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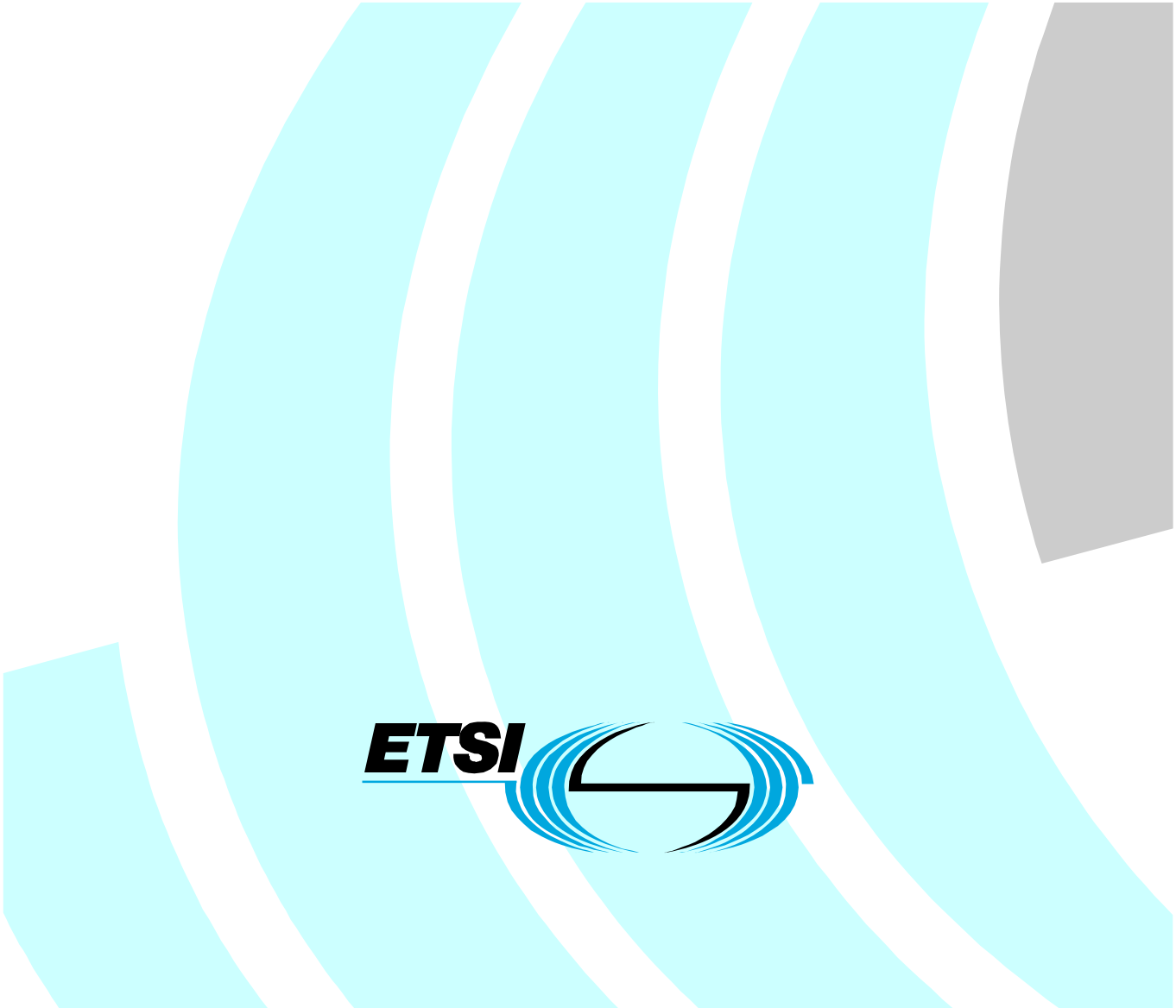
Technical Report

Electromagnetic compatibility and Radio spectrum Matters (ERM); System Reference Document; Broadband Wireless Systems in the 2 300 MHz to 2 400 MHz Range



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Foreword

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

Executive summary

Some countries around Europe have licensed or are considering licensing the 2 300 MHz to 2 400 MHz band for mobile broadband applications. Therefore the present document provides an overview of typical mobile broadband technologies that could address this opportunity. Already equipment is becoming available which is based on standardised air interfaces, and markets are growing in other parts of the world. The characteristics of mobile broadband equipment for this frequency range are similar to those for equipment in other nearby frequency ranges and in many cases, equipment will be able to support multi-band operation.

As in other frequency ranges, the typical network architecture is a point to multipoint cellular format with central base stations serving a surrounding (or sectorised) coverage area in which mobile terminals are served. Systems are planned so that the base station uses specific frequency channels from the licensed block in a regular pattern that may vary according to capacity or coverage requirements.

The proponents of these technologies have an interest in addressing a growing market for mobile broadband services in the 2 300 MHz to 2 400 MHz frequency range but are concerned that no specific regulatory guidance from CEPT/ECC exists for administrations wishing to issue licences in parts of this range that may be available depending on national circumstances. Therefore development of an appropriate ECC deliverable is desired, that can provide guidance on typically:

- band arrangements including channelization;
- operator block sizes;
- any inter-service spectrum management measures;
- any inter-operator spectrum management measures.

The nature and availability of this frequency band is particularly suited to addressing a TDD technology opportunity and being reflected in developments in other regions and in the equipment standardisation activities, forms the core of the technology descriptions in the present document.

The proponents believe that use of this frequency range for mobile broadband applications can boost the data handling capacity of current national networks which in recent times have been coming under increasing pressure from the rapid growth in data services and new applications across mobile networks. Whilst other frequency bands remain available in some countries, the timely licensing of those frequencies can depend on national circumstances and in some cases the 2 300 MHz to 2 400 MHz band could be available on a shorter timescale.

Introduction

The present document has been developed to support the co-operation between ETSI and the Electronic Communications Committee (ECC) of the European Conference of Post and Telecommunications Administrations (CEPT).

Table 1: Status of pre-approval draft

Target version	Pre-approval date version (see note)				
Vm.a.b	**a**	**s**	**m**	**Date**	**Description**
1.1.1	1.1.1			2010-03	Sent to internal enquiry
1.1.1	1.1.2			2010-05	Internal enquiry comments resolved.
NOTE: See EG 201 788 [i.24] (V2.1.1), clause A.2.					

The present document was developed in ETSI BRAN and ERM. It contains final information.

1 Scope

The present document describes Broadband Wireless Systems which may require a change in the present regulatory framework for TDD mobile applications in the 2 300 MHz to 2 400 MHz band regarding either intended or unwanted emissions. The Broadband Wireless System technologies considered within the scope of the present document may originate from more than a single air interface standardisation body and therefore exhibit characteristics from different BWA technologies.

The Broadband Wireless Systems considered are based upon traditional cellular deployment scenarios generally consisting of central Base Stations and mobile User Equipments.

It includes in particular:

- Market information.
- Technical information including expected sharing and compatibility issues.

NOTE: The information on sharing and compatibility issues is required when new spectrum or new spectrum usage is requested.

- Regulatory issues.

2 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.

Referenced documents which are not found to be publicly available in the expected location might be found at http://docbox.etsi.org/Reference.

NOTE: While any hyperlinks included in this clause were valid at the time of publication ETSI cannot guarantee their long term validity.

2.1 Normative references

The following referenced documents are necessary for the application of the present document.

Not applicable.

2.2 Informative references

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] ERC Report 25: "The European Table of frequency allocations and utilisations in the frequency range 9 kHz to 3000 GHz", Lisboa 02- Dublin 03- Kusadasi 04- Copenhagen 04- Nice 07- Baku 08.

[i.2] ITU-R Radio Regulations, Edition 2008.

[i.3] WiMAX Forum whitepaper: "A Review of Spectrum Requirements for Mobile WiMAX Equipment to support Wireless Personal Broadband Services" - September 2007.

[i.4] CEPT/ERC Recommendation 62-02 e (Tromsø 1997): "Harmonised frequency band for civil and military airborne telemetry applications".

[i.5] ETSI EN 301 783: "Electromagnetic compatibility and Radio spectrum Matters (ERM); Land Mobile Service; Commercially available amateur radio equipment".

[i.6] Revised ERC Recommendation 25-10: "Frequency ranges for the use of temporary terrestrial audio and video sap/sab links (incl. ENG/OB)".

[i.7] ETSI EN 302 064 (all parts): "Electromagnetic compatibility and Radio spectrum Matters (ERM); Wireless Video Links (WVL) operating in the 1,3 GHz to 50 GHz frequency band".

[i.8] Com-Reg 0949: "Release of Spectrum in the 2300 - 2400 MHz band; Proposed Options & License Conditions".

[i.9] UK Ministry of Defence; Final Report: "Defence Demand for Spectrum: 2008 - 2027", 24 November 2008.

[i.10] Directive 1999/5/EC of the European Parliament and of the Council of 9 March 1999 on radio equipment and telecommunications terminal equipment and the mutual recognition of their conformity.

[i.11] CEPT Report 019: "Report from CEPT to the European Commission in response to the Mandate to develop least restrictive technical conditions for frequency bands addressed in the context of WAPECS".

[i.12] ECC Report 131: "Derivation of a block edge mask (BEM) for terminal stations in the 2.6 GHz frequency band (2500-2690 MHz)", Dublin, (January, 2009).

[i.13] ECC Report 100: "Compatibility studies in the band 3400- 3800 MHz between Broadband Wireless Access (BWA) systems and other services", Bern, February 2007.

[i.14] ERC Report 038: "Handbook on radio equipment and systems video links for eng/ob use, Stockholm", May 1995".

[i.15] RSPG09-284 Final: "RSPG working group on wireless broadband -final position paper", 14 May 2009.

[i.16] US Code of Federal Regulations. Title 47, Part 27, Section 53.

NOTE: See http://www.gpoaccess.gov/cfr/retrieve.html.

[i.17] IEEE 802.16-2009: "IEEE Standard for Local and metropolitan area networks Part 16: Air Interface for Broadband Wireless Access Systems".

[i.18] ETSI TS 136 104 (V9.2.0): "LTE; Evolved Universal Terrestrial Radio Access (E-UTRA); Base Station (BS) radio transmission and reception (3GPP TS 36.104 Release 9)".

[i.19] ETSI TS 136 101 (V9.2.0): "LTE; Evolved Universal Terrestrial Radio Access (E-UTRA); User Equipment (UE) radio transmission and reception (3GPP TS 36.101 Release 9)".

[i.20] WiMAX Forum® Mobile Radio Specifications (Revision 0.3.1: 2009-02-02).

[i.21] CEPT/ERC/Recommendation 74-01E: "Unwanted emissions in the spurious domain" (Siófok 98, Nice 99, Sesimbra 02, Hradec Kralove 05).

[i.22] ETSI TS 136 211 (V9.0.0): "LTE; Evolved Universal Terrestrial Radio Access (E-UTRA); Physical channels and modulation (3GPP TS 36.211 Release 9)".

[i.23] EC Decision 2008/477/EC: "Commission Decision of 13 June 2008 on the harmonisation of the 2 500-2 690 MHz frequency band for terrestrial systems capable of providing electronic communications services in the Community".

[i.24] ETSI EG 201 788: "Electromagnetic compatibility and Radio spectrum Matters (ERM); Guidance for drafting an ETSI System Reference document (SRdoc)".

[i.25] ETSI EN 302 217: "Fixed Radio Systems; Characteristics and requirements for point-to-point equipment and antennas".

[i.26] ERC/REC 70-03: "ERC Recommendation 70-03 (Tromsø 1997 and subsequent amendments) relating to the use of short range devices (SRD)".

[i.27] ETSI EN 300 440: "Electromagnetic compatibility and Radio spectrum Matters (ERM); Short range devices; Radio equipment to be used in the 1 GHz to 40 GHz frequency range".

[i.28] ERC/DEC(01)08: "ERC Decision of 12 March 2001 on harmonised frequencies, technical characteristics and exemption from individual licensing of Short Range Devices used for Movement Detection and Alert operating in the frequency band 2400 - 2483.5 MHz".

[i.29] ETSI EN 300 761: "ElectroMagnetic Compatibility and Radio Spectrum Matters (ERM); Short Range Devices (SRD); Automatic Vehicle Identification (AVI) for railways operating in the 2,45 GHz frequency range".

[i.30] ERC/DEC(01)07: "ERC Decision of 12 March 2001 on harmonised frequencies, technical characteristics and exemption from individual licensing of Short Range Devices used for Radio Local Area Networks (RLANs) operating in the frequency band 2400 - 2483.5 MHz".

[i.31] ETSI EN 300 328: "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 essential equirements under article 3.2 of the R&TTE Directive".

[i.32] ERC/DEC/(97)03: "ERC Decisionof 30 June 1997 on the Harmonised Use of Spectrum for Satellite Personal Communication Services (S-PCS) operating within the bands 1610-1626.5 MHz, 2483.5-2500 MHz, 1980-2010 MHz and 2170-2200 MHz".

[i.33] ERC/DEC(97)05: "ERC Decision (of 30 June 1997) amended by ECC 18 March 2005 on free circulation, use and licensing of Mobile Earth Stations of Satellite Personal Communications Services (S-PCS) operating within the bands 1610-1626.5 MHz, 2483.5-2500 MHz, 1980-2010 MHz and 2170-2200 MHz within the CEPT".

[i.34] ECC/DEC(07)04: "ECC Decision of 21 December 2007 on free circulation and use of mobile satellite terminals operating in the Mobile-Satellite Service allocations in the frequency range 1-3 GHz".

[i.35] ECC/DEC(07)05: "ECC Decision of 21 December 2007 on exemption from individual licensing of land mobile satellite terminals operating in the Mobile-Satellite Service allocations in the frequency range 1-3 GHz".

[i.36] CEPT/ERC/REC 25-10 E: "Frequency Ranges for the Use of Temporary Terrestrial ENG/OB Video Links During Events in Other CEPT Member Countries".

3 Definitions, symbols and abbreviations

3.1 Definitions

For the purposes of the present document, the following terms and definitions apply:

resource block: defined unit of time and frequency spectrum allocation

NOTE: In E-UTRA, a resource block consists in uplink of N^{UL}_{symb} consecutive SC-FDMA and in downlink of N^{DL}_{symb} consecutive OFDM symbols in the time domain and N^{RB}_{sc} consecutive subcarriers in the frequency domain with N^{UL}_{symb}, N^{DL}_{symb} and N^{RB}_{sc} defined in tables 5.2.3-1 and 6.2.3-1 of [i.22].

subchannel: logical channel for transmission or control purposes

NOTE: In the frequency domain, for OFDMA systems, the subchannel comprises a smaller number of physical OFDM sub-carriers than the total number available in the whole channel bandwidth. The specific sub-carriers associated with a particular sub-channel are usually dynamically distributed throughout the whole channel bandwidth. The minimum number of sub-carriers that may comprise a sub-channel is dependent on the system design.

3.2 Symbols

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

Δf	the frequency offset in MHz from the channel centre frequency
Δf_{OOB}	the frequency offset in MHz from the upper and lower assigned channel edge

3.3 Abbreviations

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

ACLR	Adjacent Channel Leakage Ratio
ACLR1	Adjacent Channel Leakage Ratio (First adjacent channel)
ACS	Adjacent Channel Selectivity
APT	Asia Pacific Telecommunity
AWF	Asia-Pacific Telecommunity Wireless Forum
BEM	Block Edge Mask
BS	Base Station
BWA	Broadband Wireless Access
CEPT	Commission Européenne des Postes et Télécommunications
CFR	Code of Federal Regulations
CP	Cyclic Prefix
CPE	Customer Premises Equipment
DFT	Discrete Fourier Transformation
DL	Downlink (BS to MS transmission direction)
ECA	European Common Allocation
ECC	Electronic Communications Committee of the CEPT
EIRP	Effective Isotropic Radiated Power
E-UTRA	Evolved Universal Terrestrial Radio Access
FFT	Fast Fourier Transform
FWA	Fixed Wireless Access
GSMA	GSM Association
IFFT	Inverse Fast Fourier Transform
IMT	International Mobile Telephony
MS	Mobile (subscriber) Station
NF	Noise Figure
OFDM	Orthogonal Frequency Division Multiplexing
OFDMA	Orthogonal Frequency Division Multiple Access
PAPR	Peak to Average Power Ratio
PRB	Physical Resource Blocks
QPSK	Quadrature Phase Shift Keying
R	Repetition factor
RF	Radio Frequency
RFID	Radio Frequency Identification
RSPG	Radio Spectrum Policy Group
SAP/SAB	Services Ancillary to Production / Services Ancillary to Broadcasting
SC-FDMA	Single Carrier - Frequency Division Multiple Access
SDO	Standards Development Organisation
SFN	Single Frequency Network
SRD	Short Range Device
TDD	Time Division Duplex
TD-LTE	Time Division - Long Term Evolution
TDMA	Time Division Multiple Access
TS	Terminal Station
UL	Uplink (MS to BS transmission direction)
WAPECS	Wireless Access Policy for Electronic Communication Services
WCS	Wireless Communication Services

4 Comments on the System Reference Document

4.1 Statements by ETSI Members

Germany sees coexistence problems that are extremely unlikely to be resolved, therefore Germany does not plan to open the band 2 300 MHz to 2 400 MHz for Broadband Wireless Systems.

5 Presentation of the system or technology

It is widely recognised that access to broadband data services is becoming an essential aspect of modern society and is important for consumers and businesses to remain competitive in the modern world. Consumers and businesses expect to be always connected even whilst on the move. The mobile broadband industry seeks to satisfy this demand through the deployment of technologies that provide "blanket" wireless coverage most commonly using cellular techniques and radio resource planning.

Typical mobile broadband applications are already well known from discussions relating to other frequency bands, and they include any element that requires a high speed data connection and can enable:

- remote connection to business networks allowing home/remote working, video conferencing and collaboration;
- content rich multi-media entertainment and news services relating to video or audio clips;
- e-Commerce services allowing tele-shopping;
- education services bringing ready access to educational content and knowledge information;
- social services including remote health care;
- e-Government services;
- new aspects like social networking.

6 Market information

The WiMAX Forum Whitepaper [i.3] provides an analysis of the potential size of the worldwide mobile broadband wireless market which ranges from 1 billion to 3 billion users in 2012, increasing up to between 2,5 billion and 8 billion in 2015. This is based on research carried out by Informa Telecoms and Media and assuming conservative and aggressive growth scenarios.

There are many other studies publicly and commercially available through internet resources that offer an analysis of the growth in mobile broadband wireless subscriptions and the benefits that a vibrant broadband eco-system can bring to consumers and economic well being. Organisations that have sponsored research include the GSMA and the European Commission.

Driven by the growing developments in the Asia Pacific region, industry has been incentivised to develop standardised equipment and consumer devices that cover this frequency range. In TS 136 101 [i.19] and TS 136 104 [i.18] the 2 300 MHz to 2 400 MHz frequency range is addressed as E-UTRA band 40. Multi-band devices are available today. Industry lead initiatives have been developing interoperable device certification infrastructure with agreed test procedures and accredited laboratories for equipment in this frequency range since early 2008. The WiMAX Forum certifies devices and base stations to Certification Profiles M2300T-01 and M2300T-02 for the frequency range 2 300 MHz to 2 400 MHz. The number of devices certified as interoperable is growing as markets open and new features come to market. Therefore affordable technology exists already that could support wireless broadband services in this frequency range in those European countries that are interested in the use of this band for these applications.

7 Technical information

The mobile Broadband Wireless System technologies within the scope of the present document originate from more than one standardisation body and can be considered to encompass both BWA and IMT technologies. Two technology examples are considered in this clause drawn from different standardisation sources. One is drawn from OFDMA BWA/IMT technology based upon IEEE 802.16-2009 [i.17] in conjunction with the Mobile WiMAX Radio Specification [i.20]. A second is drawn from 3GPP E-UTRA technology based on ETSI Technical Specifications TS 136 104 [i.18], TS 136 101 [i.19] and TS 136 211 [i.22].

7.1 Detailed technical descriptions

7.1.1 OFDMA Based Technology

OFDM is a multiplexing technique increasingly used in modern wireless access and cellular mobile technologies that subdivides the bandwidth into multiple frequency sub-carriers as shown in figure 1. In an OFDM system, the input data stream is divided into several parallel sub-streams of reduced data rate (thus increased symbol duration) and each sub-stream is modulated and transmitted on a separate orthogonal sub-carrier. The increased symbol duration improves the robustness of OFDM to delay spread. Since OFDM signal power spectrum has a very sharp fall off at the edge of channel, a larger fraction of the allocated channel bandwidth can be utilized for data transmission.

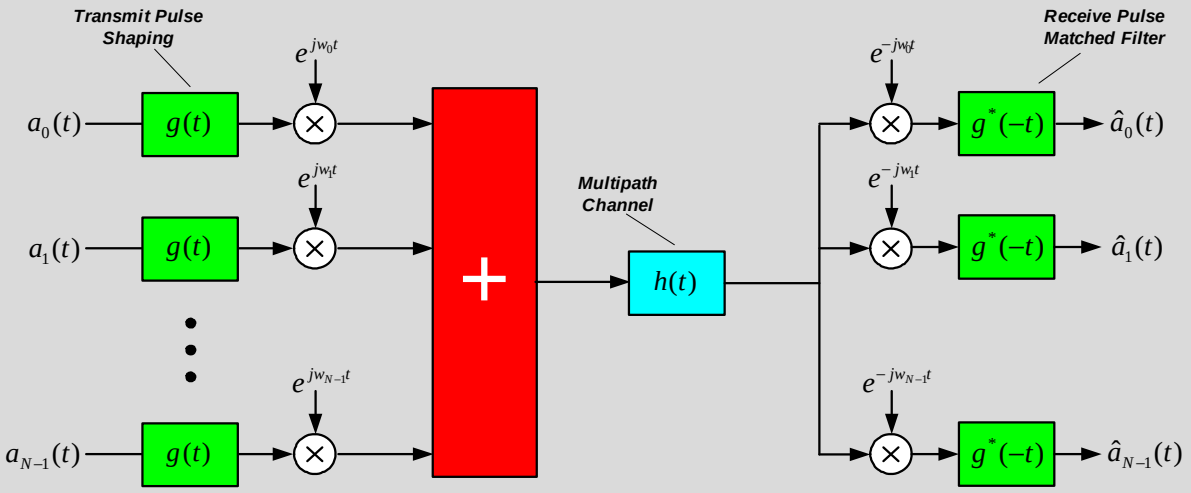

Figure 1: Basic Architecture of an OFDM System

OFDM exploits the frequency diversity of the multipath channel by coding and interleaving the information across the sub-carriers prior to transmissions. OFDM modulation can be realized with efficient Inverse Fast Fourier Transform (IFFT), which enables a large number of sub-carriers with low complexity. In an OFDM system, resources are available in the time domain by means of OFDM symbols and in the frequency domain by means of sub-carriers. The time and frequency resources can be organized into subchannels for allocation to individual users. Orthogonal Frequency Division Multiple Access (OFDMA) is a multiple-access/multiplexing scheme that provides multiplexing operation of data streams corresponding to multiple users onto the downlink subchannels. It also supports multiple access of various users by means of uplink subchannels.

Some systems apply Single Carrier - Frequency Division Multiple Access (SC-FDMA) in uplink as an alternative to OFDM. SC-FDMA offers the same degree of multipath protection as OFDM and has a transmitter and receiver architecture very similar to OFDMA, however a lower PAPR, because the underlying waveform is essentially single-carrier.

7.1.2 OFDMA / SC-FDMA Symbol Structure and Subchannelization

The OFDMA symbol structure generally consists of three types of sub-carriers as shown in figure 2:

- data sub-carriers for data transmission;
- pilot sub-carriers for estimation and synchronization purposes;
- null sub-carriers for no transmission; used for guard band and zero Hertz sub-carriers.

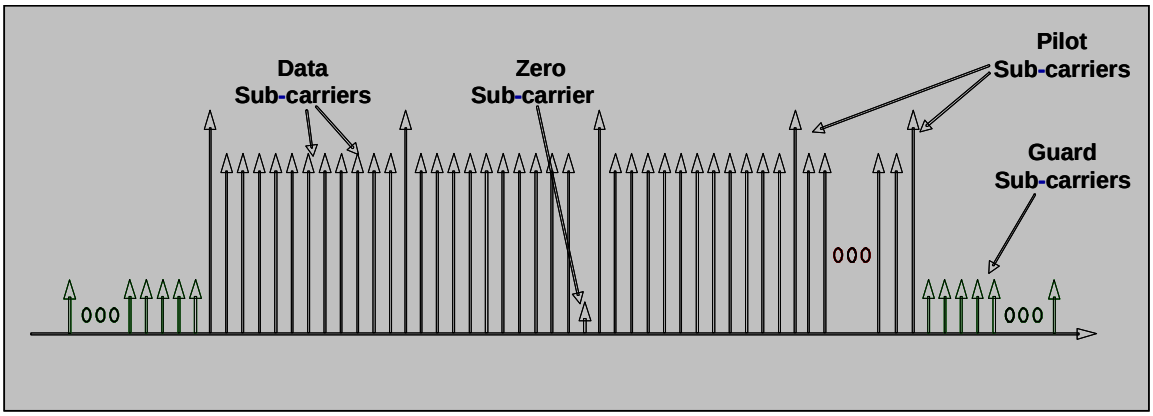

Figure 2: OFDMA sub-carrier structure

Different OFDMA system designs group data and pilot sub-carriers into subsets of sub-carriers in different way and refer to them by different terms, as subchannels, resource block, etc.

7.1.3 Scalable OFDMA

Scalability is supported by adjusting the FFT size while fixing the sub-carrier to a specific frequency spacing. Since the resource unit sub-carrier bandwidth and symbol duration is fixed, the impact to higher layers is minimal when scaling the bandwidth. Examples for typical parameters are listed in tables 2 and 3.

Table 2: OFDMA Scalability Parameters [i.17]

Parameters	Values	
System Channel Bandwidth (MHz)	5	10
Sampling Frequency (F_p in MHz)	5,6	11,2
FFT Size (N_{FFT})	512	1024
Number of Subchannels	8	16
Sub-Carrier Frequency Spacing Δf	10,94 kHz	
Useful Symbol Time ($T_b = 1/\Delta f$)	91,4 µs	
Guard Time (T_g) or Cyclic Prefix (CP) T_{CP}	11,4 µs (T_g or $T_{CP} = T_b/8$)	
OFDMA Symbol Duration ($T_s = T_b + T_g$)	102,9 µs	
Number of OFDMA Symbols (5 ms Frame)	48 (including ~1,6 symbols for TTG/RTG)	

Table 3: OFDMA Scalability Parameters (TD-LTE downlink) [i.18]

Parameters	Values			
System Channel Bandwidth (MHz)	5	10	15	20
Sampling Frequency (F_p in MHz)	7,68	15,36	23,04	30,72
FFT Size (N_{FFT})	512	1024	1536	2048
Number of Physical Resource Blocks (PRB)	25	50	75	100
Frame Duration (10 Subframes)	10 ms			
Subframe Duration (2 Slots)	1 ms			
Slot Duration (6 or 7 OFDM Symbol Duration)	0,5 ms			
Sub-Carrier Spacing Δf	15,0 kHz			
Useful Symbol Duration ($T_u = 1/\Delta f$)	66,66 µs			
Guard Time or Cyclic Prefix (CP) T_{CP}	4,69 µs for symbol 1-6 / 5,21µs for symbol 0 (normal CP for unicast, Slot consists of 7 OFDM symbols) 16,67 µs (extended CP for larger cell or SFN, Slot consists of 6 OFDM symbols)			
OFDMA Symbol Duration ($T_s = T_u + T_{CP}$)	Depends on the length of T_{CP} in the above row			
Number of OFDMA Symbols per Frame (10 ms)	140 (normal CP) / 120 (extended CP)			

The TD-LTE uplink uses basically the same numerology as downlink [i.18]. Uplink modulation parameters (including normal and extended CP length) are identical to the downlink parameters shown in table 3. Uplink modulation is, however, different from downlink. In a basic consideration, the difference from the OFDM is the addition of the DFT before the subcarrier mapping, compare figure 3 with the modulator structure in figure 1 before the multipath channel.

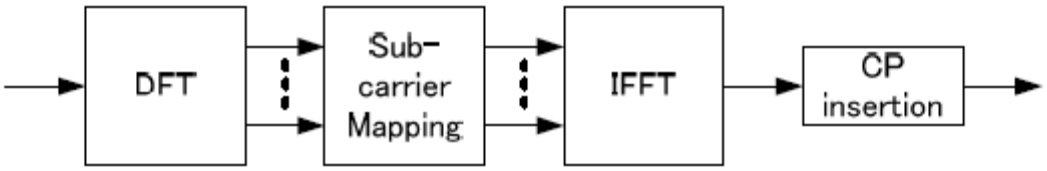

Figure 3: SC-FDMA Modulator Basic Structure

7.2 Technical parameters and implications on spectrum

The RF characteristics of mobile broadband systems and equipment for the 2 300 MHz to 2 400 MHz band will share many similarities with those from nearby frequency ranges including the 2 500 MHz to 2 690 MHz and the 3 400 MHz to 3 600 MHz ranges. However operation in the range 2 300 MHz to 2 400 MHz will be based on TDD operation.

For modern broadband applications, delivery systems are expected to be based on packet based protocols optimised for data transmission purposes.

Market opportunities in other regions have lead to equipment being developed with the capability to tune over the entire range 2 300 MHz to 2 400 MHz, introducing flexibility to adapt to any specific national sub-band of operation.

7.2.1 Common Parameters

7.2.1.1 Channel Raster

The basic channel bandwidth is based on 5 MHz blocks which can be used solely or aggregated to support both 5 MHz and 10 MHz system channel widths. System channel widths built from the basic 5 MHz blocks are the preferred option for mobile broadband technologies and are consistent with those identified in other frequency bands.

Channel raster system granularity (centre frequency setting resolution) ranging from 100 kHz to 250 kHz can be supported.

Both technology examples support a block size based on 5 MHz.

7.2.1.2 Modulation Schemes

Individual sub-carriers can be modulated using QPSK, 16-QAM and 64-QAM schemes under the dynamic control of the network in order to maximise data throughput efficiency.

Both technology examples support a range of modulation formats.

7.2.2 Status of technical parameters

7.2.2.1 Current ITU and European Common Allocations

Table 4: ECA [i.1] information for 2 300 MHz to 2 400 MHz

Utilisation	ERC/ECC Documentation	European Standard
Aeronautical Telemetry	ERC/REC 62-02 [i.4]	-
Amateur	-	EN 301 783 [i.5]
Mobile Applications	-	-
SAP / SAB	ERC/REC 25-10 [i.6]	EN 302 064 [i.7]

ERC Recommendation ERC/REC 62-02 [i.4] recommends:

"1. that for future airborne telemetry applications the tuning range of equipment should primarily be in the frequency range 2300 - 2400 MHz;

2. that the frequency band 2300 - 2330 MHz should primarily be used as a core band for airborne telemetry applications and that the band 2330 MHz - 2400 MHz should be used as an extension band where required;

3. that channels to be used in border areas be co ordinated between the individual Administrations;"

ERC Recommendation ERC/REC 25-10 [i.6] recommends:

"1. that CEPT administrations should assign frequencies for audio and video SAP/SAB links from the tuning ranges identified in Annex 2".

Extracts from [i.6] shown in table 5.

Table 5: The recommended frequency ranges for use by audio and video SAP/SAB links in the 2 300 MHz to 2 400 MHz range

Type of link	Recommended frequencies		Technical parameters
	Tuning ranges	Preferred sub-bands	
Cordless cameras	2 025 MHz to 2 110 MHz/ **2 200** MHz **to 2 500** MHz 10,0 GHz to 10,60 GHz 21,2 GHz to 24,5 GHz 47,2 GHz to 50,2 GHz	10,3 GHz to 10,45 GHz 21,2 GHz to 21,4 GHz, 22,6 GHz to 23,0 GHz and 24,25 GHz to 24,5 GHz	ERC Report 38 [i.14]
Portable video links	2 025 MHz to 2 110 MHz/ **2 200** MHz **to 2 500** MHz 2 500 MHz to 2 690 MHz (Note 4 of Annex 2 of [i.6]) 10,0 GHz to 10,60 GHz	10,3 GHz to 10,45 GHz	ERC Report 38 [i.14]
Mobile video links (airborne and vehicular)	2 025 MHz to 2 110 MHz/ **2 200** MHz **to 2 500** MHz 2 500 MHz to 2 690 MHz (Note 4 of Annex 2 of [i.6]) 3 400 MHz to 3 600 MHz (Note 5 of Annex 2 of [i.6])		ERC Report 38 [i.14]

Note 4 in Annex 2 of the recommendation [i.6] highlights that the 2 500 MHz to 2 690 MHz range will not be available for video SAP/SAB links after the introduction of UMTS/IMT-2000.

Note 5 in Annex 2 of the recommendation [i.6] highlights that in countries where the band 3 400 MHz to 3 600 MHz is widely used for Fixed Wireless Access (FWA), availability of this band for mobile video SAP/SAB links may be restricted.

7.2.2.2 Sharing and compatibility studies (if any) already available

Sharing and compatibility studies can be considered in two areas. The first being those that apply between mobile applications and other utilisations identified in the ECA [i.1] table extract in table 4. These could be considered to address "inter-service" band usage scenarios. The second being sharing and compatibility between different mobile applications or mobile licence holders operating in the same band and these could be considered to address "intra-service" scenarios.

7.2.2.2.1 Inter-Service Sharing and Compatibility

Examination of the ECA [i.1] table shows the following potential applications sharing with mobile broadband applications if they were to be licensed in the band:

- aeronautical Telemetry with the range 2 300 MHz to 2 330 MHz identified as the core band for airborne telemetry;
- SAP/SAB with specific applications including cordless cameras, portable video links and mobile video links which may also be airborne.

7.2.2.2.1.1 SAP/SAB Considerations

ERC Report 038 [i.14] provides descriptions of typical usage scenarios and equipment/system characteristics. The report highlights the need for these applications to be used in a number of scenarios that may be varied according to the particular usage scenario at any time. Antennas range from omni-directional portable types that are likely to be used at the progamme material gathering scene to high gain P-P like antennas used to link signals back to remote production facilities.

Table 1 of ERC Report 038 [i.14] suggests that the most likely uses in the 2 300 MHz to 2 400 MHz range involve low to medium gain (3 dBi to 13 dBi) transmitting antennas and higher gain receiving antennas (13 dBi to 17 dBi) for mobile, portable and temporary links (as opposed to mobile camera applications). EN 302 064 (Parts 1 and 2) [i.7] indicate channel bandwidths up to 20 MHz for professional broadcast applications for digital link equipment and ERC Report 038 [i.14] identifies EIRP levels up to 40 dBW.

Considering the potential high EIRP and unpredictable location of temporary broadcast activities, it might be difficult to share the same spectrum without specific coordination between the SAP/SAB users and any mobile broadband network. This consideration seems to be borne out by the studies reported in ECC Report 100 [i.13] from which the following text extracts are derived:

From the Executive Summary and Conclusions:

"*This study provides the values of the frequency separation which are required to enable the co-existence between BWA and ENG/OB systems in a set of scenarios, described in the document. It is shown that the interference effect from an ENG/OB into the BWA is less than the interference effect from a BWA CS into an ENG/OB receiver. For the impact of TS on ENG/OB, the study, based on worst case assumptions, shows that the required guard band between an ENG/OB and BWA TS is relatively small and the main constraint will come from the BWA CS.*

The frequency separation required to protect ENG/OB will be quite important when ENG/OB and BWA are supposed to operate in close vicinity (distances around 1 km) and decreases significantly when the separation distance is larger (5 km).

For the case of airborne ENG/OB, the required frequency separation is significantly higher, in particular when considering an omni-directional BWA CS antenna."

In addition, from section 5.3.3.4 of ECC Report 100 [i.13] (Conclusions):

"The calculations presented in sections V.3.3.1 to V.3.3.3 show that the co-channel sharing between BWA and terrestrial ENG/OB is not feasible at reasonable separation distances (1 to 5 km with BWA TS, 0.5 to 2 km for BWA CS).

However, with a certain frequency separation, the resulting I/N is below the required I/N and therefore, the adjacent band compatibility is possible. The amount of the required frequency separation will depend upon the characteristics of terrestrial ENG/OB and BWA and the distance between both systems.

It is also shown that the impact from BWA TS is less critical than the impact from BWA CS. Even the consideration of aggregate impact from 6 BWA TS transmitting simultaneously on the same channel does not change that conclusion."

7.2.2.2.2 Intra-Service Sharing and Compatibility

This topic has been extensively studied in a number of fora generally to either evaluate the compatibility issues between similar mobile broadband applications using different technologies or to assist with the frequency band plan arrangements that might be used as the basis for licence award activities. Most recently in other mobile broadband frequency ranges (e.g. 2,6 GHz or 3,5 GHz) the issue has been considered from the WAPECS perspective to develop least restrictive technical conditions to encourage increased technology neutrality in spectrum licensing.

For a multi-operator environment, with licences covering similar geographical regions there are potentially four interference scenarios to be considered, see table 6.

Table 6: TDD to TDD Inter-Network Interference Scenarios

Scenario	Interference Path	Description
1	BS to MS	BS of interferer system in adjacent channel to MS of victim system
2	MS to MS	MS of interferer system in adjacent channel to MS of victim system
3	BS to BS	BS of interferer system in adjacent channel to BS of victim system
4	MS to BS	MS of interferer system in adjacent channel to BS of victim system

If adjacent networks operating in adjacent frequency blocks operate using the same technology and can be synchronised in terms of DL and UL timing, then scenarios 2 and 3 are avoided.

If adjacent networks operating in adjacent frequency blocks cannot be synchronised then generally scenario 3 is considered to represent the worst case due to the static nature of the BS and the generally open location designed to serve the coverage area. Assessment of the interference from/to MS's usually requires statistical analysis due to the variable nature of the traffic, the usage periods and the location.

There are several studies that can be drawn upon to assess the possibilities for the 2 300 MHz to 2 400 MHz frequency range. CEPT Report 019 [i.11] reports in section 5.4.4 that: "*Compatibility between FDD and TDD or two unsynchronised TDD blocks leads to the conclusion that a frequency separation of 5 MHz is needed*." In Annex A4.4 the Report continues: "*Extra protection i.e., 5 MHz guard block is deemed necessary to handle the increased interference probability for the case where TDD frequency blocks are used directly adjacent to FDD-UL frequency blocks or for unsynchronised TDD frequency blocks of different licensees that are directly adjacent to each other*." Recognising the importance of addressing the BS to BS scenario, the Report continues to develop an out of block emission requirement based upon a separation assumption of 100 m between uncoordinated BSs. Based upon this scenario, the following could be considered appropriate for an all TDD 2 300 MHz to 2 400 MHz band.

Table 7: Block Edge Mask Baseline Level

Frequency Range	Maximum mean EIRP (integrated over a 1 MHz bandwidth)	Description
Frequencies allocated to victim base stations in the range 2 300 MHz to 2 400 MHz ±5 MHz outside the block of the aggressor base station.	-45 (+ x) dBm/MHz (see note)	Uncoordinated BS deployment down to 100 m distance
NOTE: x may be required to account for the slightly lower frequency band.		

ECC Report 131 [i.12] also assessed the MS to MS interference in order to develop a MS out of block baseline emission level. That Report concludes that: *"… in order to appropriately manage the risk of TS-TS adjacent-channel interference:*

a) Where probability of collisions between victim and interfere packets cannot be taken into account, a TS BEM baseline level of PBL = -27 dBm / (5 MHz) can be justified,

b) And furthermore, where probability of collisions between victim and interfere packets can be taken into account (as among packet-based mobile broadband systems), a TS BEM baseline level of PBL = -15,5 dBm / (5 MHz) can be justified."

Therefore it may be possible that the measures developed to address the inter-network issues in the 2,6 GHz band could be adapted to apply to the limited set of scenarios in the 2 300 MHz to 2 400 MHz frequency range. As highlighted in the outcome of the 2,6 GHz activity (including the EC Decision 2008/477/EC [i.23]) these measures can be alleviated through inter-operator cooperation and coordination.

7.2.2.2.3 Adjacent Band Compatibility

According to ERC Report 25 [i.1] the European common allocations shown in tables 8 and 9 are made in the bands adjacent to the 2 300 MHz to 2 400 MHz band.

Table 8: ECA [i.1] information for 2 200 MHz to 2 300 MHz

Utilisation	ERC/ECC Documentation	European Standard	Comments
For 2 200 MHz to 2 290 MHz:			
Defence Systems			Radio Relay links 2 200 MHz to 2 245 MHz
Fixed Links	T/R 13-01	EN 302 217 [i.25]	
Radio Astronomy			Continuum line and VLBI observations
SAP/SAB		EN 302 064 [i.7]	See table C2 in [i.1]
Space Research			Satellite payload and platform telemetry
For 2 290 MHz to 2 300 MHz:			
Mobile applications			
Space Research			Satellite payload and platform telemetry for space research (deep space)

Table 9: ECA [i.1] information for 2 400 MHz to 2 500 MHz

Utilisation	ERC/ECC Documentation	European Standard
Amateur and Amateur Satellite		EN 301 783 [i.5]
Non- Specific SRD's	ERC/REC 70-03 [i.26]	EN 300 440 [i.27]
Radiodetermination applications	ERC/REC 70-03 [i.26] ERC/DEC(01)08 [i.28]	EN 300 440 [i.27]
Railway Applications	ERC/REC 70-03 [i.26]	EN 300 761 [i.29]
RFID	ERC/REC 70-03 [i.26]	EN 300 440 [i.27]
Wideband Data Transmitting Systems	ERC/DEC(01)07 [i.30] ERC/REC 70-03 [i.26]	EN 300 328 [i.31]
IMT Satellite Component		
Mobile Satellite Applications	ECC/DEC(07)04; [i.34] ECC/DEC(07)05 [i.35] ERC/DEC/(97)03 [i.32] ERC/DEC(97)05 [i.33]	
SAP/SAB	ERC/REC 25-10 [i.36]	EN 302 064 [i.7]

7.2.2.3 Sharing and compatibility issues still to be considered

The proponents could find no specific ECC compatibility studies for aeronautical telemetry systems.

7.2.3 Transmitter parameters

The following parameters are relevant to two different technologies drawn from the ETSI specifications [i.18], [i.19] and IEEE/WiMAX specifications [i.20].

7.2.3.1 Transmitter Output Power / Radiated Power

7.2.3.1.1 Transmitter Spectrum Emission Mask - BS

Tables 10 and 11 provide TDD BS spectrum emission masks for 5 MHz and 10 MHz:

Table 10: TDD BS Spectrum emission mask for a 5 MHz channel [i.20]

Frequency offset from centre	Allowed emission level	Measurement bandwidth
2,5 MHz ≤ Δ*f* < 3,5 MHz	-13 dBm	50 kHz
3,5 MHz ≤ Δ*f* < 12,5 MHz	-13 dBm	1 MHz

Table 11: TDD BS Spectrum emission mask for a 10 MHz channel [i.20]

Frequency offset from centre	Allowed emission level	Measurement bandwidth
5 MHz ≤ Δ*f* < 6 MHz	-13 dBm	100 kHz
6 MHz ≤ Δ*f* < 25 MHz	-13 dBm	1 MHz

Another example of a BS mask for channel bandwidths ranging from 5 MHz to 20 MHz is in table 12 [i.18].

The mask applies from transmitted channel edge out to 10 MHz outside the operating band edge. Δf is the offset from the channel edge, and Δf_{max} is the offset to the frequency 10 MHz outside the downlink operating band.

Table 12: General operating band unwanted emission limits for 5 MHz, 10 MHz, 15 MHz and 20 MHz channel bandwidth

Frequency offset of measurement filter -3 dB point, Δf	Frequency offset of measurement filter centre frequency, f_offset	Minimum requirement	Measurement bandwidth
0 MHz ≤ Δf < 5 MHz	0,05 MHz ≤ f_offset < 5,05 MHz		100 kHz
5 MHz ≤ Δf < min(10 MHz, Δf_{max})	5,05 MHz ≤ f_offset < min(10,05 MHz, f_offset_{max})	-14 dBm	100 kHz
10 MHz ≤ Δf ≤ Δf_{max}	10,5 MHz ≤ f_offset < f_offset_{max}	-15 dBm	1 MHz

7.2.3.1.2 Transmitter ACLR - BS

In general terms, the Adjacent Channel Leakage power Ratio (ACLR) is defined as the ratio of the filtered mean power centred on the assigned channel frequency to the filtered mean power centred on an adjacent channel frequency.

Table 13: BS ACLR for 5 MHz (and 10 MHz) channel bandwidth [i.20]

Adjacent channel centre frequency	Minimum required ACLR (dB)
BS channel centre frequency ± 5 MHz (±10,0 MHz)	45
BS channel centre frequency ± 10 MHz (±20,0 MHz)	55

Another example of ACLR values for channel bandwidths ranging from 5 MHz to 20 MHz is in table 14. ACLR values are listed for the first and second adjacent channel of the same channel bandwidth.

Table 14: Base Station ACLR in unpaired spectrum with synchronized operation [i.18]

E-UTRA transmitted signal channel bandwidth $BW_{Channel}$ (MHz)	BS adjacent channel centre frequency offset below the first or above the last carrier centre frequency transmitted	Assumed adjacent channel carrier (informative)	Filter on the adjacent channel frequency and corresponding filter bandwidth	ACLR limit
5, 10, 15, 20	$BW_{Channel}$	E-UTRA of same BW	Square (BW_{Config})	45 dB
	2 x $BW_{Channel}$	E-UTRA of same BW	Square (BW_{Config})	45 dB
NOTE: $BW_{Channel}$ and BW_{Config} are the channel bandwidth and transmission bandwidth configuration of the E-UTRA transmitted signal on the assigned channel frequency.				

7.2.3.1.3 Transmitter Spectrum Emission Mask - MS

Tables 15 and 16 provide examples for TDD MS spectrum emission masks for 5 MHz and 10 MHz:

The integration bandwidth refers to the frequency range over which the emission power is integrated.

Δf is defined as the frequency offset in MHz from the channel centre frequency.

Table 15: TDD spectrum emission mask for 5 MHz carrier [i.20]

Segment number	Offset from channel centre frequency (MHz)	Integration bandwidth (kHz)	Allowed emission level within the integration bandwidth (dBm)
1	2,5 to < 3,5	50	-13,00
2	3,5 to < 7,5	1 000	-13,00
3	7,5 to < 8	500	-16,00
4	8 to < 10,4	1 000	-25,00
5	10,4 to < 12,5	1 000	-25,00

Table 16: TDD spectrum emission mask for 10 MHz carrier [i.20]

Segment number	Offset from channel centre frequency (MHz)	Integration bandwidth (kHz)	Allowed emission level within the integration bandwidth (dBm)
1	5 to < 6	100	-13,00
2	6 to < 10	1 000	-13,00
3	10 to < 11	1 000	-13 - 12(Δf - 10)
4	11 to < 15	1 000	-25,00
5	15 to < 20	1 000	-25,00
6	20 to < 25	1 000	-25,00

Another example is table 17 which provides the spectrum emission mask of a TDD terminal station for different channel bandwidths of 5 MHz and above. The mask applies to frequencies (Δf_{OOB}) starting from the ± edge of the assigned channel bandwidth. For frequencies greater than (Δf_{OOB}) as specified in table 17, the spurious requirements are applicable.

Table 17: Spectrum emission mask for different channel bandwidths [i.19]

Spectrum emission limit (dBm) / Channel bandwidth					
Δf_{OOB} (MHz)	5 MHz	10 MHz	15 MHz	20 MHz	Measurement bandwidth
±0 to 1	-15	-18	-20	-21	30 kHz
±1 to 2,5	-10	-10	-10	-10	1 MHz
±2,5 to 2,8	-10	-10	-10	-10	1 MHz
±2,8 to 5	-10	-10	-10	-10	1 MHz
±5 to 6	-13	-13	-13	-13	1 MHz
±6 to 10	-25	-13	-13	-13	1 MHz
±10 to 15		-25	-13	-13	1 MHz
±15 to 20			-25	-13	1 MHz
±20 to 25				-25	1 MHz

7.2.3.1.4 Transmitter ACLR - MS

In general terms, the Adjacent Channel Leakage power Ratio (ACLR) is defined as the ratio of the filtered mean power centred on the assigned channel frequency to the filtered mean power centred on an adjacent channel frequency.

Table 18: MS ACLR for 5 MHz (and 10 MHz) channel bandwidth [i.20]

Adjacent channel centre frequency	Minimum required ACLR relative to assigned channel frequency (dB)
Mobile station channel centre frequency ± 5 MHz (± 10 MHz)	30
Mobile station channel centre frequency ± 10 MHz (± 20 MHz)	44

The MS ACLR is specified considering the following receiver bandwidths based on a rectangular filter response:

- 4,75 MHz for a 5 MHz channelized system;
- 9,5 MHz for a 10 MHz channelized system.

For the second technology example and channel bandwidth of 5 MHz and above, the ACLR1 is the ratio of the filtered mean power centred on the assigned channel frequency to the filtered mean power centred on the first adjacent channel frequency at nominal channel spacing. The assigned channel power and adjacent channel power are measured with rectangular filters with measurement bandwidths specified in table 19.

Table 19: MS ACLR requirements for different channel bandwidths [i.19]

	Channel bandwidth / ACLR1 / measurement bandwidth			
	5 MHz	10 MHz	15 MHz	20 MHz
ACLR1	30 dB	30 dB	30 dB	30 dB
Channel Measurement bandwidth	4,5 MHz	9,0 MHz	13,5 MHz	18 MHz
Adjacent channel centre frequency offset (in MHz)	+5/-5	+10/-10	+15/-15	+20/-20

7.2.3.2 Operating Frequency

The nominal channel centre frequencies can be set in accordance with a 100 kHz step size. This brings flexibility to set the operating channel in accordance with national circumstances and band availability. BS and MS will generally have a tuning range over the entire 2 300 MHz to 2 400 MHz frequency range although BS equipment may be supplemented with band specific filtering arrangements to suit specific licences or national allocations.

7.2.3.3 Occupied Channel Width

Both technology examples support occupied channel bandwidths based on multiples of 5 MHz blocks.

7.2.3.4 Unwanted emissions

Emissions levels in the spurious domain would be compliant with annex 2 of ERC Recommendation 74-01E [i.21]. Other unwanted emission levels are identified through the transmitter spectrum emission masks and ACLR specifications. In some cases additional spurious emission limits may be specified to protect other services.

7.2.3.5 Transmitter Power and EIRP - BS

The typical transmitter RF power at the BS antenna port averaged during the transmit burst is 36 dBm, and the maximum RF power capability may be up to 43 dBm for the 5 MHz channel bandwidth.

The typical BS EIRP spectral density assuming a typical 120 degree sector antenna (effective gain = 17 dBi) would be equivalent to 46 dBm/MHz in a 5 MHz channel. The maximum BS EIRP could rise to 53 dBm/MHz in a 5 MHz channel.

For higher channel bandwidths, the transmitter power spectral density remains constant, therefore the overall power in the channel will increase accordingly.

7.2.3.6 Transmitter Power and EIRP - MS

The typical transmitter RF power averaged during the transmit burst is 20 dBm. The maximum RF power capability can increase up to 25 dBm. Power control techniques are employed which can result in a spread of MS power levels across a deployment area.

The typical MS antenna gain is 0 dBi.

7.2.3.7 Power Control - MS

For correct and efficient operation of a network, power control is employed in the mobile station as a dynamic function under the control of the Base Station.

Typical power control range = 45 dB.

Typical power control setting step size = 1 dB.

7.2.4 Receiver parameters

The following parameters are relevant to two different technologies drawn from the ETSI specifications [i.18], [i.19] and IEEE/WiMAX specifications [i.17] and [i.20].

7.2.4.1 Receiver Sensitivity - BS

Receiver Sensitivity = -114+ SNR_{Min} - 10log (Repetition Factor R) + 10log (Receiver Bandwidth [MHz]) + Implementation Loss+ Receiver noise figure (NF) [i.17] and [i.20].

Based on a NF = 5 dB and a repetition factor, R, of 1, the reference sensitivity can be calculated as:

- -94,5 dBm in a 5 MHz system;
- -91,5 dBm in a 10 MHz system.

For example 2 and channel bandwidth of 5 MHz and above, the BS reference sensitivity power level in tables 20 to 22 is the minimum mean power applied the antenna ports for a throughput that is $\geq$ 95 % of the maximum throughput of the reference measurement channel as specified in [i.18]. Values are given for Wide Area BS (for macro scenarios), Local Area BS (for pico scenarios) and Home BS (for femto scenarios) in tables 20 to 22 respectively.

Table 20: Wide Area BS reference sensitivity levels [i.18]

Channel Bandwidth (MHz)	Reference sensitivity power level, $P_{REFSENS}$ (dBm)
5	-101,5
10 (see note)	-101,5
15 (see note)	-101,5
20 (see note)	-101,5
NOTE: $P_{REFSENS}$ is the power level of a single instance of a 5 MHz reference measurement channel. This requirement is specified to be met for each consecutive application of a single instance of the 5 MHz reference channel mapped to disjoint frequency ranges with a width of 25 resource blocks each.	

Table 21: Local Area BS reference sensitivity levels [i.18]

Channel Bandwidth (MHz)	Reference sensitivity power level, $P_{REFSENS}$ (dBm)
5	-93,5
10 (see note)	-93,5
15 (see note)	-93,5
20 (see note)	-93,5
NOTE: $P_{REFSENS}$ is the power level of a single instance of a 5 MHz reference measurement channel. This requirement is specified to be met for each consecutive application of a single instance of the 5 MHz reference channel mapped to disjoint frequency ranges with a width of 25 resource blocks each.	

Table 22: Home BS reference sensitivity levels [i.18]

Channel Bandwidth (MHz)	Reference sensitivity power level, $P_{REFSENS}$ (dBm)
5	-93,5
10 (see note)	-93,5
15 (see note)	-93,5
20 (see note)	-93,5
NOTE: $P_{REFSENS}$ is the power level of a single instance of a 5 MHz reference measurement channel. This requirement is specified to be met for each consecutive application of a single instance of the 5 MHz reference channel mapped to disjoint frequency ranges with a width of 25 resource blocks each.	

7.2.4.2 Receiver Sensitivity - MS

Receiver Sensitivity = -114+ SNR_{Min} - 10log(R) + 10log (Receiver Bandwidth [MHz]) + Implementation Loss + Pilot Boosting Offset + Receiver NF [i.17] and [i.20].

Based on a NF of 8 dB and a repetition factor, R, of 1 the reference sensitivity can be calculated as:

- -91 dBm in a 5 MHz system;
- -88 dBm in a 10 MHz system.

In both cases QPSK ½ rate Convolutional Turbo Code in AWGN is assumed.

For the second technology example and channel bandwidth of 5 MHz and above, the reference sensitivity power level in table 23 is the minimum mean power applied to both the MS antenna ports for a throughput that is ≥ 95 % of the maximum throughput of reference measurement channels defined in [i.19]. This reference sensitivity is defined for the allocated uplink frequency resource given in table 24.

Table 23: Reference sensitivity QPSK [i.19]

Channel bandwidth					
Band	**5 MHz (dBm)**	**10 MHz (dBm)**	**15 MHz (dBm)**	**20 MHz (dBm)**	**Duplex Mode**
2 300 MHz to 2 400 MHz	-100	-97	-95,2	-94	TDD

Table 24: Minimum uplink configuration for reference sensitivity [i.19]

Channel bandwidth					
Band	**5 MHz**	**10 MHz**	**15 MHz**	**20 MHz**	**Duplex Mode**
2 300 MHz to 2 400 MHz	4,5 MHz	9 MHz	13,5 MHz	18 MHz	TDD

7.2.5 Channel access parameters

In common with other cellular technologies, MS equipment will only transmit under the control of a BS within a valid network.

7.2.6 Deployment Parameters

The deployment parameters of the systems can vary according to, for example, the geographical location, the market to be addressed and local constraints not necessarily associated with radio network planning. However, the ECC has carried out a number of studies requiring scenario and parameter assumptions in the nearby 2,6 GHz band. Therefore CEPT/ ECC Reports are available that can be consulted for typical deployment parameters that might be used in studies for the 2 300 MHz to 2 400 MHz frequency range [i.11] and [i.12].

Based upon these references the deployment parameters in table 25 could be assumed for any compatibility activities.

Table 25: Other Deployment Parameters

Parameter	Typical Assumption
Operating frequency	2 350 MHz
BS antenna height	30 m
MS antenna height	1,5 m
Cell sizes	500 m to 1 000 m
Minimum BS separation for uncoordinated operation	100 m
I / N	-6 dB

7.3 Information on relevant standard(s)

ETSI will develop a candidate Harmonised Standard for the presumption of conformity with the RTTE Directive [i.10].

8 Radio spectrum request and justification

The interest in examining the potential for spectrum in the 2 300 MHz to 2 400 MHz range is driven by the developments taking place in other global regions and the interest in maintaining some commonality and maximising benefits from those developments. Within the band itself the national spectrum requirement for mobile broadband services will depend to a large extent on local circumstances and may take into account the availability of other frequency bands, the local market and the local demographics. However based on work carried out in other fora, it is possible to put forward estimates of the spectrum requirements needed for the provision of compelling broadband services.

8.1 Spectrum Required per Operator

The Whitepaper in [i.3] puts forward an estimate of the amount of spectrum required per licence to provide viable broadband services. This is based on use of the 2 500 MHz to 2 690 MHz frequency range, but this can be equally applicable to the 2 300 MHz to 2 400 MHz range. Based on traffic estimates over busy periods of the day and expected usage patterns, it concludes that at least 30 MHz of spectrum is required to provide mobile broadband services. However this is not a single definitive answer and less spectrum in some cases can still provide a viable resource albeit with some compromises.

In addition a minimum of 30 MHz of spectrum is consistent with efficient cell planning for dense deployments requiring three sector cells with each sector occupied by a single 10 MHz channel.

8.2 Spectrum Status around CEPT

8.2.1 Norway

Norway has awarded licences to at least two telecommunications networks operators in the band 2 300 MHz to 2 400 MHz:

- 2 301 MHz to 2 323 MHz Licensed to NextGenTel on flexible conditions, expires 31.12.2019.
- 2 336 MHz to 2 356 MHz Licensed to Norkring AS on flexible conditions, expires 31.12.2019.
- Other awards have resulted in spectrum assigned with other applications in mind.
- 2 356 MHz to 2 366 MHz Licensed to TV2 AS on flexible conditions, expires 31.12.2019.
- 2 366 MHz to 2 376 MHz Licensed to TV Norge AS on flexible conditions, expires 31.12.2019.
- 2 376 MHz to 2 386 MHz Licensed to NRK on flexible conditions, expires 31.12.2019.
- 2 323 MHz to 2 331 MHz General licence (licence exempt) for mobile video links.
- 2 386 MHz to 2 394 MHz General licence (licence exempt) for mobile video links.

8.2.2 Ireland

In June 2009 the Irish administration issued a consultation document [i.8] seeking views on proposals to issue licences for mobile applications within the 2 300 MHz to 2 400 MHz range. In this document ComReg expresses a view that there are significant benefits to be gained by both Irish consumers and service providers in making this spectrum available in a timely manner across Ireland. Proposals are made to release the spectrum in a manner that protects existing users in the band. A second consultation process is under development and expected to be publicly available in June 2010.

8.2.3 UK

In the UK the band is managed by the Ministry of Defence but has come under scrutiny as part of a wider review of spectrum requirements. A review of spectrum usage [i.9] identified that the band 2 310 MHz to 2 390 MHz is used widely for data, video and/or telemetry links along with spectrum in other ranges. The report indicates that demand for the use of this spectrum appears to exceed the supply to around 2015 and beyond. However major utilisation appears concentrated to specific geographic locations around the UK and may preclude national assignments for mobile broadband technologies. Despite this, the report identifies the possibility for localised geographic band sharing and recommends further study on this aspect.

Public information indicates that the timetable for release of any spectrum in this range extends beyond November 2012.

8.2.4 Russian Federation

In August 2009 the State Commission on Radio Frequency announced measures to licence mobile broadband wireless access systems in the 2 300 MHz to 2 400 MHz range based on a Decision from April 2008. The full band is available and a minimum assignment of 30 MHz per one licence holder is expected.

Draft technical conditions are currently under consideration and include the following elements:

- System bandwidths of 5 MHz, 8,75 MHz, 10 MHz and 20 MHz.
- BS transmitter powers up to 16 dBW.
- CPE transmitter power up to 0 dBW.
- TDD operation and TDMA or OFDMA multiple access techniques.
- Maximum CPE antenna gain 25 dBi; Maximum BS antenna gain 18 dBi.
- Licences will be made available on a regional basis with 4 licences in 10 regions anticipated.

8.2.5 Germany

In Germany, the band is allocated for aeronautical telemetry. This kind of use is continuously increasing (see WRC-07 Agenda item 1.5), also for future airborne telemetry applications where the tuning range of equipment will primarily be in the frequency range 2 300 MHz to 2 400 MHz. Such applications have to operate in this frequency range and would put severe constraints on broadband wireless deployment/IMT over very large areas. In addition, industrial wireless video links and PPDR are operating in the band with a maximum permitted power of 25 Watt EIRP and in the near future wider channel bandwidth requirements can be expected for these applications.

8.2.6 France

In France, the band 2 300 MHz to 2 400 MHz has never been under consideration for BWA.

This band is used for aeronautical telemetry in several European countries, France being one of them, and such use is continuously increasing. Such applications have to operate in this frequency range and would put severe constraints on wireless broadband applications over very large areas.

Additionally, no scarcity among the frequencies used for mobile is expected in the next 10 years, considering the availability of the 800 MHz and 2,5 GHz bands in a near future as well as the band 3 400 MHz to 3 800 MHz in the mid-time range. The RSPG position paper on Wireless Broadband (RSPG 09 - 284) [i.15] confirms this.

9 Regulations

In this clause the term "regulation" should be taken in its broadest sense.

9.1 Current regulations

Article 5 of the ITU-R Radio Regulations [i.2] allocates the 2 300 MHz to 2 400 MHz band as follows in table 26 and the footnotes underneath.

Table 26: Extracts from the ITU-R Radio Regulations [i.2]

Allocation to services		
Region 1	**Region 2**	**Region 3**
2 300-2 450 FIXED MOBILE 5.384A Amateur Radiolocation 5.150 5.282 5.395	2 300-2 450 FIXED MOBILE 5.384A Amateur Radiolocation 5.150 5.282 5.393 5.394 5.396	

Footnotes:

5.384A The bands, or portions of the bands, 1 710-1 885 MHz, 2 300-2 400 MHz and 2 500-2 690 MHz, are identified for use by administrations wishing to implement International Mobile Telecommunications (IMT) in accordance with Resolution **223 (Rev.WRC-07)**. This identification does not preclude the use of these bands by any application of the services to which they are allocated and does not establish priority in the Radio Regulations. (WRC-07)

5.393 *Additional allocation:* in Canada, the United States, India and Mexico, the band 2 310-2 360 MHz is also allocated to the broadcasting-satellite service (sound) and complementary terrestrial sound broadcasting service on a primary basis. Such use is limited to digital audio broadcasting and is subject to the provisions of Resolution **528 (Rev.WRC-03)**, with the exception of *resolves* 3 in regard to the limitation on broadcasting-satellite systems in the upper 25 MHz. (WRC-07)

5.394 In the United States, the use of the band 2 300-2 390 MHz by the aeronautical mobile service for telemetry has priority over other uses by the mobile services. In Canada, the use of the band 2 360-2 400 MHz by the aeronautical mobile service for telemetry has priority over other uses by the mobile services. (WRC-07)

5.395 In France and Turkey, the use of the band 2 310-2 360 MHz by the aeronautical mobile service for telemetry has priority over other uses by the mobile service. (WRC-03)

5.396 Space stations of the broadcasting-satellite service in the band 2 310-2 360 MHz operating in accordance with No. **5.393** that may affect the services to which this band is allocated in other countries shall be coordinated and notified in accordance with Resolution **33 (Rev.WRC-97)***. Complementary terrestrial broadcasting stations shall be subject to bilateral coordination with neighbouring countries prior to their bringing into use.

5.282 In the bands 435-438 MHz, 1 260-1 270 MHz, 2 400-2 450 MHz, 3 400-3 410 MHz (in Regions 2 and 3 only) and 5 650-5 670 MHz, the amateur-satellite service may operate subject to not causing harmful interference to other services operating in accordance with the Table (see No. **5.43**). Administrations authorizing such use shall ensure that any harmful interference caused by emissions from a station in the amateur-satellite service is immediately eliminated in accordance with the provisions of No. **25.11**. The use of the bands 1 260-1 270 MHz and 5 650-5 670 MHz by the amateur-satellite service is limited to the Earth-to-space direction.

As a result of the ITU-R framework, the frequency range 2 300 MHz to 2 400 MHz is an interesting band for mobile wireless access applications in a number of countries around the world. By Q3 2009, in the Asia Pacific region around 6 countries summarised in table 27 have licensed or are considering licensing the band (or parts of the band) for these applications. Licence blocks range from 5 MHz to 35 MHz and therefore can be considered useful for the delivery of broadband services.

Table 27: Asia Pacific Region Summary

Country	Frequency Range (MHz)	Block size (MHz)
Korea	2 300 to 2 390	27
Malaysia	2 300 to 2 390	30
Singapore	2 300 to 2 350	30/20
Indonesia	2 300 to 2 360 (Mobile) 2 360 to 2 390 (Fixed)	15
New Zealand	2 300 to 2 395	35/35/25
Vietnam	2 300 to 2 395	30
China	2 300 to 2 400	5

In the US regional WCS licences have been issued in the ranges 2 305 MHz to 2 315 MHz paired with 2 350 MHz to 2 360 MHz and in two unpaired blocks at 2 315 MHz to 2 320 MHz and at 2 345 MHz to 2 350 MHz. These licences are flexible to allow either FDD or TDD operation but due to a need to protect broadcast satellite radio operations in 2 320 MHz to 2 345 MHz range, there are technical constraints on the WCS systems identified in the FCC rules. These emissions limits can be found in 47 CFR 27.53(a) [i.16]. The US Federal Communications Commission is considering revision of the emission limits, based on extensive analysis and testing of the interference environment. A summary of this effort by the WCS licensees is available at http://fjallfoss.fcc.gov/ecfs2/document/view?id=7020347748.

In Europe, major utilisations identified for the band include aeronautical telemetry on a national basis, ancillary broadcast services, mobile applications and amateur use [i.1]. In addition it is a band identified for civil-military sharing. However, there is no harmonised usage and some countries have been able to issue licences for applications including mobile broadband services in some parts of the band (Norway for example). In addition some other European countries have expressed interest in national licensing procedures for parts of the band for broadband wireless services especially where there are some national constraints on the availability of other frequency bands such as the 2 500 MHz to 2 690 MHz band for these applications.

The Asia-Pacific Telecommunity Wireless Forum has drafted a report on APT Frequency Arrangements in 2 300 MHz to 2 400 MHz examining the arrangements in several countries in that region and proposing options from a regional perspective. The AWF finalised the draft report during the AWF-8 meeting at the end of Q1 2010. The APT is expected to approve the report later in 2010.

9.1.1 Current CEPT publications

ERC Report 25 [i.1] identifies the European Common Allocation of the 2 300 MHz to 2 400 MHz range to Fixed, Mobile, Radiolocation and amateur services. The first two on a primary basis with the second two on a secondary basis. The major utilisations identified include the following, as shown in table 28.

Table 28: ECA [i.1] information for 2 300 MHz to 2 400 MHz

Utilisation	ERC/ECC Documentation	European Standard
Aeronautical Telemetry	ERC/REC 62-02 [i.4]	-
Amateur	-	EN 301 783 [i.5]
Mobile Applications	-	-
SAP / SAB	ERC/REC 25-10 [i.6]	EN 302 064 [i.7]

However examination of the relevant ERC/ECC Recommendations shows that these services might not utilise the entire frequency band.

9.2 Proposed regulation and justification

No appropriate ECC deliverable that could form the basis for administrations considering the licensing issue for broadband mobile services in the 2 300 MHz to 2 400 MHz range exists.

If such a deliverable was available it could provide the following:

- Appropriate band arrangements and channelization schemes.
- Guidance on the expected spectrum utilisation by broadband mobile services including appropriate spectrum block sizes.
- Guidance on technical measures to protect other services using the spectrum.
- Guidance on technical measures to protect other broadband mobile networks using the spectrum.
- Spectrum engineering guidance to protect other services using the spectrum.

History

Document history		
V1.1.1	August 2010	Publication