Satellite Services
ODC	Object Discrimination and Characterization
OFDM	Orthogonal Frequency Division Multiplexing
OOK	On-Off Keying
PAM	Pulse Amplitude Modulation
PPM	Pulse Position Modulation
PRF	Pulse Repetition Frequency
PSD	Power Spectral Density
RAS	Radio Astronomy Services
REC	Recommendation
RF	Radio Frequency
RFID	Radio Frequency Identification Device
RNSS	Radio Navigation Satellite Services
SRD	Short Range Devices
TLPR	Tank Level Probing Radar
TPC	Transmit Power Control
TR	Technical Report
TRT	Thales Research and Technology
TS	Technical Specification
UWB	Ultra Wide Band
WPR	Wall Probing Radar

4 CEPT/ECC and EC UWB Framework

4.1 UWB Definition:

UWB Definition out from 2007/131/EC [i.2]:

"equipment using ultra-wideband technology' means equipment incorporating, as an integral part or as an accessory, technology for short-range radiocommunication, involving the intentional generation and transmission of radio-frequency energy that spreads over a frequency range wider than 50 MHz, which may overlap several frequency bands allocated to radiocommunication services."

Figures 1, 2 and 3 show an overview on the current regulatory and standardization framework of UWB in CEPT/ECC, EC and ETSI. A written overview is given in table 2.

- Figure 1: Generic, location tracking, vehicular and specific sensor UWB
- Figure 2: Railway environment, (tank) level probing and ground/wall probing
- Figure 3: Automotive applications (not all seen as UWB)

NOTE: The overviews are reflecting the status at the time of the publication of the present document. Based on the new Radio Equipment Directive (RED) in EC-Countries amendments of all ETSI harmonised standards will be necessary. This could lead to a rearrangement of the standard (numbering, merging of standards, etc.) but in most cases the numbers will kept (only document version will be changed).

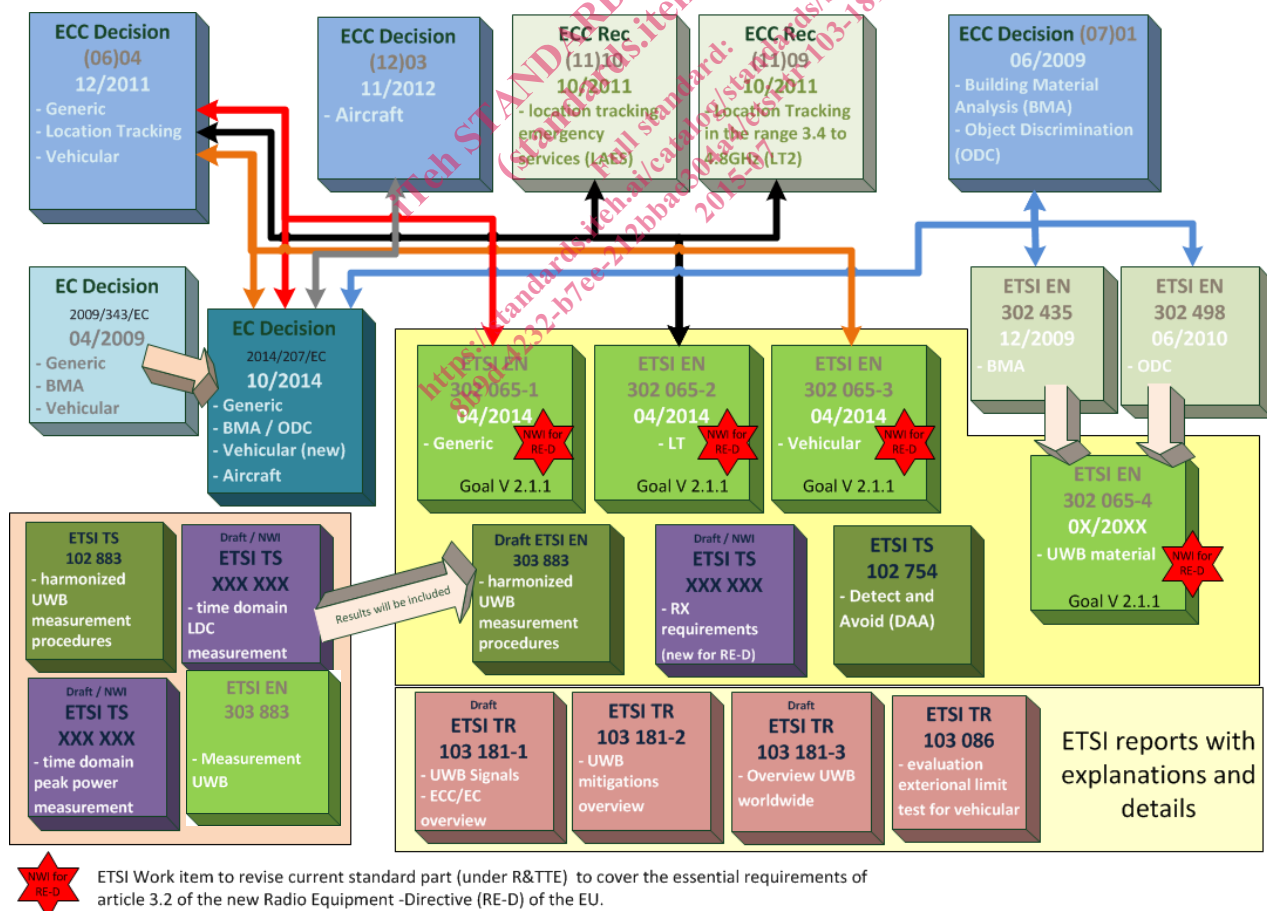


Figure 1: Regulation and Standardization - overview 1