CEPT Report 39

Report from CEPT to the European Commission in response to the Mandate to develop least restrictive technical conditions for 2 GHz bands

Final Report on 25 June 2010 by the

CEPT ECC
Electronic Communications Committee

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

0 EXECUTIVE SUMMARY

This Report is the response by CEPT to the Mandate from the European Commission issued in June 2009 relating to the 2 GHz band (1900-1980 MHz / 2010-2025 MHz / 2110-2170 MHz) [1].

'Task 1' of the Mandate is related to the summary of the national experience with implementation of the WAPECS approach. The summary is derived from the replies of 23 administrations and 9 Operators or Manufacturers on the ECO questionnaire distributed in November 2009.

The key messages extracted from the replies are:

- Most European countries have already implemented or by 2012 are going to implement the WAPECS approach described and defined in the EC and ECC Decisions.
- Up to now there is a lack of experience with licensing and cross-border coordination.
- The preferred technical conditions are based on the Block edge mask (BEM).
- The majority of industry responses considered a harmonised band plan as an essential requirement to achieve the best spectrum efficiency and avoiding interferences between different networks.

'Task 2'of the Mandate is related to the development of common and minimal (least restrictive) technical conditions. The study is mainly based on the applicability of the results achieved on the 2.6 GHz band to the 2 GHz band, with the aim of achieving as much commonality as possible, while taking due account of existing technologies and band plans.

The band plan for the 2 GHz bands is described in ECC/DEC/(06)01[4]. Annex 1 of the decision contains the harmonized spectrum scheme for UMTS and the annex is based on the compatibility studies in ERC Report 065 [9]. It consists in 2x60 MHz FDD in the bands 1920-1980 MHz paired with 2110-2170 MHz. The frequency bands 1900-1920 MHz and 2010-2025 MHz can be used for TDD operation or FDD uplink transmission paired with another frequency band. The technical conditions developed in this report are developed based on this band plan. Adjacent band compatibility studies for use of the 2 GHz band for UMTS/IMT-2000 have previously been presented in ERC Report 065 [9]. This report builds on the work carried out in ERC Report 065, by considering developments in characteristics of systems operating in and adjacent bands and by considering technology neutral approach to allow technologies other than UMTS to be deployed. It was found that the conclusions of the ERC Report 065 remain valid.

This Report has been developed on the assumption that the new technical conditions would be applied on request of an operator (e.g. in order to deploy LTE), and the existing license conditions would continue until that time.

The definition of the least restrictive technical conditions is based on the block edge mask (BEM) approach taking into account the corresponding work conducted by CEPT in the previous WAPECS Mandate, in particular the 2.6 GHz band covered by CEPT Report 19 and ECC Report 131.

The BEM approach consists of in-block (where appropriate) and out-of-block limits depending on frequency offset. The out-of-block component of the BEM itself consists of a baseline limit as well as transitional (or intermediate) limits, to be applied, where applicable, at the frequency boundary of an individual spectrum license. These limits were derived using studies of appropriate compatibility and sharing scenarios between electronic communications network (ECN) and other applications in adjacent bands but in the same geographical area.

The BEM has to be applied in conjunction with other conditions necessary for the coexistence between ECN systems and other applications in adjacent geographical areas (co-channel or adjacent bands).

The current use of the 2 GHz bands is a cellular like topology with two-way communication for mobile communication networks and should still be the case in the near future. Therefore, two sets of technical conditions are developed – one for the base station (BS) and one for the terminal station (TS) – taking into consideration mobile service parameters. A similar approach to that one used in CEPT Report 19 and ECC Report 131 has been applied to derive block edge mask values.

A baseline limit of -43 dBm/5MHz in the relevant frequencies of TDD spectrum and -50 dBm/5MHz in the FDD uplink band have been derived for the TDD ECN base stations. In addition an in-block limit in the range from 20 to 43 dBm/5MHz is needed depending on the frequency separation with the FDD uplink band based on the assumptions that both FDD and TDD are deployed as macrocellular networks where

TDD and FDD BS antennae are at the same heights and pointing to each other at 100 m separation distance. These limits could be increased at national level based on agreement between operators or on implementation of interference mitigation measures. When unpaired spectrum within the 1900-1920 MHz or 2010-2025 MHz band is allocated to more than one TDD operator, a guard band of at least 5 MHz is needed between unsynchronized operation of macro cell networks. For protection of TDD BS receiver the in-block EIRP limit should be 20 dBm/5MHz without additional interference mitigation measures or specific conditions of use (synchronized TDD or downlink transmission only). These technical conditions are relaxed in the case of synchronised TDD or downlink only transmission use.

"It has to be highlighted that these limitations in the use of the unpaired spectrum in the 1900-1920 MHz are due to the protection of the existing rights of use above 1920 MHz (i.e. UMTS FDD networks). This is the main difference between the assumptions that are used in the interference assessment of the 2 GHz band as opposed to the 2.6 GHz band. The initial situation in the 2 GHz band may evolve in the future, where appropriate, according to national authorisation process (e. g. if operators license needs to be renewed or if an operator makes a request for a change of use and/or technology). This could lead to similar technical conditions as those encountered previously in the 2.6 GHz band."

In this new situation the in-block power limits of TDD base stations could be relaxed in order to enable a more efficient and flexible use. This could be achieved, e.g., by using a 5 MHz guard band or restricted block between TDD networks or between TDD and FDD networks. Consequently no in-block power limit would be necessary in any of the bands.

As quoted in the ECC Report 119 [34] for the 2.6 GHz band, this could be achieved through the introduction of additional front-end filters on FDD and TDD base stations to limit adjacent channel interference. Another methodology, similar to using a restricted block, but applied to the interfered system, is to accept an increased level of interference in channels near the block edge. In such cases micro or pico cells which may benefit from additional shielding given from building clutters could still be deployed.

BEM for FDD base stations is derived directly by integration of the spectrum emission mask of UMTS and as plans for current ECN standards (e.g. LTE, WiMAX) indicate that alignment with this UMTS SEM is feasible, it is considered that this should not impose any constraint on equipment implementation.

A baseline level of -27 or -15.5 dBm/5MHz applies for ECN terminal stations depending whether probability of collision between victim and interferer packets can be taken into account. Some transitional levels are derived from the LTE band-independent spectrum emission mask, which is representative of the technologies envisaged in this band. No compatibility issue is expected between terminals used on different FDD operators' networks, due to the frequency separation with FDD downlink frequencies. It has to be highlighted that there will be an impact by FDD TS on TDD users in the 1900-1920 MHz band when considering emission masks compliant with ETSI EN301 908-13 [7] and TS 36.101 [7] specifications (E-UTRA standard). This will imply introduction of up to 10 MHz guard band to take into account impact of wider bandwidth used by FDD TS (10 or 15 MHz), e.g. LTE or DC-HSUPA.

The use of the unpaired spectrum (1900-1920 MHz and 2010-2025 MHz) for TDD cannot be guaranteed without inter-operator interference for emission mask compliant with ETSI EN301 908-1361 [7] and TS 36.101 [7] specifications. This is mainly due to the limited number of TDD blocks available and the fact that there may be discrepancies between the regulatory emission mask for terminals defined in this Report and the spectrum emission masks given in the standards, especially for terminals having a bandwidth greater than 5 MHz.

The studies have highlighted the limitations in the use of the unpaired spectrum in the 1900-1920 and 2010-2025 MHz bands for broadband communication under the current arrangements. The introduction of flexibility gives the potential for a wider range of uses of these bands. However, other measures are needed to realise the efficient and flexible use of this spectrum.

Table of contents

LIST OF ABBREVIATIONS

Abbreviation	Explanation
3GPP	3rd Generation Partnership Project
ACIR	Adjacent Channel Interference Ratio
ACLR	Adjacent Channel Leakage Ratio
ACS	Adjacent Channel Selectivity
BEM	Block Edge Mask
BER	Bit Error Rate
BS	Base station
CEPT	European Conference of Postal and Telecommunications Administrations
CS	Circuit Switched
DC-HSUPA	Dual Carrier High Speed Uplink Packet Access
DCS	Dynamic Channel Selection
DECT	Digital Enhanced Cordless Telecommunications
DL	Down Link
EIRP or e.i.r.p.	Equivalent isotropically radiated power
EC	European Commission
ECC	Electronic Communications Committee
ECN	Electronic Communications Network
ECO	European Communication Office
ECS	Electronic Communications Service
EESS	Earth Exploration Satellite Service
ETSI	European Telecommunications Standards Institute
EU	European Union
FDD	Frequency Division Duplex
FS	Fixed Service
GOS	Grade of Service
GSM	Global System for Mobile communication
IEEE	Institute of Electrical and Electronics Engineers
IMT/IMT-2000	International Mobile Telecommunications/International Mobile Telecommunications-2000
ITU-R	International Telecommunication Union – Radiocommunication Sector
LTE	Long Term Evolution (IMT technology developed by 3GPP)
MCBTS	Multi Carrier Base Transceiver Station
MCL	Minimum Coupling Loss
MSD	Minimum Separation Distance
MSS	Mobile Satellite Service
OOB	Out Of Band
PFD	Power Flux Density
PS	Packet Switched
PSD	Power Spectral Density
RF	Radio Frequency
RSPG	Radio Spectrum Policy Group
SAP/SAB	Services Ancillary to Programming / Services Ancillary to Broadcasting
SDO	Standards Development Organisations
SEM	Spectrum Emission Mask
SP	Spurious
SRS	Space Research Service
TDD	Time Division Duplex
TDMA	Time Division Multiple Access
TRP	Total Radiated Power
TS	Terminal Station
UL	Up Link
UMTS	Universal Mobile Telecommunications System
WAPECS	Wireless Access Policy for Electronic Communications Services
WiMAX	Wireless Microwave AXcess (IMT technology developed by IEEE)

1 INTRODUCTION

In task 1 of the EC Mandate on the 2 GHz bands (1900-1980 MHz /2010-2025 MHz /2110-2170 MHz) [1], CEPT is mandated to:

"Summarise national experience with implementation of the WAPECS approach, in particular on BEMs so far: Noting the wish of Member States to reflect on experience, a summary of national situations where the WAPECS approach has been applied in the authorisation process should be made and views on the experience should be reflected. "

This task has been completed through the use of a questionnaire sent to administrations and industry with the view to collect some initial feedback on this matter. An analysis and synthesis of the responses are contained in section 2.

In task 2 of the EC Mandate CEPT is mandated to:

"Develop common and minimal (least restrictive) technical conditions for the 2GHz bands: Study how the results achieved on Block Edge Masks (BEMs) for the EC Decision on 2500-2690 MHz could be transposed to the 2 GHz band, with the aim of achieving as much commonality as possible, while taking due account of existing technologies and band plans."

This task is considered as a follow-up of previous CEPT activities on the WAPECS mandate that resulted in the CEPT Report 19 [5], ECC Report 131 [6] and CEPT Report 30 [8]. Therefore, this report applies a similar approach to the 2 GHz band with a particular emphasis for the results related to the 2.6 GHz activity.

The technical conditions for the 2.6 GHz band were intended to be applied when new licenses for this band were awarded, and it was envisaged that the license holders for paired and unpaired spectrum would be distinct. The situation for the 2 GHz bands is different:

- In almost all CEPT countries, licenses have already been awarded for most of the spectrum
- Most licenses include both paired and unpaired spectrum.
- The operators from the original round of license awards now have well established networks in the paired spectrum.
- In most cases each operator only has 5 MHz of unpaired spectrum but networks have not been deployed widely yet.

The definition of the least restrictive technical conditions is based on the electronic communication service already deployed and likely to be deployed in the future in this band, i.e., two-way fixed/mobile communication services. However, it does not prejudge the type of applications that can be implemented under the determined technical conditions. It should be noted that some Administrations are looking at the possibility of other uses not originally envisaged, including downlink only broadcast, semi-duplex and non-ECN applications.

For a matter of simplicity, the systems to which the technical conditions are defined will be called ECN (Electronic Communication Networks) in the document. The term non-ECN refers to radiocommunication systems operating in adjacent bands.

The following items are addressed in all the other sections after section 2 in this Report:

- The most appropriate model for defining least restrictive technical conditions for ECN applicable for the 2 GHz band. The technical conditions are based on studies assessing the risk of interference between current and future ECN neighbouring networks, whilst considering the potential implications of the non-ECN use.
- Determination of the technical assumptions for ECN systems in the 2 GHz band. This includes the selection of reference network scenarios and the choice of technical characteristics for reference ECN systems.
- Identification of the compatibility and sharing scenarios.

- Proposed approach for the technical conditions applicable for the 2 GHz band.
- Analysis of the studies and derivation of the technical conditions for ECN in the 2 GHz band.

The 2 GHz bands are heavily used in most of the European countries, starting from 2002. The technical conditions designed for IMT-2000/UMTS, outside these bands, based on compatibility studies described in ERC Report 065 [9] will continue to apply.

It is intended that the technical conditions developed in the study below would not replace existing technical license conditions (e.g. in existing technology specific UMTS licenses) and related regulation, unless a license holder requests to modify these to allow the introduction of new technologies into the band. This includes the need to properly address the foreseen extension to wider system bandwidths (currently up to 20 MHz) and also the update or change of existing TDD licenses.

2 SUMMARY OF EXPERIENCE WITH IMPLEMENTATION OF THE WAPECS APPROACH, IN PARTICULAR ON BEMS

(1) Summarise national experience with implementation of the WAPECS approach, in particular on BEMs so far: Noting the wish of Member States to reflect on experience, a summary of national situations where the WAPECS approach has been applied in the authorisation process should be made and views on the experience should be reflected.

In relation to task 1 of the EC mandate, a questionnaire has been sent to administrations and industry in order to depict national situations and also collect some feedback from mobile operators and manufacturers/vendors with respect to the implementation of the WAPECS approach. 23 answers have been received from administrations (among which 16 of them from EU member states). 9 answers from industry have also been analysed.

2.1 The WAPECS approach: the state of the art

The RSPG delivered an opinion on WAPECS (see RSPG 05-102 [22]) which describes the WAPECS concept, the identified constraints, the relevant challenges for Member States, the long term policy goals and the need to establish a transition to a WAPECS framework without implementing overnights in a “big bang” approach. Moreover, a recommendation from the European Commission provides the coherent application of non-technical conditions attached to rights of use for the frequency bands identified for WAPECS implementation.

Consequently, the WAPECS concept has been studied in several frequency bands by CEPT further to mandates from the European Commission. Outcomes of this work are twofold.

- On the one hand, the less restrictive technical conditions (e.g. channelling arrangements and emission masks) which apply to spectrum granted to a network operator will be defined by an EC Decision based on results of CEPT studies (CEPT reports) (e.g. Spectrum Decision framework).
- On the other hand, CEPT deliverables on spectrum sharing and some national license conditions could also contain technical conditions related to terminal equipment which are not included in the above EC decisions. Therefore, these should be clearly identified in ETSI harmonised standard(s) in line with the RSPG opinion on streamlining regulation (and particularly recommendations 5.8 to 5.10).

So far, at the EU level, six frequency bands have been identified for implementation of the WAPECS approach (The “WAPECS bands”). These are the 900/1800 MHz bands currently used for GSM, the 2 GHz band, the 2.6 GHz band, the 3.4 GHz band as well as the 800 MHz band. The context of each of these frequency bands at national level is different and thus, may impact the technical conditions accordingly. For example, different approaches had to be considered according to the usage of the band prior to the implementation of the WAPECS concept: a new band for fixed or mobile ECN&S, a band where fixed and mobile ECN&S are already operational, a band with other use to be taken into account or to be tendered. The table below recalls environment related to these frequency bands as reflected in the responses. It has to be noted that the most likely uses assumed for these bands are based on a cellular network topology (i.e. a two way communication system with a network of base station servicing multiple subscribers/terminal stations).

It should be noted that the WAPECS approach is in a very early stage of implementation. Consequently, the practical effect of the WAPECS principles on industry and consumers is not yet fully apparent. Several mandates have been fulfilled by CEPT on the 3.4 GHz, 2.6 GHz, 800 MHz but national implementation is not really already in place.

Most administrations that replied to the questionnaire indicate that they will apply the WAPECS approach, implementing relevant EC Decisions which set the regulatory and technical conditions based on relevant CEPT reports. They have already implemented or are going to implement, in the next few years, the WAPECS approach (with some exceptions) in the 6 WAPECS bands already identified. One country provided very detailed plans to introduce flexibility in the usage rights in the various bands. Implementation of the WAPECS approach is not just limited to EU countries, it also includes a number of non-EU-countries, for example one non-EU country has implemented it in 2.6 GHz and plans to implement it in 900/1800 MHz and in another country possible applications are under investigations.

To some extent, the regulatory framework for WAPECS implementation can be considered as already defined or to be about to be defined. Nevertheless, implementation may differ at a national level. So, national implementation is still an on-going process and administrations have very limited experience with it. Table 1 below provides information about the early implementation of the WAPECS concept within CEPT.

Band	Frequency range	Context	Particularity
900/1800 MHz	880-915 MHz 925-960 MHz 1710-1785 MHz 1805-1880 MHz	- FDD Band plan already defined - Bands used by GSM	- EC decision 2009/766 and Directive 2009/114 - Sharing conditions with non WAPECS systems inside WAPECS bands (i.e. GSM) - Sharing conditions with non WAPECS systems outside WAPECS bands (e.g. above 960 MHz) - Technologies in conformity with UMTS standards allowed. 900/1800 MHz EC mandate – on going
2 GHz	1900-1980 MHz 2010-2025 MHz 2110-2170 MHz	- Band plan already defined for TDD and FDD according to ECC/DEC/(06)01 [4] - Bands used by UMTS	- Band already in use for UMTS. Licenses already in force. - TDD spectrum granted in some countries but not used - UMTS Technologies allowed. Introduction of a BEM under investigation 2 GHz EC mandate on going
800 MHz	790-862 MHz	- Release from broadcasting use planned in large number of countries - Free band after broadcasting tender - Preferred harmonised FDD band plan	- Sharing conditions with non WAPECS systems outside WAPECS bands (i.e. broadcasting use below 790 MHz) - Usage of Low power applications such as PMSE in the FDD duplex gap - preferred harmonised FDD band plan - Technical conditions defined by a BEM

2.6 GHz	2500-2690 MHz	- Band in use by public sector in some countries. - Free band after public tender - Flexible band plan	- Market could influence the FDD and TDD spectrum size (i.e. flexibility in location and number of FDD/TDD boundaries according to EC Decision 2008/477/EC [32]) - ECC/DEC/(05)05 [28] fixed FDD /TDD band plan - Public tender (band release) can delay selection process - Legal actions in some countries can delay selections - Technical conditions defined by a BEM
3.4-3.8 GHz	3400-3800 MHz	- No band plan defined	- Framework defined in the BWA context (before introduction of the WAPECS approach) EC Decision 2008/411/EC [29], ECC/DEC/(07)02 [30], ECC/REC/(04)05 [31] - Technical conditions defined by a BEM - Regional licenses in some countries - in some countries Licenses limited to 3.4-3.6 GHz due to the FSS use in the 3.6-3.8 GHz (3.4-3.8GHz) band in some countries - Sharing conditions with non WAPECS systems inside WAPECS bands (i.e. P-P FS links)

Table 1 : Context and particularities of each WAPECS band

2.2 The early implementation of the WAPECS approach

Table 1 reveals that the WAPECS approach is largely in the early stages of implementation. Two cases of WAPECS implementation can be considered:

1. frequency bands where (legacy) networks are already operational (e.g. 900/1800 MHz and 2 GHz bands); and
2. frequency bands where network deployment is still in the planning stage (e.g. 800 MHz, 2.6 GHz).

For case 2 initial feedback from implementation is likely to come from the 800 MHz, 2.6 GHz and 3.6 GHz bands. These bands emerged in a number of countries as frequency bands for which the technical conditions have been defined or are under definitions in number of responses. Therefore, the technical conditions provided in the relevant EC decisions will be included in the national licensing process. Therefore, it is expected that the block edge mask (BEM) approach will be used. For example, Commission Decision 2008/477/EC sets least restrictive technical conditions including a block edge mask for terrestrial systems capable of providing electronic communication services in the 2.6 GHz band.

For case 1 (e.g. the 900/1800 MHz and 2 GHz bands), specific consideration has been given to their continued use by existing (legacy) technologies. Consequently, technical conditions may be defined relatively to the existing ones (i.e. compliance with UMTS standards). To some extent, the WAPECS concept could be considered as partially implemented in the 900 MHz, 1800 MHz bands through, an EC Decision 2009/766/EC [23] and the Directive 2009/114/EC [24].

The WAPECS approach is being implemented using a band by band approach, e.g. defining the most appropriate technical conditions and the EC regulation applicable to each specific band. Implementation of the WAPECS concept may differ in the situation where networks are already operational (case 1) and benefit from a migration path and from the others (case 2) where networks will be deployed in new mobile bands (e.g. 800 MHz band and 2.6 GHz Band).

It is interesting to note that, largely as a consequence of WAPECS considerations, the specifications of LTE base stations recently changed to align the LTE base station at 900 and 1800 MHz SEM with the UMTS ones.

It should be also highlighted that, mainly for competition reasons, some administrations foresee the need for some WAPECS bands (including some other bands for some administrations) to be considered jointly or in combination. For example, some administrations intend to combine auctions for different frequency bands (e.g. the 800 MHz and 2.6 GHz bands). Some administration are thinking about the introduction of spectrum caps (including the need to release some spectrum in specific bands) in order to limit the spectrum holdings of operators. A defragmentation process is also foreseen for spectrum management purposes in order to optimise spectrum use between operators.

In the most cases, negotiations between operators are possible to relax the levels of emissions pre-defined in the regulatory envelope. There are a few exceptions, in one case the Frequency Agency has to be involved.

There is no unique procedure to protect non-WAPECS services, if those services are used in the different countries.

2.3 Cross border coordination issues

At this stage there is very little feedback from implementation of the WAPECS approach at a national level. Authorisation procedures are likely to differ among the countries where the approach WAPECS is implemented. Even if multilateral agreements are in place for specific bands, e.g. 3.4-3.6 GHz, some countries referred to the added value of CEPT and HCM[1] to facilitate cross border coordination. Undefined band plans may increase the level of complexity in such issues. Some administrations do not anticipate cross border coordination problems. CEPT ECC should continue to investigate the development of preferred harmonised band plans including necessary flexibility and appropriate least restrictive conditions to facilitate economies of scale. Such band plans may help to reduce the complexity of cross border coordination. It should be noted that most of the WAPECS bands have preferred harmonised band plans.

Different CEPT countries, including EU countries, may apply different band plans either side of a border potentially complicating cross border coordination, However even if two countries implement a band plan (e.g. for 2.6 GHz, different from that one defined in the ECC/DEC/(05)05 (2*70 MHz for FDD and 50 MHz for TDD)), coordination can still be facilitated by setting a field strength trigger at the lowest levels (proposed in the relevant CEPT cross border coordination recommendation) in order to limit base stations desensitization. It may constrain therefore, the operators in covering the border areas. From this point of view, there would be a clear benefit of harmonising not only the technical conditions but also the band plan. ECC is currently studying new approaches to border coordination that will address the scenario of different deployments on either side of the border. Another issue that raised some concern was the cross-border coordination between EU and non-EU countries where different radiocommunications services are deployed, e.g. satellite service on one side and mobile service on the other side of the border. In addition, preferred harmonised band plans would also help to further mitigate interference between terminal stations.

2.4 Technical conditions applying to terminal equipment

Another concern is about the management within the EU of interference between terminals. Since they are not included in the relevant EC decisions, CEPT assumes that these conditions have to be taken into account with care when developing harmonised standards by ETSI. There may be an issue because within the EU, mobile terminals are generally exempted from individual licensing and also because

---

[1] Harmonised Calculation Method: Agreement between some Administrations in Europe on the coordination between fixed services and mobile services

network operators are required to connect terminal stations having an appropriate interface and meeting the essential requirements of Article 3 of the R&TTE Directive [21] (in the context of spectrum masks, the relevant provision is Article 3.2, relating to harmful interference). To ensure that interference between terminals is managed effectively it is therefore extremely important that ETSI takes account of relevant ECC work on WAPECS bands – amending their harmonised standards as necessary. It has to be noted that some administrations assume that interference between terminals will be successfully handled by ensuring conformity to the R&TTE Directive – if ETSI does not take this issue into account in the development of harmonised standards then this may not be a safe assumption.

The R&TTE Directive relates to both placing equipment on the market and putting it into service. In the past, there has generally been a one-to-one correspondence between harmonized standard, application/technology and frequency band (i.e., one applicable harmonized standard for an application or technology in a particular frequency band), and the national measures for license exemption have almost always been based on this standard. In other words, the spectrum emission mask for the terminal relative to the nominal channel edge will be the same as the block edge mask relative to the block edge, or more stringent.

However, this one-to-one correspondence may not necessarily apply under the WAPECS concept. There might be different criteria for putting equipment into service, associated with different operational restrictions. Without the appropriate directions given in the harmonised standards to ensure compliance, this could lead to a non-compliance with the CEPT sharing criteria. Therefore it is important to ensure that the development of harmonised standards takes account of the sharing criteria developed by CEPT for terminals in order to avoid such non-compliances.

- Only few administrations referred to additional technical conditions for terminal equipment on the basis of CEPT or ECC reports.
- One administration refers explicitly to these technical conditions even in the licensing process.

This is clearly an area for which the RSPG opinion on streamlining is particularly relevant. CEPT should cooperate with ETSI to ensure that development of harmonised standards will include instructions on how the CEPT sharing criteria can be met by equipment.

2.5 Industry responses in relation to Harmonised frequency arrangements and associated trade-offs with a more flexible environment

The majority of the industry responses to the questionnaire indicated that the cost associated with a more flexible use of spectrum in terms of band plan neutrality appears to be too high for the telecom industry, examples of the points raised are as follows:

- Technical conditions able to cope with a flexible band plan are more stringent than those linked with a fixed band plan.
- There are cases where networks are essentially not able to coexist in adjacent channels due to differences in fundamental design principles (such as the choice of the different duplex methods).
- Coexistence in such a situation may lead to severe constraints on the allowed parameters for operations of the systems involved. These constraints lead to significant additional cost and decreased power efficiency of the hardware, and significantly reduce the overall efficiency of spectrum use by introduction of an additional guard band or restricted block between operators. It should be highlighted that such an outcome is possible due to a pragmatic approach in derivation of technical conditions which takes into account a balance between requirements necessary to ensure coexistence among different services and the state-of-the-art of RF technology.

Other responses did not raise cost as an issue (there was no specific question on this point).

Therefore, a harmonised frequency arrangement is preferred by the majority of industry as well as some administrations as a beneficial component for an efficient implementation of WAPECS approach. This does not preclude the possibility for harmonised frequency arrangements to include flexibility, e.g. for applications (mobile/fixed) or duplex arrangements (FDD/TDD) and different channel bandwidths where possible and relevant. A preferred harmonised frequency arrangement is a key point to avoid uncertainty regarding the development of new mobile generations and to help manage interference between networks and to facilitate spectrum efficiency. Moreover the same spectrum emission mask in different bands might ease the implementation of multi-band base band chipsets. It would also solve the issue of roaming between countries following different band plans. It should be mentioned that a harmonised band plan designed to accommodate only one duplex arrangement could create an imbalance in terms of the amount of spectrum available between technologies based on FDD and TDD. At the same time, coexistence of FDD and TDD might be helped by a large amount of spectrum to be available (e.g. in the 2.6 GHz band), otherwise, the cost in terms of spectrum efficiency could be too high and would lead to a lose-lose situation. Every FDD/TDD boundary (FDD and TDD based networks in close vicinity, e.g. 1920 MHz, 2570 MHz, or 2620 MHz) or varying regulatory conditions could lead to added cost for terminal and base station.

A number of industry responses indicated that band plan neutrality created uncertainties e.g. in the 2.6 GHz band. The EC Decision 2008/477/EC allows flexibility in partitioning between FDD and TDD, it is claimed that this could create a challenging coexistence situation at country borders when countries make different decisions (i.e. coexistence of FDD and TDD networks in geographically adjacent areas), it is also claimed that this might result in additional roll-out delays since there, according to this view, are no mature technologies today that can support such flexibility. It has been claimed that this results in some countries delaying their decisions and waiting for the decisions in their neighbouring countries. As a consequence, if true, a deadlock situation could be created and network deployment might be significantly delayed.

The majority of Industry respondents envisage implementing the 3GPP technology family (GSM, UMTS, HSPA, and LTE, LTE-Advanced) in WAPECS bands, but, at least one operator is also considering deploying WiMAX (IEEE 802.16) in some WAPECS bands. Although the majority of industry respondents were happy with the plans envisaged in the current EU mandate for 900/1800 MHz bands which limit usage conditions to specific (named) technologies, one manufacture responded that it would be preferable to develop a block edge mask approach for these bands. This manufacturer also considers that TDD is disadvantaged with respect to FDD in certain CEPT band plans (e.g. ECC/DEC/(05)05).

2.6 WAPECS concept and the implications on the equipment regulatory framework (e.g. R&TTE Directive)

Most of the responding countries suggested they would rely on the provisions of the R&TTE directive to provide compliance with the appropriate technical conditions. But some expressed the opinion that they would also implement the technical conditions for the Terminal Stations that are imposed in the EC Decisions. One country decided not to include technical conditions for terminal stations, since this was considered not a condition that could be put on the operators.

Some technologies have to be considered as representative examples for the derivation of the least restrictive technical conditions. In the most desirable case (that is, without operational restrictions or bilateral negotiations), the SEM for the equipment (BS or TS) relative to the nominal channel edge will be the same as the BEM relative to the block edge, or more stringent. Other technologies are still allowed providing that their SEM still comply with the BEM. For that purpose, additional mitigation techniques may need to be implemented (e.g. additional filtering, frequency offset or reduced power).

Most industry stakeholders expressed concerns about the cost of filters which may be required either for protection of other application (broadcasting below 790 MHz) or due to flexible band plan (e.g. 2.6 GHz), but other industry stakeholders have indicated that they do not have such concerns. One industry response mentioned that coexistence can also be achieved by other means e.g. based on time (or even code) separation.

An important consideration is that certain mitigation measures (particularly filtering) may be possible for base stations since this is under control of the network operator, however not all mitigation techniques are possible for terminal stations and this is the reason why the technical conditions for terminal stations are generally no more restrictive than the emission requirements in voluntary specifications since their characteristics are not regulated by an EC deliverable. This creates a risk of interference between terminal stations when introducing technologies with wider bandwidths than those considered during the development of the least restrictive technical conditions.

All Industry responses supported the principle of harmonised band plans, one response summarised that harmonised frequency arrangements and a common band plan with well defined technical conditions will ensure that the WAPECS approach is a success. Other responses explained that the implementation of the WAPECS approach without harmonised band plans could require specific terminal implementations for non-harmonised arrangements. Passive components (filters) may be needed in equipment to provide the required amount of protection to the neighbouring service. Given the differences between these technical conditions and the emission limits defined in the corresponding harmonised standards, industry mentioned a lack of clear guidance in this area. Such uncertainty may impact the availability and price of products.

The WAPECS studies have been conducted assuming a technology-neutral approach which encompasses several technologies with different bandwidths (i.e. multi-carrier HSPA with 5 MHz, 10 MHz and potentially larger bandwidths, LTE with 10 MHz and 20 MHz bandwidths, etc.). As a result it is impossible to define a single boundary between the out-of-band domain and the spurious domain for all combinations of technology and channel bandwidth. For this reason WAPECS technical conditions focus on the out-of-band domain and do not deal with the regulation of spurious emissions which continue to be addressed under the requirements of the R&TTE directive. It should be noted that the spurious domain will be determined by the channel bandwidths used by the equipment not the BEM block sizes.

Some industry stakeholders mentioned also the possible discrepancy in terms of measurement and control of conformity between technical conditions based on BEM EIRP limits and conducted emission limits at the BS antenna connector as used by technical specifications standards.

3 ANALYSIS FOR THE DEVELOPMENT OF TECHNICAL CONDITIONS FOR ELECTRONIC COMMUNICATION NETWORKS IN THE 1900-1980 MHZ / 2010-2025 MHZ / 2110-2170 MHZ BANDS

3.1 Appropriate models for defining least restrictive technical conditions

During its recent work, e.g. on the 790-862 MHz [8], the 2.5-2.69 GHz [5], [6] and the 3.4 – 3.8 GHz bands [5], CEPT has gained expertise on the definition of least restrictive technical conditions with the Block Edge Mask (BEM) model.

In order to meet the ambitious timescales established in the Commission Mandate, the previous experience and results gained of developing similar technical conditions for the BEMs in 2.6 GHz band were used. The BEM approach was able to fulfil the objectives set out in previous WAPECS Mandates, and it was therefore decided to use a similar approach as a working assumption for the development of the least restrictive technical conditions for the 2 GHz band, noting that in the 2 GHz bands there is a need to take into account of existing rights of use.

The block-edge mask (BEM) approach consists of in-block and out-of-block components as a function of frequency. The out-of-block component of the BEM itself consists of a baseline level and, where applicable, intermediate levels which describe the transition from the in-block level to the baseline level as a function of frequency.

Correspondingly, the BEMs over all frequencies under study are built up by combining the different values resulting from compatibility studies in such a way that the limit at each frequency is given by the higher (less stringent) value of a) the baseline requirements, b) the boundary-specific requirements and c) the in-block requirements. The BEMs are applicable only within the sub-bands 1900-1980, 2010-2025 und 2110-2170 MHz.

It has to be noted that the BEM components have been derived so far following compatibility studies between ECN and other applications in adjacent bands but in the same geographical area. Therefore, the BEM has to be associated with other requirements ensuring coexistence between ECN systems and other applications in adjacent geographical areas (co channel or adjacent bands).

These technical conditions applicable for the 2 GHz band are optimised for, but not limited to, fixed/mobile communications networks (two-way). Therefore, they are derived both for base stations (BS) and terminal stations (TS).

The BEM is applied as an essential component of the necessary conditions for the coexistence in the absence of bilateral or multilateral agreements between neighbouring mobile networks in the 2 GHz band, without precluding less stringent technical parameters if agreed among the operators of such networks.

Administrations should ensure that operators in this band are free to enter into bilateral or multilateral agreements to develop less stringent technical parameters and, if agreed among all affected parties, these less stringent technical parameters may be used, if the level of protection for other networks is not affected.

The BEM is a ‘regulatory mask’, i.e. it can not be applied directly to Spectrum Emission Mask (SEM) parameters for equipment. It is noted that the BEM concept does not in itself define the means by which the equipment in an operator’s network meet the BEM. The easiest way to comply with the BEM (at least in regulatory terms) is for the equipment (including antenna and feeders) to inherently meet the BEM when the channel edge is aligned with the block edge.

3.2 Radio network scenario and reference ECN system

3.2.1 Radio Network scenario

The main purpose of this report is to define technical conditions optimised for but not limited to two-way electronic communication networks. Therefore, the basic radio network scenario used in the studies is a cellular like topology with mobile terminals and two-ways communication as illustrated in Figure 1.

Figure 1: Communication link including terminal at an unknown location (mobile TS antenna)

3.2.2 Reference ECN system characteristics

The principles for considering reference ECN system characteristics are outlined in the CEPT Report 19 [5].

There is a need to define assumptions for the basic ECN system characteristics in order to conduct the necessary technical studies. The assumptions are based on the most likely systems characteristics envisaged for ECN in the 2 GHz band. They are mentioned in the ITU-R Report M.2039 [10]. The list of parameters for ECN base station and terminal station are presented in Table 2 and Table 3.

e.i.r.p	61dBm/5MHz
Antenna gain	17dBi
Antenna height	30m
Antenna pattern	F.1336 sector antenna (120°)

Table 2: List of parameters for ECN base station

It has to be noted that Annex A of ERC Report 065 [9] mentioned similar assumptions. The BS antenna gain ranges from 11 to 17dBi and an average value of 14.5 dBi was considered. Similarly, a transmitted power ranging from 41 to 43 dBm per UMTS channel was also considered. A 3dB margin for design margin was also considered to some extent.

e.i.r.p or TRP	23 dBm
Antenna gain (feeder loss included)	0dBi
Antenna height	1.5m
Antenna pattern	Omnidirectionnal

Table 3: List of parameters for ECN terminal station

3.3 Partitioning of the band – Channelling arrangements

The band plan was agreed by CEPT and it was published as ERC/DEC/(99)25 [2]. This decision was withdrawn and replaced with ECC/DEC/(06)01 [4]. Annex 1 of this decision contains the harmonized spectrum scheme for UMTS and the annex is based on the compatibility studies in ERC Report 065 [9]. There is also an EC Decision No 128/1999/EC [3]. Examples for the implementation of this band plan are provided in Annex 1.

The bands 1920-1980 MHz/2110-2170 MHz are used or are planned to be used for IMT-2000 technologies as defined in ITU-R Recommendation M.1457 [11] in most of the countries and are covered by Harmonized Standards, e.g., EN 301 908 series.

It is proposed to take ECC/DEC/(06)01 as the basis for these studies.

- 1900-1920 MHz considered for either TDD or FDD uplink paired with another (currently unspecified) FDD downlink band,
- 1920-1980 MHz considered for FDD uplink paired with 2110-2170 MHz or TDD,
- 2010-2025 MHz for either TDD or FDD uplink paired with another (currently unspecified) FDD downlink band
- 2110-2170 MHz for FDD downlink.

4 APPROACH FOR DERIVING THE TECHNICAL CONDITIONS IN THE 2 GHZ BAND

Similarly to the approach introduced in CEPT Report 19 and CEPT Report 30, the following stages are used to conduct the analysis.

- Stage 1 Define which basic radio network scenario, including duplex model, for ECN and which reference ECN systems would be suitable in the considered band.
- Stage 2 Consider, if necessary, compatibility analysis between ECN systems and non–ECN systems operating in this band.
- Stage 3 Consider the results of compatibility analysis between ECN systems and non–ECN systems operating in adjacent band. Derive the appropriate technical conditions for ECN that would apply at the adjacencies between ECN and non-ECN.
- Stage 4 Derive appropriate technical conditions (Block Edge Mask or other) by looking at ECN vs. out of block ECN analysis also taking into account any limitations imposed by the results of Stages 2 and 3.

- Stage 5 Derive appropriate technical conditions (Block Edge Mask or aggregate PFD or other) by looking at ECN vs. co-frequency ECN studies in a geographically adjacent area also taking into account any limitations imposed by the results of Stages 2, 3 and 4.
- Stage 6 Analysis of the technical conditions result.

4.1 Stage 1: Assumptions for WAPECS in this band

The assumptions for ECNs in this band are described in sections 3.2 and 3.3. This includes elements related to radio network scenario, partitioning of the band and reference system characteristics.

UTRA-FDD (5 MHz) and LTE (5 to 20 MHz bandwidth) are considered as representative examples of ECN FDD technology. UTRA-TDD (5 MHz) is considered as representative examples of ECN TDD technologies. Other technologies such as WiMAX could be considered and it is noted that standardisation activities on multi-carrier HSPA are ongoing in 3GPP.

In the fifth release of the standard EN 301 908 [12][13][14][15], a new option is expected to be available for the E-UTRA mask in the 2 GHz band. This option consists in aligning the current emission mask for base stations contained in the fourth release with the UTRA mask of the standard EN 301 908. It is important to note that both E-UTRA BS and Multi-Standard Radio (MSR) BS emissions already follow the UTRA emission mask in the 900 and 1800 MHz bands.

This is the easiest way to ensure that the current sharing scenario would not require specific treatment. Without this alignment, reconsideration of the sharing conditions inside the band as well with systems outside the band may be needed and would need further investigation.

4.2 Stage 2: WAPECS vs in-band non-WAPECS

The in-band non-WAPECS systems are only Fixed Service on a national basis. ERC Report 64 [16] provides a method for the evaluation of sharing possibilities between IMT-2000 and Fixed Services. The methodology is applicable for all mobile technologies. It should be noted that some administrations might introduce other non-WAPECS applications in unpaired spectrum in the future.

4.3 Stage 3: WAPECS vs out of band non-WAPECS

The following other systems/services that are out of the WAPECS band need to be considered:

- Below 1900 MHz: DECT
- Between 1980 and 2010 MHz: MSS
- Between 2025 and 2110 MHz: FS, Space Research, EESS
- Above 2170 MHz: MSS

The adjacent channel services can be seen in the Table 4 and the system parameters as well as the used/agreed sharing criteria can be seen from ERC Report 065 [9]. Sharing scenarios to be considered have been already considered in ERC Report 065 when adjacent band compatibility between UMTS and other 2 GHz services have been studied.

MHz	<1900	1900 - 1920	1920 - 1980	1980 - 2010	2010 - 2025	2025 - 2110	2110 - 2170	2170 - 2200
Service	DECT	T-UMTS TDD	T-UMTS FDD UL	MSS/ UMTS-S	T-UMTS TDD	FS SRS E-S/s-s	T-UMTS FDD DL	MSS/ UMTS-S
Report 065 parameters	Annex A3	Annex A1	Annex A1	Annex A2	Annex A1	Annex A4	Annex A1	Annex A2
Report 065 Methodology	Annex E	Annex E	Annex B	Annex B	Annex B&D	Annex D	Annex B&D	Annex B

Table 4 : Systems operating in the 2 GHz band

The compatibility studies in section 3 of ERC Report 065 resulted in additional guard bands taking into account minimum carrier separations between UMTS and adjacent systems carriers.

The summary of Table13 of ERC Report 065 is reproduced here below in Table 5. The values have been updated to take into account ECC/DEC/(06)01 [4].

Adjacent services	Minimum carrier separation	Calculated Extreme position of the UMTS carrier centre	"Additional" guard band[C]
1900 MHz: DECT UMTS (TDD) (see section 3.1 of ERC Report 065 [9])	5.2 MHz	1902.4 MHz	-
1980 MHz MSS (E-s) UMTS (FDD) (section 3.2.1.1 of ERC Report 065)	3.04 MHz	1977.2 MHz	0.54 MHz
2010 MHz MSS (E-s) UMTS (TDD used outdoors) (see section 3.2.1.3 of ERC Report 065)	>3.5 MHz[E]	>2013 MHz	>1.0 MHz
UMTS (TDD used indoor) (see section 3.2.1.2 of ERC Report 065)	3.0 MHz	2013.0 MHz	0.5 MHz
2025 MHz SSS UMTS (TDD used outdoors) UMTS (TDD used indoors) (see sections 3.3.1 of ERC Report 065)	3.0-3.3[A] MHz 2.96-3.26[A] MHz	2022.2 MHz 2022.2 MHz	0.3 MHz 0.3 MHz
2025 MHz FS[B] (see section 3.4 of ERC Report 065)	8.3 MHz	2022.5 MHz	-
2110 MHz SSS SSS/UMTS (FDD) (section 3.3.2 of ERC Report 065)	3.0- 3.3[A] MHz	2112.8 MHz	0.3 MHz
2110 MHz FS[B] UMTS(FDD) (see section 3.4 of ERC Report 065)	8.3 MHz	2112.8 MHz	-
2170 MHz MSS (s-E) UMTS (FDD) (see section 3.2.3.1 of ERC Report 065)	<3.5 MHz[D]	2167.2 MHz	0.9 MHz

A *These carrier separations would be required for compliance with recommendation ITU-R SA.1154. In view of the specific use of the border regions by the space science services, a separation of 2.8 MHz appears to be sufficient.*

B *This separation distance can be implemented by not utilising the 3 outermost FS.channels (1.75 MHz ch. spacing) or the outermost FS-channel (3.5 and 7 MHz ch spacing) in the upper part of 2025-2110 MHz (ERC Rec T/R 13-01). For the lower part of 2025-2110 MHz all 7 MHz channels can be used. At both edges all FS channels with 14 MHz ch. spacing can be utilised. It is further recommended to use the 2020-2025 MHz and 2110-2115 MHz UMTS channel preferably in micro and pico-cells.*

C *This is the difference between the calculated and nominal extreme UMTS carrier position. The nominal extreme UMTS carrier position is taken to be 2.5 MHz from the UMTS band edge.*

D *This value is applicable for the sub-urban environment for 10% probability and 0.5 dB loss in MSS fade margin. A smaller carrier separation would impact to the ability to operate MSS on the affected channels due to degradation in the fade margin (see section 3.2.3.3 of ERC Report 065). For the rural environment the required spacing is less.*

E *The compatibility does not significantly improve with further increase in carrier spacing because of the shape of the emission mask.*

Table 5: Summary of the carrier separations, based on ERC Report 065 (Table 13 of [9])

It is assumed that all ECN will have the same interference scenarios in terms of geometry as those used in ERC Report 065. Therefore, impact on the adjacent non-WAPECS systems will remain the same if the out-of-band power of interfering systems (base station or terminal station) will fit with that one used in ERC Report 065, i.e. the out of band power interference resulting from UMTS spectrum emission mask.

Hence, the technical conditions derived in this report (to ensure coexistence between WAPECS systems) should be complemented with compliance with UMTS mask below 1900 MHz, between 1980 and 2010 MHz, between 2025 and 2110 MHz and above 2170 MHz.

With respect to the compatibility between ECN systems and MSS systems (used in the band 1980-2010 and 2170-2200 MHz), it has to be noted that the provisions (Decides-5) of ECC/DEC/(06)09 [17] requires '*that mobile satellite systems operating in accordance with this Decision shall ensure compatibility with terrestrial systems operating in the mobile service in the adjacent bands below 1980*

MHz and between 2010 MHz and 2170 MHz'. This also includes the use of CGC (Complementary Ground Component). Therefore, the European regulatory framework calls for MSS systems to ensure compatibility with terrestrial systems in adjacent bands. Compatibility studies may need to be performed to establish technical conditions for the introduction of MSS including CGC. Geographical distribution of other systems expected in this band, e. g. LTE, are not expected to be significantly different from the distribution of existing UMTS cell sites. Hence, the interference arising from the network components (BSs) of such systems is not expected to be significantly different from the interference arising from existing UMTS BS. Therefore, on the BS side, no requirement in addition to compliance with UMTS mask is needed for ECN systems with respect to MSS systems.

On the terminal side, the hypothesis of ERC Report 065 relied on circuit switched operation, i.e. a large number of terminal stations operating simultaneously, on a continuous time basis, all based on 5 MHz bandwidth. Future ECN terminals are expected to use packet based operation, i.e. discontinuously. Furthermore, when one ECN terminal uses the whole system bandwidth, other systems do not transmit. As a result, different assumptions may be applicable from the hypothesis used in the ERC Report 065. Therefore, it can be assumed that there may be scope to relax the emission mask of the ECN TS in comparison to the current requirement to meet the UMTS mask.

With respect to the compatibility between ECN systems and DECT systems (used below 1900 MHz), sharing scenarios to be considered have been already considered in ERC Report 065 [9] when adjacent band compatibility between UMTS and other 2 GHz services have been studied. Regarding DECT and UMTS, 30 different scenarios were defined. Of those were only four critical. These four can be included in two main scenarios:

a) Mutual interference between a UMTS Macro BTS and above roof-top a DECT WLL system, and
b) Mutual interference between an indoor DECT system and an indoor TS belonging to a UMTS Macro cell system.

These scenarios relate directly to the scenario of two unsynchronised TDD ECNs operating on adjacent bands. Case a) corresponds to mutual BS-BS interference and b) to mutual TS-TS interference.

Regarding a), ERC Report 065, section 3.1.7 concludes: *"UMTS TDD Macro BTS systems should not be applied on the band 1900-1910 MHz in areas where DECT WLL systems are installed (Eastern Europe), unless special measures are taken."* This conclusion will not be affected by introduction of WAPECS, and thus no further analysis is required for this report.

Regarding b), some complementary studies on coexistence between an indoor DECT system and an indoor ECN TS are provided in Annex 3. The studies have shown that the fraction of locations in which a DECT TS may suffer from excess of interference are less than 2% on average over the DECT carriers.

Studies have shown that it is possible for ECN TS to achieve compatibility with DECT by complying with an emission level of -30 dBm/MHz below 1900 MHz. When this level cannot be fulfilled compatibility can be achieved by ECN TS using a time frame that is detectable by DECT DCS mechanism. In addition compatibility can be achieved if the ECN TS uses the same slot repetition rate as DECT.

4.4 Stage 4: WAPECS vs. out of block WAPECS but in-band

The band plan in Annex 1 of ECC/DEC/(06)01 is based on the results of ERC Report 065 and is applicable to other technologies that fit in the mask and other conditions used in ERC Report 065. Whilst ERC Report 065 is a useful starting point for the 1900-1980 and 2110-2170 MHz bands, for the band 2010-2025 MHz any assumptions may need to take account of the broader situation with regard to the regulatory status in this band across CEPT.

4.4.1 Out-of-band requirement for ECN terminal stations

Interference analysis from TSs is presented in the following section (see Figure 2 and Figure 3).

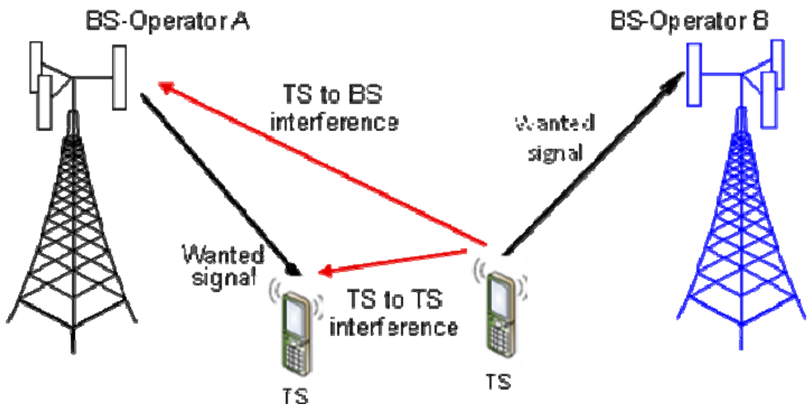

Figure 2: Interference from TS to TS and BS (geographical scenarios)

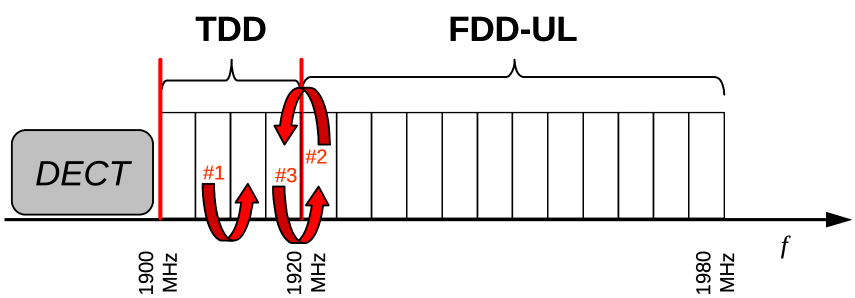

Figure 3: possible interference scenarios from TS (frequency scenarios)

Scenario #1: TDD-TS to TDD-TS in adjacent spectrum bands

If the adjacent bands belong to two different operators, it may not be always possible to have synchronous operation of two TDD networks deployed in adjacent bands.

Scenario #2: FDD-TS to TDD-TS and FDD-TS to TDD-BS at the FDD/TDD boundary.

This interference scenario can exist if there is a TDD/FDD boundary in the given band.

Scenario #3: TDD-TS to FDD-BS at the FDD/TDD boundary.

This interference scenario can exist if there is a TDD/FDD boundary in the given band. Similar type of intra-system interference occurs at the channel boundaries within cellular systems. Technical standards have been derived with sufficient mitigation techniques to overcome this type of interference.

4.4.1.1 *Derivation of BEM out-of-block baseline level for TS*

TS to TS interference for 2.6 GHz band is presented in ECC Report 131 [6]. A similar approach is taken during this analysis to calculate the out of band (OOB) emission levels.

Firstly, user density is calculated by taking similar assumptions to the user density calculation for 2.6 GHz analysis presented in ECC Report 131. User density calculation for the 2 GHz band is presented in Table 19 in Annex 2. Analysis suggests that hot spot user density assumed in 2.6 GHz band investigation is of the same order compared to the approximate user density expected in 2 GHz band. Therefore, it was assumed that the baseline level calculations for 2.6 GHz band are applicable to the baseline level calculations at 2 GHz band. The main difference between the two bands considered is the difference in propagation loss. Analysis shows that the OOB power level, P_{OOB}, is proportional to the square of the operating frequency f, i.e. $P_{OOB} \propto f^2$

For the 2.6 GHz band, two baseline levels were derived to limit terminal station desensitization below 3 dB for less than 5 % of the time:

a) In a network where probability of collision between victim and interferer packets cannot be taken into account, a BEM baseline level of -27 dBm/5MHz can be justified. This is applicable to network provide circuit switch (CS) services.

b) In a network where probability of collision between victim and interferer packets can be taken into account, as it would be the case for two packet-based mobile broadband systems (or packet switch, PS network), a BEM baseline level of -15.5 dBm/5 MHz can be justified.

From above results, baseline levels for 2 GHz band can be deduced as follows:

$$P_{\mathrm{OOB\_2GHz}} \approx P_{\mathrm{OOB\_2.6GHz}} + 20 \cdot \log_{10}\left(\frac{2140}{2600}\right) \text{ dB} \quad (1)$$

$$P_{\mathrm{OOB\_2\,GHz}} \approx P_{\mathrm{OOB\_2.6GHz}} - 1.7 \text{ dB} \quad (2)$$

Beyond these calculations derived from the 2.6 GHz band (ECC Report 131), it is suggested that the "correction factor" of 1.7 dB for transposing the 2.6 GHz results into 2 GHz is finally not taken into account. Such an approach doesn't compromise the coexistence performance (the percentage of cases where TS may suffer from interference is slightly the same). Moreover, it enables the reuse of RF components developed for 2.6 GHz TSs in the implementation of TSs for the 2 GHz band. Hence, the derivation of this level by applying the methodology used for the 2.6 GHz band resulting in -27 dBm/5MHz baseline.

From above analysis, it can be seen that TS to TS OOB baseline level for the 2 GHz band is the same as for the 2.6 GHz band.

- $P_{\mathrm{OOB\_2\,GHz}} \approx -15.5\ \mathrm{dBm/5MHz}$ for two PS networks
- $P_{\mathrm{OOB\_2\,GHz}} \approx -27\ \mathrm{dBm/5MHz}$ for two CS networks or one CS network and PS network

4.4.1.2 Derivation of BEM out-of-band transitional level for TS

TS to BS OOB transition level can be derived by numerical integration of the power spectral density (PSDs) of the LTE TS spectrum emission mask (SEM) specified in 3GPP TS 36.101 [7] over bandwidth of 5 MHz channel.

The transitional level for TDD TS was found to be 1.6 dBm/5MHz.

4.4.1.3 Considerations related to the implementation of the out-of-band levels

Figure 4 shows measured radiated emissions of commercially available UTRA FDD TSs in the 2 GHz band[2]. Results are presented for TSs from five different manufactures when transmitting with an EIRP of 20 dBm/3.84MHz. The figure also shows the corresponding requirements for TS emissions in 3GPP TS 25.101 [18] (scaled to adjust for a constant measurement bandwidth) and the baseline level of a BEM. It will be observed that the emissions exceed the baseline level in the 5 MHz blocks immediately adjacent to the channel in which the terminal transmits. This is due to inherent limits in the performance of the components used in terminals and the constraints in power consumption in a device supplied by a battery.

---

[2] Ofcom analysis on the impact of interference from TDD TS to FDD TSs in the 2.6 GHz band.

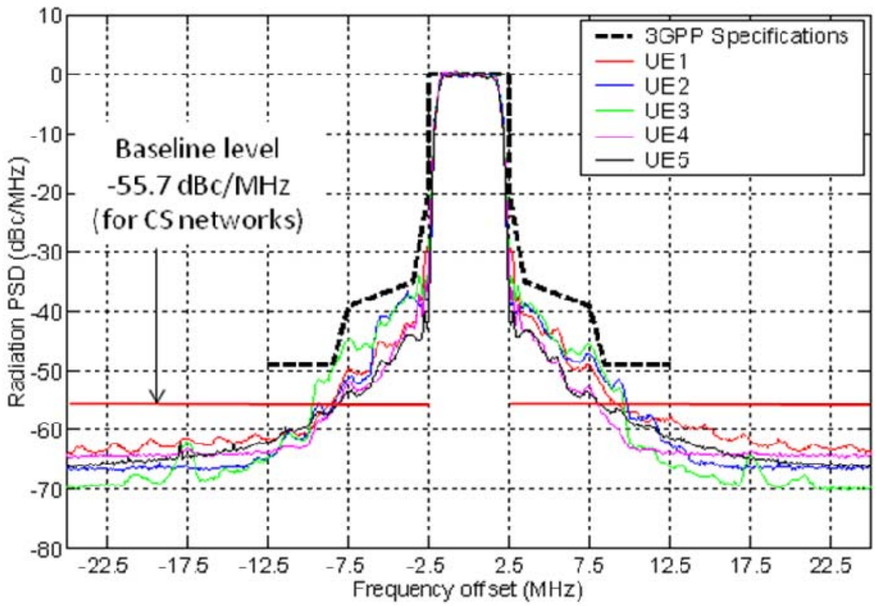

Figure 4: Spectrum emission from UMTS 5 MHz bandwidth

The technologies considered as representative examples for the 2 GHz band are UMTS (TDD and FDD), LTE and WiMAX. The derivation of out-of-block requirements shows that a baseline of -27 dBm/5MHz can be fulfilled by 5 MHz UMTS terminals with the introduction of a 5 MHz guard band. Such a baseline is not fulfilled by wider bandwidth technologies (e.g. 10 MHz LTE, 10 MHz DC-HSUPA and potentially WiMAX terminals[3]) even with 10 MHz guard band.

In case of adjacencies between two operators using bursty transmission, a baseline of -15.5dBm/5 MHz applies and this relaxed baseline can be fulfilled by 5 MHz LTE terminals and WiMAX terminals considering also the introduction of a 5 MHz guard band.

The guard band has to be introduced between unsynchronised TDD networks in the bands 1900-1920 MHz and 2010-2025 MHz or between TDD and FDD network at the 1920 MHz boundary.

---

[3] It is expected that spectrum emission mask of TDD WiMAX terminal will be more stringent than LTE ones.

4.4.2 Out-of-block requirement for ECN base stations

Interference analysis from BSs is presented in this section. Figure 5 and Figure 6 shows possible interference scenarios arising from BSs.

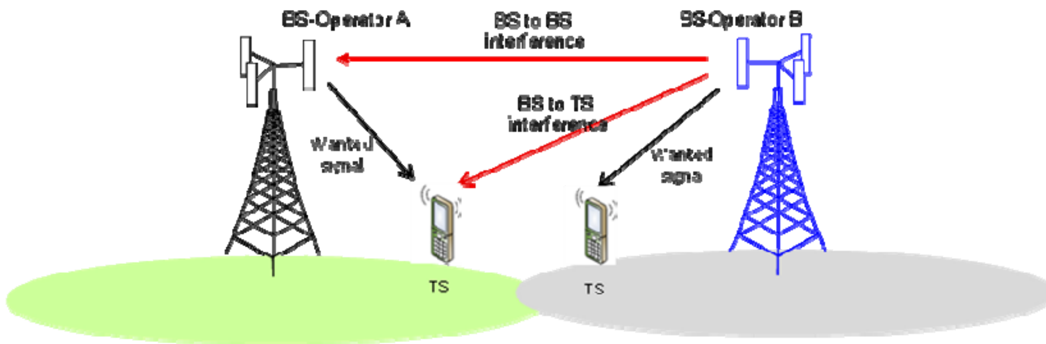

Figure 5: Interference from BSs

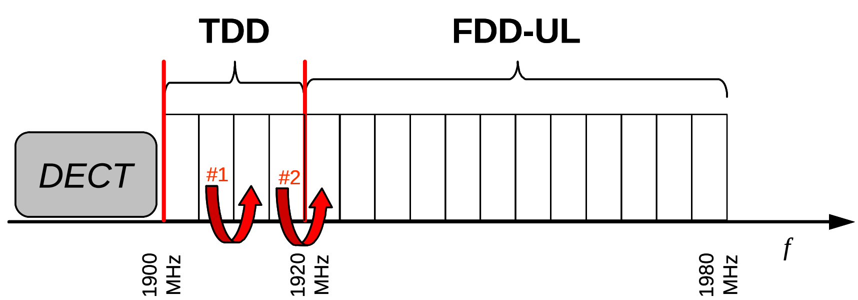

Figure 6: Interference from BSs

Scenario #1: TDD-BS to TDD-BS and TDD-BS to TDD-TS in adjacent spectrum blocks

If the adjacent spectrum blocks belong to two different operators, it may not always be possible to have synchronous operation of two TDD networks deployed in these bands.

BS to TS interference is similar to intra-system interference occurs at the channel boundaries within cellular systems. Technical standards have been derived with sufficient mitigation techniques to overcome this type of interference.

Scenario #2: TDD-BS to FDD-BS at the FDD/TDD boundary.

4.4.2.1 Derivation of BEM out-of-block baseline level for BS

For a given spatial separation, BS-BS interference is most severe where transmission powers are high, where the respective antennas have high gains and are within line-of-sight of each other, and where radio propagation conditions approach those of free space. This is likely to be the case for wide-area (macro-cellular) base stations with high antenna placements, resulting in the worst-case geometry depicted in Figure 7.

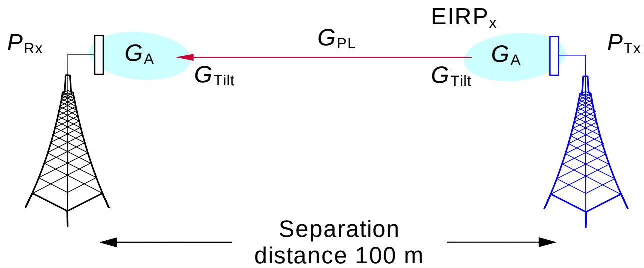

Figure 7: Base-to-base interference scenario

Clearly, a requirement for large coordination distances can result in excessive coordination overheads and inefficiencies in network deployment. In accordance with the assumptions in CEPT Report 19 [5], the BS BEM baseline level is computed for a line-of-sight base-to-base separation distance of 100 m, and for a 1 dB desensitisation of the victim BS.

For line-of-sight base station separations of less then 100 metres, some form of cooperation between the licensees may be required. This might involve a judicious choice of carrier frequencies and/or antenna orientations, or some other form of mitigation.

The requirements that must be met in order to avoid the need for coordination at separations of 100 m (and beyond) can be considered with reference to the adjacent-channel interference ratio[4] (ACIR). This can be seen by noting that (in the logarithmic domain),

$$\begin{aligned} ACIR &= P_{Rx} - P_I \\ &= (EIRP_x + G_{Tilt} + G_{PL} + G_{Tilt} + G_A) - (P_N + INR) \\ &= (61 - 3 - 79 - 3 + 17) - (-102 - 6) \\ &= 101 \quad \text{dB} \end{aligned}$$

where P_{Rx} is the received adjacent-channel interferer power, P_{I} is the “experienced” interference power at the receiver, $\mathrm{EIRP}_{\mathrm{x}}$ = 61 dBm/(5 MHz) is the interfering base station’s in-block mean EIRP (see CEPT Report 19), G_{Tilt} = -3 dB represents loss due to antenna tilt at each of the transmitter and receiver, G_{PL} = -79 dB is free-space mean path gain[5] for a separation of 100 metres at a nominal frequency of 1920 MHz, G_{A} = 17 dBi is the receiver antenna gain, P_{N} = -102 dBm/(5 MHz) is the receiver noise floor[6] (for a nominal receiver bandwidth of 5 MHz and noise figure of 5 dB), and finally, INR = -6 dB is the interference-to-noise ratio for a 1 dB receiver desensitization. Note that a 1 dB desensitization implies an experienced interference power of -108 dBm/(5 MHz).

The required ACIR of 101 dB can be achieved through various combinations of transmitter adjacent-channel leakage ratio (ACLR) and receiver adjacent-channel selectivity (ACS)[7]. Subject to the constraint that the interferer’s ACLR and the victim’s ACS be equal (i.e., that the burden of protection from interference is placed equally on the interferer and victim BSs), it follows that we require ACS = ACLR = 104 dB in order to realise an ACIR of 101 dB.

---

4 The ACIR is defined as the ratio of the power of an adjacent-channel interferer as received at the victim, divided by the interference power “experienced” by the victim receiver as a result of both transmitter and receiver imperfections.

5 Path loss is 32.5 + 20 $\log_{10}(f)$ + 20 log10(d) dB where d is separation in km, and f is frequency in MHz.

6 Equal to kTB.NF, where k is Boltzmann’s constant, T is the ambient temperature, B is the noise-equivalent bandwidth, and NF is the noise factor.

7 The ACLR of a signal is defined as the ratio of the signal’s power divided by the power of the signal when measured at the output of a (nominally rectangular) receiver filter centred on an adjacent frequency channel. The ACS of a receiver is defined as the ratio of the receiver’s filter attenuation over its passband divided by the receiver’s filter attenuation over an adjacent frequency channel. It can be readily shown that $\mathrm{ACIR}^{-1} = \mathrm{ACLR}^{-1} + \mathrm{ACS}^{-1}$.

Given an interferer ACLR of 104 dB, the corresponding BS BEM baseline level, $P_{\mathrm{BS,BL}}$, may be computed as

$$P_{BL,BL} = EIRP_x - ACLR = 61 - 104 = -43\,\mathrm{dBm}/(5\ \mathrm{MHz})$$

where $\mathrm{EIRP_x}$ is the base station in-block EIRP.

4.4.2.2 Derivation of BEM out-of-block transitional level for BS

BS to TS case, out-of-channel emission within the FDD band can be derived by numerical integration of the PSDs of the E-UTRA BS SEM specified in 3GPP TS 36.104 [19] over bandwidth of 5 MHz channel. It was found that the transitional levels for BS are16.3 dBm/5 MHz in the first adjacent block, 11 dBm/5MHz, in the second adjacent block and 9 dBm/5MHz for the remaining FDD downlink frequencies.

4.4.2.3 Derivation of BEM in-block requirement for BS

BS to BS interference scenario include

- Interference between two TDD blocks
- Interference from TDD user to FDD UL blocks (FDD BS receives)

This is illustrated in Figure 8.

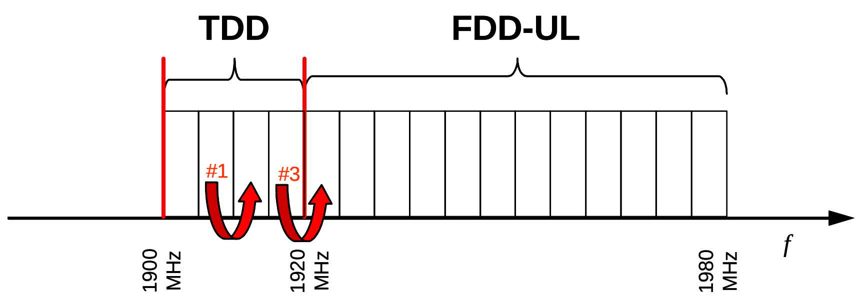

Figure 8: Illustration of interference scenario involving in block limit

This scenario implies that

- There is leakage from interferer into the victim block
- There is an additional contribution to the interference due to victim receiver selectivity according to frequency offset with victim. Note that receiver selectivity is typically implicitly defined by ACS and blocking requirements found in e.g. 3GPP specifications.

A link budget can be performed assuming different situations.

- Between two TDD blocks granted to different operators
- Between FDD block 1920-1925 MHz and TDD block 1900-1905 MHz (15 MHz offset)
- Between FDD block 1920-1925 MHz and TDD block 1905-1910 MHz (10 MHz offset)
- Between FDD block 1920-1925 MHz and TDD block 1910-1915 MHz (5 MHz offset)
- Between FDD block 1920-1925 MHz and TDD block 1915-1920 MHz (no offset)

The first step of the calculation is to derive the interference power limit in order to limit BS desensitisation to 1 dB, based on a receiver noise floor of -102 dBm (including a receiver noise figure of 5 dB and based on a receiver bandwidth of 5 MHz).

Typical values for FDD base station total receiver selectivity (including RF selectivity and duplex filter attenuation) provided by one manufacturer are then considered according to the frequency offset between victim and interferer. For simplicity the selectivity values at the centre frequency of the blocks is considered. The coupling loss that corresponds to the BS-BS interference scenario shown in Table 6 (with a separation of 100 m) is then determined. An in block limit can then be estimated based on an assumed baseline limit within the victim's wanted channel.

This is summarized in Table 6 below. It is noted that in the calculation a baseline limit of -50 dBm/5MHz has been assumed (7 dB more stringent than the baseline level derived in section

4.4.2.1.). The motivation for this is that on the one hand with this lower baseline limit, up to 3 dB higher in-block limits are obtained, and on the other hand such levels are expected to be significantly less constraining for base stations that are limited in terms of their in-block TX power, since in practice the out-of-band emissions decrease with decreasing TX power.

A review of Table 6 shows that an in-block limit is needed in the TDD blocks. FDD operation in the block 1920-1925 MHz limits the in-block power of BS to 43dBm/5MHz in the 1900-1905 MHz block. This limit is 30 dBm/5MHz in the 1905-1910 MHz block TDD block and 20 dBm/5MHz in the last two blocks 1910-1920 MHz. It has to be mentioned that the in-block limits given in this table are derived for the protection of BS receiver.

The in-block limits defined in this Table are developed without assuming any additional practical implementation measures (e.g. at FDD BS reception side). They could be increased accordingly at national level based on agreement between operators or on implementation of interference mitigation measures. For example, better FDD BS adjacent channel selectivity/blocking performance, additional filters at FDD BS receiver side through a mast head amplifier or a specific external filter can justify these relaxations.

When unpaired spectrum within the 1900-1920 MHz or 2010-2025 MHz band is allocated to more than one TDD operator, a guard band of at least 5 MHz is needed between unsynchronized macrocell TDD networks. For protection of TDD BS receiver operating at a 5 MHz frequency offset from another TDD network, the in-block EIRP limit should be 20 dBm/5MHz without additional interference mitigation measures or specific conditions of use (synchronized TDD or downlink transmission only). For these cases, the limits given in Table 6 still apply in the band 1900-1920 MHz but there is no limit required in the band 2010-2025 MHz.

		Interferer:					
		ECN TDD BS	ECN TDD BS 1900-1905 MHz	ECN TDD BS 1905-1910 MHz	ECN TDD BS 1910-1915 MHz	ECN TDD BS 1915-1920 MHz	
		Victim:	Victim:	Victim:	Victim:	Victim:	
Parameter	Units	ECN TDD BS	ECN FDD BS 1920-1925 MHz	ECN FDD BS 1920-1925 MHz	ECN FDD BS 1920-1925 MHz	ECN FDD BS 1920-1925 MHz	Comment
Frequency	MHz	1900	1905	1910	1915	1920	fo
Target performance							
Target desensitisation	dB	1,00	1,00	1,00	1,00	1,00	Performance criterion: D
INR (IoverN ratio)	dB	-5,87	-5,87	-5,87	-5,87	-5,87	INR = 10log(10^(D/10) - 1)
Receiver NF	dB	5,00	5,00	5,00	5,00	5,00	NF
Thermal noise floor (5 MHz)	dBm	-101,99	-101,99	-101,99	-101,99	-101,99	Pn = 10log(kTB) + NF + 30
Target interference power	dBm	-107,85	-107,85	-107,85	-107,85	-107,85	PI = Pn + INR
Victim's performance							
Receiver selectivity	**dB**	**61,24**	**84,24**	**71,24**	**61,24**	**61,24**	**FDD BS receiver selectivity/in-band blocking are derived from measurements provided by a manufacturer**
Geometry							
Horizontal distance	m	100,00	100,00	100,00	100,00	100,00	
Link budget							
Free space losses	dB	-78,08	-78,10	-78,12	-78,14	-78,17	Gpl
Interferer ant. Elevation pattern	dB	-3,00	-3,00	-3,00	-3,00	-3,00	Gd,i
Victim ant. elevation pattern	dB	-3,00	-3,00	-3,00	-3,00	-3,00	Gd,v
Victim antenna gain	dBi	17,00	17,00	17,00	17,00	17,00	Gv
Coupling loss	**dB**	**-67,08**	**-67,10**	**-67,12**	**-67,14**	**-67,17**	**G = Gpl + Gd,i + Gd,v + Gv**
Interferer out-of-block EIRP within victim wanted channel	**dBm/(5 MHz)**	**-50,00**	**-50,00**	**-50,00**	**-50,00**	**-50,00**	**7dB more stringent than the baseline of -43dBm/5MHz**
Interferer in-block EIRP	**dBm/(5MHz)**	**20**	**43**	**30**	**20**	**20**	**Pib=(PI/G-Poob).ACS**

Table 6: Detailed calculations of in block power limit for TDD ECN base stations

Note: The FDD BS receiver selectivity/in-band blocking used in the Table 6 is derived from measurements provided by a manufacturer, whilst some other manufacturers have stated that their FDD BS receiver selectivity/in-band blocking can be typically up to 10 dB better compared to the values used in the Table 6.

4.5 Stage 5: WAPECS vs co-frequency WAPECS in a geographically adjacent area

For the co-channel operation, Annex 1 of ERC/REC/(01)01 [20] gives the field strength figures for the cross border coordination between UMTS networks. For non-UMTS technologies ERC/REC/(01)01 is not applicable. Nevertheless, it may be possible that some of the methods and triggers values provided in ERC/REC/(01)01 are also applicable to future LTE and WiMAX systems.

It should be noted that there are ongoing studies within CEPT which will detail the various field strength values that may be used for technology neutral co-ordination of dissimilar systems. However, the studies are not finalised.

Three different scenarios can be defined for co-frequency WAPECS systems operating in the 2 GHz Band in geographically adjacent areas:

1. For FDD vs. FDD co-frequency cross-border coordination field strength level:
   - UTRA/UTRA case
     65 dBµV/m/5MHz at a height of 3 m above ground at the borderline between countries and **37 dBµV/m/5MHz** at a height of 3 m above ground at a distance of 6 km inside the neighbouring country.
     These values are based on the ERC/REC/(01)01 and downlink statistic studies. It is necessary to study the other cases like uplink compatibility and technical studies.
2. For TDD/TDD co-frequency cross-border coordination field strength level :
   - For unsynchronised case

     21 dBµV/m/5 MHz at a height of 3 m above ground at the borderline between countries for UTRA vs. UTRA,
   - For synchronised case

     Synchronisation between different technologies e.g. between WiMAX and UTRA is not foreseen.[8]

     UTRA/UTRA [9]:

     65 dBµV/m/5MHz at a height of 3 m above ground at the borderline between countries and **37 dBµV/m/5MHz** at a height of 3 m above ground at a distance of 6 km inside the neighbouring country,
3. For the TDD and FDD case, if there is need for co-frequency cross-border coordination it should be based on mutual agreements between operators of neighbouring countries. In practice, such a case does not exist since no TDD system is deployed in the bands 1920-1980/2110-2170 MHz (although it is possible according to the ECC/DEC/(06)01 [4], Annex1: the frequency band 1920 – 1980 MHz may also be used for TDD operation).

4.6 Results for the 1900-1980 MHz / 2010-2025 MHz / 2110-2170 MHz bands

The technical conditions developed in this Report are based on a block-edge mask (BEM) approach.

A BEM is an emission mask that is defined, as a function of frequency, relative to the edge of a block of spectrum that is licensed to an operator. It consists of in-block and out-of-block components which specify the permitted emission levels over frequencies inside and outside the licensed block of spectrum respectively. The out-of-block component of the BEM itself consists of a baseline level and, where applicable, intermediate (transition) levels which describe the transition from the in-block level to the baseline level as a function of frequency.

Accordingly, the BEMs levels are built up by combining the values listed in Table 7 and Table 8 below in such a way that the limit at any frequency is given by the highest (least stringent) value of a) the baseline requirements, b) the transition requirements and c) the in-block requirements (where appropriate).

The BEMs in the 2 GHz band are optimised for, but are not limited to, FDD and TDD mobile/fixed communications networks (two-way). Therefore, the BEMs are derived for base stations (BSs), terminal stations (TSs).

The BEMs are presented as upper limits on the mean EIRP or TRP (total radiated power) over an averaging time interval, and over a measurement frequency bandwidth. In the time domain, the EIRP or TRP is averaged over the active portions of signal bursts and corresponds to a single power control setting. In the frequency domain, the EIRP or TRP is determined over the measurement bandwidth (e.g.

---

[8] Because WiMAX and UTRA can not be synchronised.

[9] This value has been derived from FDD vs FDD case

block) specified in Table 7 to Table 8. It should be noted that the actual measurement bandwidth of the measurement equipment used for purposes of compliance testing may be smaller than the measurement bandwidth provided in Table 7 to Table 8.

TRP is a measure of how much power the antenna actually radiates. The TRP is defined as the integral of the power transmitted in different directions over the entire radiation sphere. For an isotropic antenna radiation pattern, EIRP and TRP are equivalent. For a directional antenna radiation pattern, EIRP in the direction of the main beam is (by definition) greater than the TRP.

In general, and unless stated otherwise, the BEM levels correspond to the power radiated by the relevant device irrespective of the number of transmit antennas, except for the case of ECN base stations transition requirements which are specified per antenna.

The term *block edge* refers to the frequency boundary of spectrum licensed to an ECN. The term *band edge* refers to the boundary of a range of frequencies allocated for a certain use (e.g., 1900 MHz is the upper band edge for DECT, while 2110 MHz is the lower band edge for FDD downlink). For requirements with a *measurement bandwidth* of 5 MHz, the measurement bandwidth is aligned within a block.

Illustrative examples can be found in section 4.6.3 in relation with FDD and TDD technologies.

To achieve compatibility, a 5 MHz frequency separation is needed between two unsynchronised networks operating in TDD mode. In principle, such separation could be achieved by leaving these blocks unused as guard blocks. Alternatively, these blocks could also be used as restricted blocks (i.e. more stringent technical conditions apply or only some applications are allowed).

There is no need for this 5 MHz frequency separation between two synchronised TDD blocks or for TDD use restricted to applications using downlink transmission only. Other uses of a 5 MHz guard block are liable to an increased risk of interference.

In addition to the BEM requirements, compatibility with a victim system in non-WAPECS bands adjacent to 2 GHz bands (i.e. at 1900, 1980, 2010, 2025, 2110 and 2170 MHz) can be assumed if out-of-band emission of the interfering ECN within the receiving bandwidth of the victim system complies with the interference power of the UMTS emission mask defined in Annex A1.4 of ERC Report 065.

4.6.1 Technical conditions for ECN base stations (FDD or TDD)

4.6.1.1 BEM for FDD ECN Base stations

In-block limit for FDD ECN Base Station

ITU-R Report M.2039 [10] provides typical base stations EIRP of 61 dBm/5MHz for sharing studies. The studies in this report have not identified any need to change the existing in-block power license condition.

Therefore, an in block EIRP limit for BS is not necessary in the band 2110-2170 MHz. However, administrations may set an EIRP limit of 61 dBm/5MHz, noting that this limit can be relaxed for specific deployments, e.g. in areas of low population density provided that this does not significantly increase the risk of terminal station receiver blocking.

Out-of-block limits for FDD ECN Base Station

Table 7 defines the out-of-block BEM requirements for ECN base stations within the spectrum allocated to ECN applications.

Frequency range of out-of-block emissions	Maximum mean out-of-block EIRP	Measurement bandwidth
–10 to –5 MHz from lower block edge	11 dBm	5 MHz
–5 to 0 MHz from lower block edge	16.3 dBm	5 MHz
0 to +5 MHz from upper block edge	16.3 dBm	5 MHz
+5 to +10 MHz from upper block edge	11 dBm	5 MHz
Other blocks	9 dBm	5 MHz

Table 7: Transition requirements – BS BEM out-of-block EIRP limits per antenna[10]

4.6.1.2 BEM for ECN TDD Base stations

In-block limits for TDD ECN Base Station

Parameter	Maximum mean in-block EIRP	Measurement bandwidth
1900-1905 MHz	43 dBm	5 MHz
1905-1910 MHz	30 dBm	5 MHz
1910-1920 MHz	20 dBm	5 MHz
2010-2025 MHz	No requirement for one operator An administration may choose to specify an in-block EIRP limit for base stations. 20 dBm/5MHz for more than one operator	

Table 8: Block specific requirements – BS BEM in-block EIRP limits per antenna[11] over TDD frequencies (1900-1920 MHz and 2010-2025 MHz)

The in-block limits given in Table 8 are derived for the protection of FDD BS receiver based on FDD BS receiver adjacent channel selectivity and in-band blocking performance provided for typical existing FDD base stations. It should be noted that some manufacturers have stated that their FDD BS receiver selectivity/in-band blocking can be typically up to 10 dB better compared to the values used for the derivation of the TDD in-band power limits.

The in-block limits defined in Table 8 are assuming that both FDD and TDD are deployed as macrocellular networks where TDD and FDD BS antennae are at the same heights and maximum antenna gain (with 3 dB downtilt) are pointing to each other at 100 m separation distance, without assuming any additional interference mitigation measure at FDD BS reception side. They could be increased accordingly at national level based on agreement between operators or on implementation of interference mitigation measures. For example, better FDD BS adjacent channel selectivity/blocking performance, additional filters at FDD BS receiver side through a mast head amplifier or a specific external filter can justify these relaxations.

When unpaired spectrum within the 1900-1920 MHz or 2010-2025 MHz band is allocated to more than one TDD operator, a guard band of at least 5 MHz is needed between unsynchronized operation of networks. For protection of TDD BS receiver the in-block EIRP limit should be 20 dBm/5MHz without

[10] For one to four antennas

[11] For one to four antennas

additional interference mitigation measures or specific conditions of use (synchronized TDD or downlink transmission only). For these cases, the guard band is not needed. The requirements of Table **8** still apply in the band 1900-1910 MHz but not in the 2010-2025 MHz for which no in-block limit is required.

It has to be highlighted that these limitations in the use of the unpaired spectrum in the 1900-1920 MHz are due to the protection of the existing rights of use above 1920 MHz (i.e. UMTS FDD networks). This is the main difference between the assumptions that are used in the interference assessment of the 2 GHz band as opposed to the 2.6 GHz band. The situation in the 2 GHz band may evolve in the future if operators license needs to be renewed or if an operator makes a request for a change of use and/or technology. This could lead to similar technical conditions as those encountered previously in the 2.6 GHz band.

In this new situation the in-block power limits of TDD base stations could be relaxed in order to enable a more efficient and flexible use. This could be achieved, e.g., by using a 5 MHz guard band or restricted block between TDD networks or between TDD and FDD networks. The technical condition on the limits described in section 4.6.1.1 apply to both FDD and TDD base stations.

Out-of-block limits for TDD ECN Base Station

Frequency range of out-of-block emissions	Maximum mean out-of-block EIRP	Measurement bandwidth
1900-1920 MHz	-43 dBm	5 MHz
1920-1980 MHz	-50 dBm	5 MHz
2010-2025 MHz	-43 dBm	5 MHz

Table 9: Baseline requirements – BS BEM out-of-block EIRP limits

The requirements in Table 9 for the frequency range 1900-1920 and 2010-2025 MHz do not apply for TDD synchronized operation or use of the TDD band for downlink transmission only. For these cases the requirement of Table 7 applies.

Frequency range of out-of-block emissions	Maximum mean out-of-block EIRP	Measurement bandwidth
–5 to 0 MHz from lower block edge	16.3 dBm	5 MHz
0 to +5 MHz from upper block edge	16.3 dBm	5 MHz

Table 10: Transition requirements – BS BEM out-of-block EIRP limits per antenna[12] over TDD frequencies (1900-1920 MHz and 2010-2025 MHz)

[12] For one to four antennas

4.6.2 Technical conditions for ECN FDD or TDD terminal stations

In-band requirements for all terminal stations

No scenarios[13] were identified for this band for which studies of in-band emissions limits were required. The maximum power currently defined for terminals in 3GPP TS specifications are in the range from 21-33 dBm (conducted limits) for different power classes.

Out-of-band requirements for all terminal stations

The requirements given in this section apply without prejudice to spurious emission requirements (which continue to apply). This document does not address spurious emission levels; this is the responsibility of the standards development organisations (SDOs)[14]. The technical conditions for these terminals are defined relative to the channel edge to enable them to be taken into account by the SDOs.

Table 11 and Table 12 define the out-of-band requirements for FDD and TDD terminal stations. The power limits are specified as EIRP for TS designed to be fixed or installed and as TRP for the TS designed to be mobile or nomadic. Note that EIRP and TRP are equivalent for isotropic antennas.

It was shown in section (4) that following baseline levels P_{BL} are justified:

a) Where probability of collision between victim and interfere packets cannot be taken into account, a TS BEM baseline P_{BL} = -27 dBm/5MHz.
b) Where probability of collision between victim and interfere packets can be taken into account (as among packet-based systems) P_{BL} = -15.5 dBm/5MHz.]

Out-of-band requirements for FDD terminal stations

Frequency range of out-of-band emissions	Maximum mean out-of-band power	Measurement bandwidth
–10 to -5 MHz from lower channel edge	-6 dBm	5 MHz
–5 to 0 MHz from lower channel edge	+1.6 dBm	5 MHz
0 to +5 MHz from upper channel edge	+1.6 dBm	5 MHz
+5 to 10 MHz from upper channel edge	-6 dBm	5 MHz
Remaining Frequencies allocated to FDD uplink	-6dBm	5 MHz
Remaining Frequencies allocated to TDD	P_{BL}	5 MHz

Table 11: Out-of-band requirements for FDD TS applicable to TS used in the band 1920-1980 MHz

---

13 For the determination of out of band emissions of terminals the maximum conducted transmit power of 23 dBm was used as a reference.

14 The CEPT recommended spurious emission limits given in ERC/REC 74-01 [25].

Out-of-band requirements for TDD terminal stations

Frequency range of out-of-band emissions	Maximum mean out-of-band power	Measurement bandwidth
–10 to -5 MHz from lower channel edge	P_{BL}	5 MHz
–5 to 0 MHz from lower channel edge	+1.6 dBm	5 MHz
0 to +5 MHz from upper channel edge	+1.6 dBm	5 MHz
+5 to 10 MHz from upper channel edge	P_{BL} over TDD frequencies -6 dBm over FDD uplink frequencies	5 MHz
Remaining Frequencies allocated to TDD	P_{BL}	5 MHz
Remaining Frequencies allocated to FDD uplink	-6 dBm	5 MHz

Table 12: Out-of-band requirements for TDD TS applicable to TS used in the bands 1900-1920 MHz and 2010-2025 MHz

4.6.3 Illustrative examples

Figure 9 to Figure 25 illustrate the base station block edge masks and terminal station emission masks which are defined in Sections 4.6.1 and 4.6.2.

- **BEM for FDD BS**

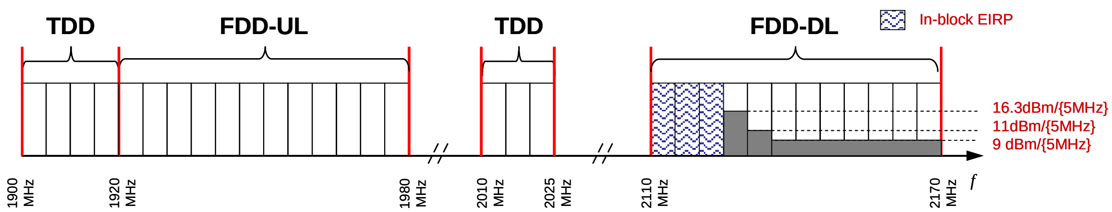

Figure 9: BS BEM for a FDD operator in the lowest three 5 MHz blocks.

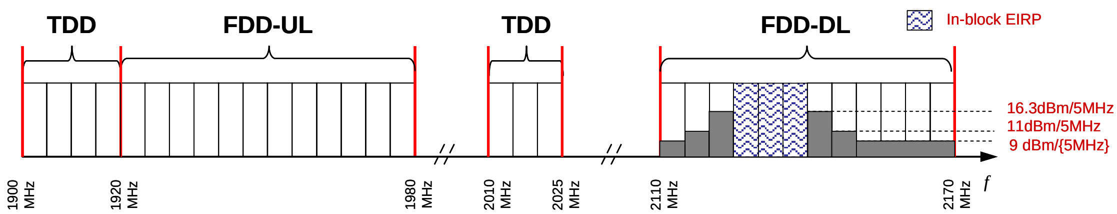

Figure 10: BS BEM for a FDD operator in the three 5 MHz blocks in the middle

- **BEM for TDD BS**
  - o **Case of one TDD operator**

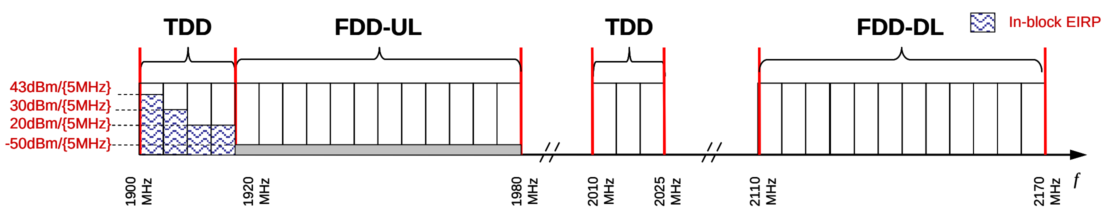

Figure 11: BS BEM for a single TDD operator in the band 1900-1920 MHz

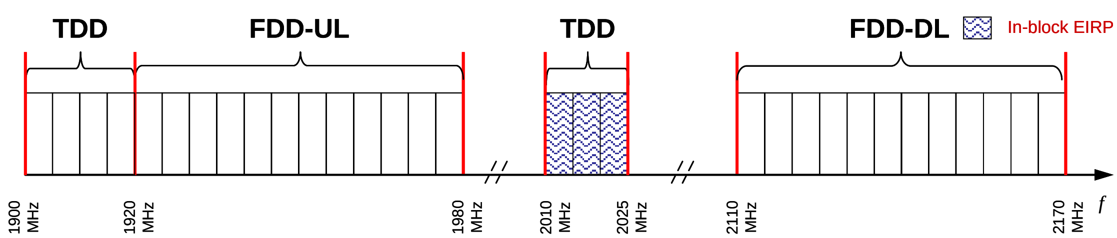

Figure 12: BS BEM for a single TDD operator in the band 2010-2025 MHz

  - o **Case of more than one TDD license in the TDD unpaired spectrum**

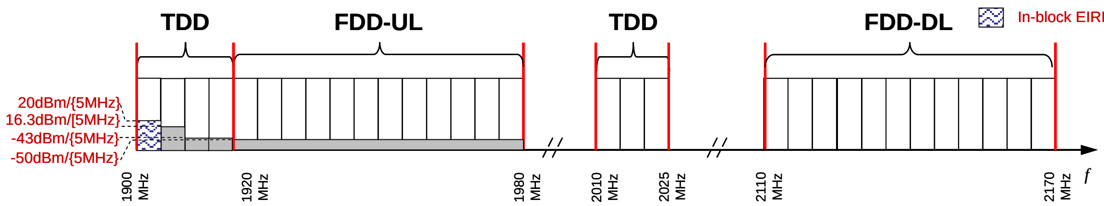

Figure 13: BS BEM for one TDD operator using the block 1900-1905 MHz (1905-1910 MHz is a guard or restricted block)

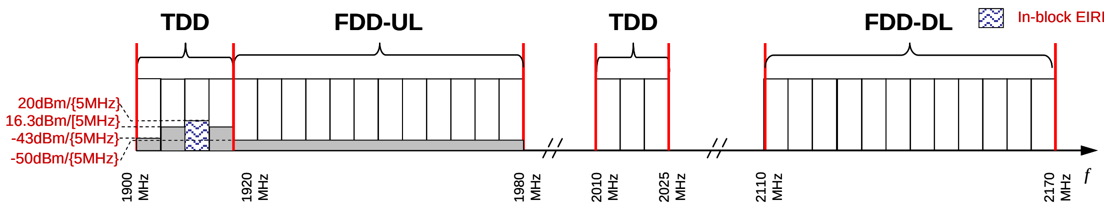

Figure 14: BS BEM for one TDD operator using the block 1910-1915 MHz (1905-1910 MHz and 1915-1920 MHz are a guard or restricted blocks)

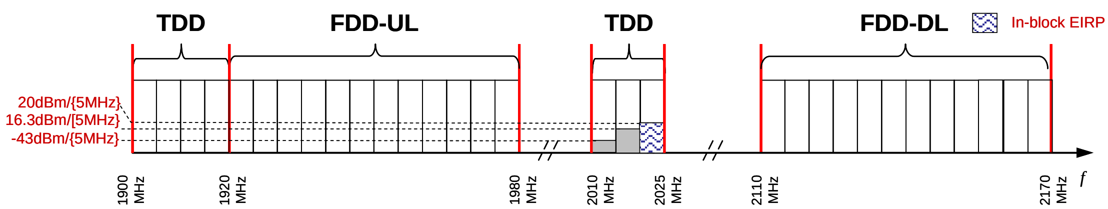

Figure 15: BS BEM for one TDD operator using the block 2020-2025 MHz (2015-2020 MHz is a guard or restricted blocks)

- **Alternative use of the band 2010-2025 MHz for synchronised TDD or downlink transmission only**

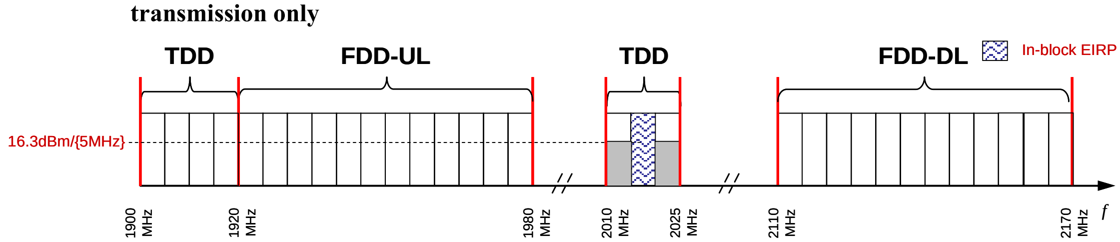

Figure 16: Alternative BS BEM for a TDD operator in the block 2015-2020 MHz

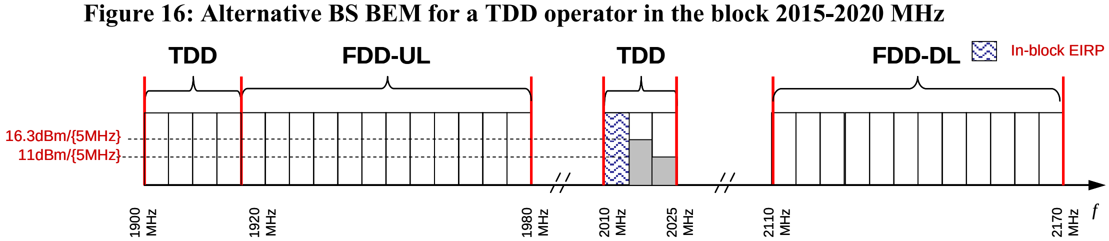

Figure 17: Alternative BS BEM for a TDD operator in the block 2010-2015 MHz (Symmetric mask applies in the block 2020-2025 MHz)

- **Emission masks for FDD terminal stations**

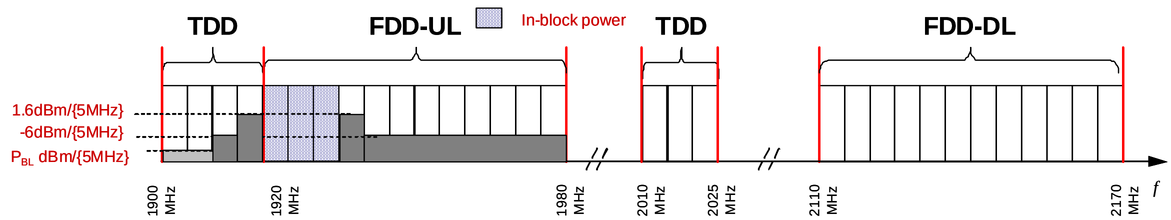

Figure 18: Emission mask for terminal stations for a FDD operator in the lowest three 5 MHz blocks.

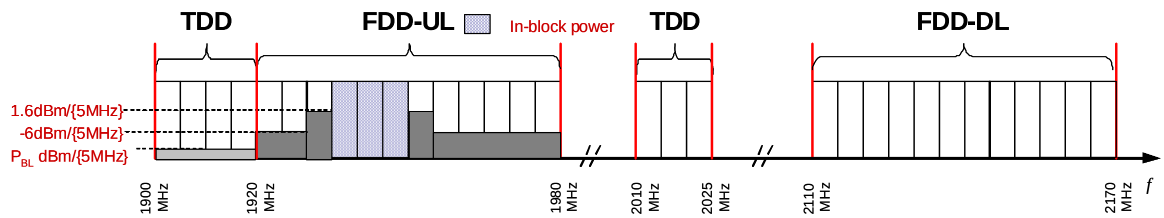

Figure 19: Emission mask for terminal stations for a FDD operator in the three 5 MHz blocks in the middle

- **Emission masks for TDD terminal stations**
  - **Case of one TDD operator**

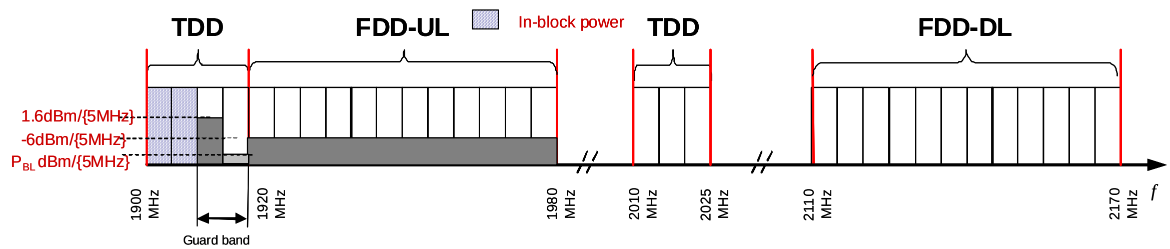

Figure 20: Emission mask for terminal stations for a single TDD operator in the band 1900-1920 MHz

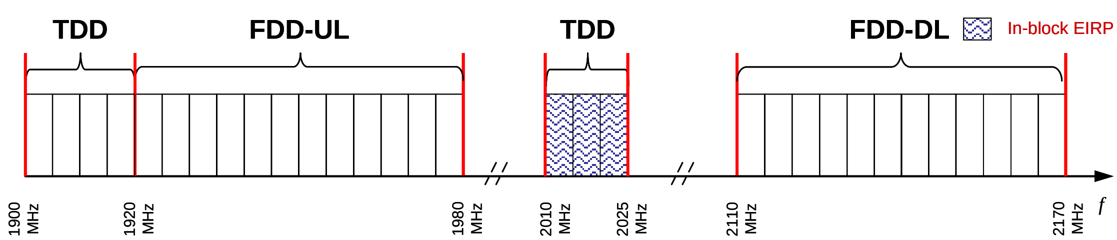

Figure 21: Emission mask for terminal stations for a single TDD operator in the band 2010-2025 MHz

  - **Case of more than one TDD license in the unpaired spectrum**

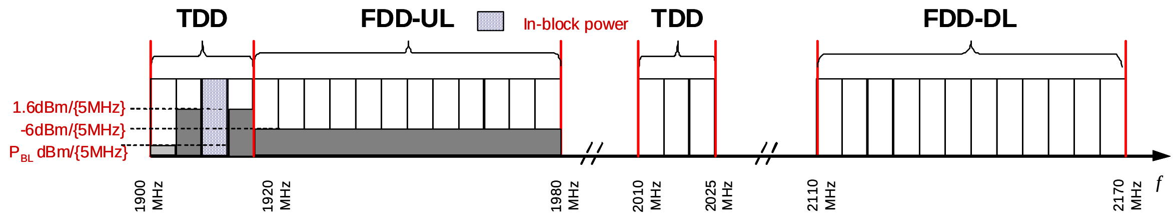

Figure 22: Emission mask for terminal stations for one TDD operator (using the block 1910-1915 MHz for illustration) (1905-1910 MHz and 1915-1920 MHz are a guard or restricted blocks)

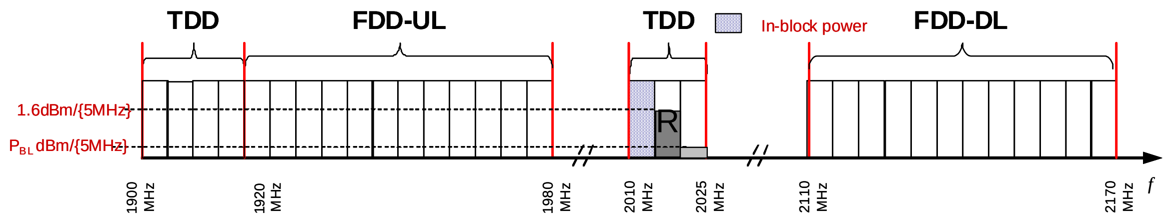

Figure 23: Emission mask for terminal stations for one TDD operator (using the block 2010-2015 MHz for illustration) (2015-2020 MHz is a guard or restricted block)

- **Alternative use of the band 2010-2025 MHz for synchronised TDD**

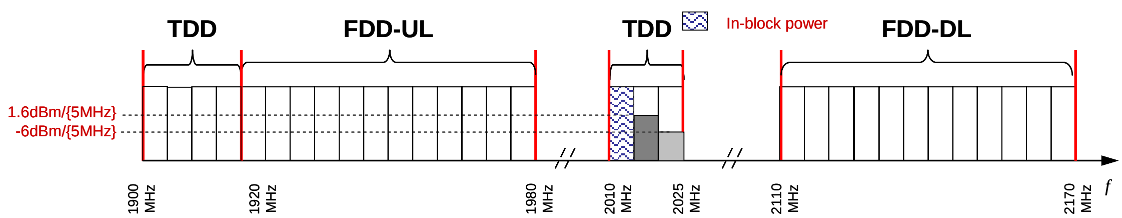

Figure 24: Alternative emission mask for terminal stations for one TDD operator (using the block 2010-2015 MHz for illustration)

- **Alternative use of the band 1900-1920 MHz for synchronised TDD**

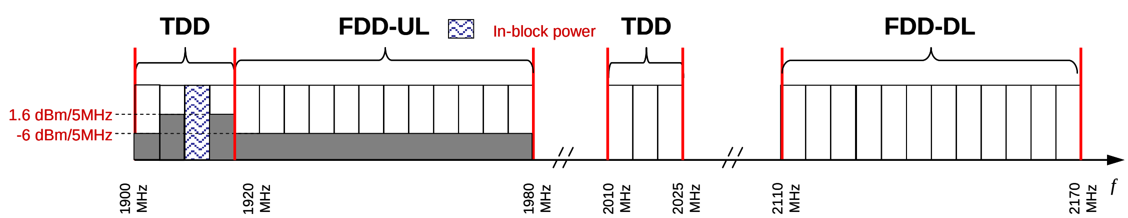

Figure 25: Alternative emission mask for terminal stations for one TDD operator (using the block 1910-1915 MHz for illustration)

5 IMPLICATIONS OF TECHNICAL CONDITIONS FOR ELECTRONIC COMMUNICATION NETWORKS IN THE UNPAIRED SPECTRUM

5.1 The current situation

Almost all existing licenses for unpaired spectrum in the 1900-1920 MHz and 2010-2025 MHz bands are for a single block of 5 MHz. Many of these licenses are currently restricted to UMTS TDD. However, there is very little, commercial use of this spectrum.

ECC Decision ECC/DEC/(06)01 [4] defines a harmonized spectrum scheme for the 2GHz band in which the 1900-1920 MHz and 2010-2025 MHz bands may be used either for TDD or for FDD uplink. ETSI MSG has developed a technical specification TS 102 735 for UTRA FDD with an uplink in these bands; this pairs 1900-1920 MHz uplink with 2600-2620 MHz downlink (Band XV) and 2010-2025 MHz uplink with 2585-2600MHz downlink (Band XVI). It is believed that these bands have not yet been implemented in equipment.

The frequency arrangements defined in TS 102 735 have a fixed duplex separation, which means that an operator could only use them if it is able to acquire the specific unpaired block at 2.6 GHz corresponding to its existing unpaired block at 2 GHz. Many license award procedures for the 2.6 GHz band do not allow an operator to bid for a specific single frequency block of unpaired spectrum.

5.2 Increasing flexibility in use of unpaired spectrum

The technical conditions described in this Report would allow the deployment of other TDD technologies than UMTS TDD considering the existing band plan. However, these technical conditions imply the introduction of a guard band between operators. The width of this guard band is at least 5 MHz, which means that all of an operator's spectrum would be subject to a low power limit. For the band 1900-1920 MHz, these power limits should also be consistent with the required levels to protect FDD systems above 1920 MHz as long as there is no request to modify the existing FDD networks or no appropriate mitigation technique is introduced. Consequently, an operator would be allowed to deploy only low power systems such as picocells, using a technology other than UMTS TDD, but little else.

The WAPECS approach envisages that license holders are able to negotiate less restrictive conditions amongst themselves[15]. These negotiations are likely to be easier when the planned uses of the spectrum are similar. With the trend towards broadband services, 5 MHz bandwidth is less than optimum for many of the potential applications for deployment in this spectrum. If the plans of the license holders are similar, a single system occupying more than 5 MHz bandwidth is likely to be a more efficient use of the spectrum than separate networks.

In many countries, the 1915-1920 MHz unpaired block was awarded to the operator with the lowest paired spectrum. This avoided difficulties of coordination between different TDD and FDD operators without a restricted block. However, the technical considerations that lead to a restricted block also restrict the use of the 1915-1920 MHz block by this operator (in particular, it would be very difficult to co-site TDD or downlink use with FDD macrocells). One possible future use of the unpaired spectrum (1900-1920 MHz and 2010-2025 MHz) is either to deploy a single system utilising TDD in each sub-band or in each sub-band downlink-, noting that a guard band of 10 MHz or 5 MHz will still be needed below the paired band[16] in any case to protect existing FDD networks and limit impact of them in the TDD networks. There are a number of possible options, which would require further detailed review, to facilitate effective use of the 1900-1920 MHz and 2010-2025 MHz bands:

- The use of 1900-1920 MHz and 2010-2025 MHz bands for downlink or synchronized TDD.
- To adopt the technical conditions described in this report separately for paired and unpaired spectrum in the 2 GHz band.

---

[15] See CEPT Report 19, section 3.2.

[16] 10MHz guard band may be optimal for practical reasons, so allow the new system to be co-sited on existing FDD cell sites, or to allow implementation of terminals supporting both frequency arrangements.

- Enabling the operation of a network requiring more than 5 MHz of spectrum in these bands.

6 CONCLUSIONS

6.1 Conclusions of Task 1

The WAPECS approach is at an early stage of implementation. This implementation has assumed that the most likely use of WAPECS bands is by technologies using a cellular network topology based on a two ways communication system with a network of base station and associated subscribers/terminal stations. Several mandates from the European Commission have been fulfilled by CEPT and initial feedback on the least restrictive technical conditions identified so far have been received from administrations and industry.

Most administration responses indicate that they intend to apply the WAPECS approach, through the effective implementation of the EC Decisions, based on relevant CEPT Reports, and conformity with relevant harmonised standards. Implementation of the WAPECS approach may differ between the situation where mobile networks are already operational (e.g. 900/1800 MHz and 2 GHz bands; and in some extent the 3.6 GHz band where fixed, nomadic use is already in place) from the others where networks will be deployed in new mobile bands (e.g. 800 MHz, 2.6 GHz). National implementation is an on-going process and administrations have very limited experience in licensing based on block edge masks and flexible channel arrangements.

For frequency bands with existing licenses, e.g. 2 GHz, work on common and minimal (least restrictive) technical conditions to implement the WAPECS approach should not lead to changes to the current technical licensing conditions unless operators plan to change the use of their spectrum. Furthermore, the technology evolution path for the existing networks should be ensured.

The general view seems to support a more flexible use of spectrum from a technology neutral approach (including various bandwidths for a given technology). However, there were concerns expressed about the extension of this concept of flexibility to include flexible band plans.

Therefore, there is support for preferred harmonized band plans to optimize the benefits of WAPECS approach. Such preferred harmonization could help to:

- facilitate the cross border coordination between countries
- facilitate the development of equipment able to support flexibility
- reduce some complexities in the national licensing process
- minimize the need to develop a greater number of product variants
- facilitate international roaming.
- Minimise any uncertainties around writing harmonised standards to demonstrate presumption of conformity of terminal stations with the representative minimal technical conditions agreed in CEPT.
- Facilitate negotiations between operators

At the same time, it should be mentioned that a preferred harmonised band plan does not imply necessarily only one channel arrangement method (FDD or TDD) . FDD and TDD can be introduced in the same frequency band especially where there is a large amount of spectrum to be available (e.g. in the 2.6 GHz band). In other bands where available spectrum is limited (e.g. 800 MHz) it would be inefficient to try to allocate both FDD and TDD in the same band due to the amount of guard spectrum that may be needed between operators.

The selection of a preferred harmonised band plan can facilitate the introduction of the WAPECS approach while maintaining the framework of the R&TTE Directive and Europe-wide roaming. The view was also expressed that a preferred harmonised band plan could include relevant flexibility where needed. The introduction of a WAPECS approach may not solve cross border coordination problems with non EU countries.

The WAPECS approach has implications for other regulatory frameworks (e.g. the Article 3.2 of the R&TTE Directive, terminal roaming requirements). For example, notified bodies will in future need to keep abreast of the conclusion of CEPT studies. Also the management of interference between terminals in WAPECS bands within the EU may require ETSI to make changes to their harmonised standards to reflect block-edge-mask requirements

6.2 Conclusions of Task 2

The 2 GHz bands are in a different situation to the previously investigated 'WAPECS bands' at 800 MHz and 2.6 GHz. The paired band is densely used and the unpaired bands each have a narrower bandwidth than at 2.6 GHz.

The current use of the 2 GHz bands is a cellular like topology with two-way communication for mobile communication networks and should still be the case in the near future. Therefore, two sets of technical conditions are developed - one for the base station (BS) and one for the terminal station (TS) – taking into consideration mobile service parameters. A similar approach to that one used in CEPT Report 19 and ECC Report 131 has been applied to derive block edge mask values.

A baseline limit of -43 dBm/5MHz in the relevant frequencies of TDD spectrum and -50 dBm/5MHz in the FDD uplink band have been derived for the TDD ECN base stations. In addition an in-block limit in the range from 20 to 43 dBm/5MHz is needed depending on the frequency separation with the FDD uplink band based on the assumptions that both FDD and TDD are deployed as macrocellular networks where TDD and FDD BS antennae (with 3 dB downtilt) are at the same heights and pointing to each other at 100 m separation distance. These limits could be increased at national level based on agreement between operators or on implementation of interference mitigation measures. When unpaired spectrum within the 1900-1920 MHz or 2010-2025 MHz band is allocated to more than one TDD operator, a guard band of at least 5 MHz is needed between unsynchronized operation of macrocell networks. For protection of TDD BS receiver the in-block EIRP limit should be 20 dBm/5MHz without additional interference mitigation measures or specific conditions of use (synchronized TDD or downlink transmission only). These technical conditions are relaxed in the case of synchronised TDD or downlink only transmission use.

"It has to be highlighted that these limitations in the use of the unpaired spectrum in the 1900-1920 MHz are due to the protection of the existing rights of use above 1920 MHz (i.e. UMTS FDD networks). This is the main difference between the assumptions that are used in the interference assessment of the 2 GHz band as opposed to the 2.6 GHz band. The initial situation in the 2 GHz band may evolve in the future, where appropriate, according to national authorisation process (e.g. if operators license needs to be renewed or if an operator makes a request for a change of use and/or technology). This could lead to similar technical conditions as those encountered previously in the 2.6 GHz band."

In this new situation the in-block power limits of TDD base stations could be relaxed in order to enable a more efficient and flexible use. This could be achieved, e.g., by using a 5 MHz guard band or restricted block between TDD networks or between TDD and FDD networks. Consequently no in-block power limit would be necessary in any of the bands.

As quoted in the ECC Report 119 [34] for the 2.6 GHz band, this could be achieved through the introduction of additional front-end filters on FDD and TDD base stations to limit adjacent channel interference. Another methodology, similar to using a restricted block, but applied to the interfered system, is to accept an increased level of interference in channels near the block edge. In such cases micro or pico cells which may benefit from additional shielding given from building clutters could still be deployed.

BEM for FDD base stations is derived directly by integration of the spectrum emission mask of UMTS and as plans for current ECN standards (e.g. LTE, WiMAX) indicate that alignment with this UMTS SEM is feasible, it is considered that this should not impose any constraint on equipment implementation.

A baseline level of -27 or -15.5 dBm/5MHz applies for ECN terminal stations depending whether probability of collision between victim and interferer packets can be taken into account. Some transitional levels are derived from the LTE band-independent spectrum emission mask, which is representative of the technologies envisaged in this band. No compatibility issue is expected between terminals used on different FDD operators' networks, due to the frequency separation with FDD downlink frequencies. It has to be highlighted that there will be an impact by FDD TS on TDD users in the 1900-1920 MHz band when considering emission masks compliant with ETSI EN301 908-13 [7] and TS 36.101 [7] specifications (E-UTRA standard). This will imply introduction of up to 10 MHz guard band to take into account impact of wider bandwidth used by FDD TS (10 or 15 MHz), e.g. LTE or DC-HSUPA.

The use of the unpaired spectrum (1900-1920 MHz and 2010-2025 MHz) for TDD cannot be guaranteed without inter operator interference for emission mask compliant with TS 36.101 [7] specifications. This is mainly due to the limited number of TDD blocks available and the fact that there may be discrepancies between the regulatory emission mask for terminals defined in this Report and the spectrum emission masks given in the standards, especially for terminals having a bandwidth greater than 5 MHz.

The studies have highlighted the limitations in the use of the unpaired spectrum in the 1900-1920 and 2010-2025 MHz bands for broadband communication. The introduction of flexibility gives the potential for a wider range of uses of these bands. However, other measures are needed to realise the efficient and flexible use of this spectrum.

ANNEX 1: EXAMPLES OF SPECTRUM ALLOCATIONS IN THE 2 GHz BAND IN CEPT AND EU MEMBER STATES

A1.1 The United Kingdom (May 2010)

UK spectrum allocations in the 2 GHz band are shown in Figure 26. In Figure 26, blocks 1-4 denote unpaired TDD band. Blocks 5-16 and 5'-16' denote paired FDD band.

Further, T, O, O2, 3 and V denote the operators T-Mobile, Orange, O2, 3UK, and Vodafone respectively.

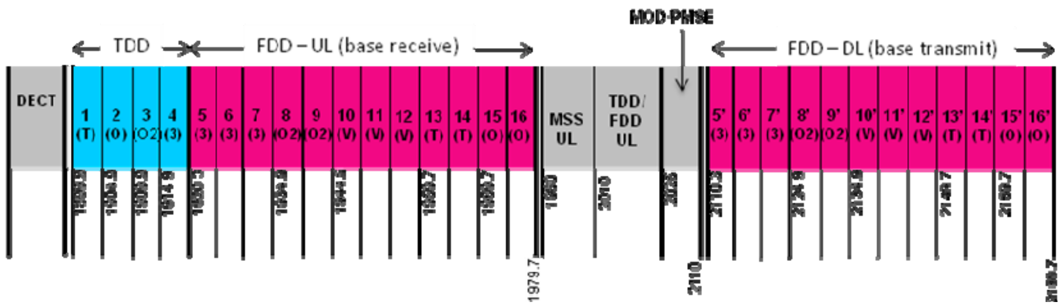

Figure 26: UK spectrum allocation in 2 GHz band

A1.2 France (May 2010)

French spectrum allocation in the 2 GHz band is still on going as shown in Figure 27. The three incumbent operators, Orange, SFR and Bouygues Telecom hold a 3G license based on IMT-2000 technologies of 2x14.8 MHz blocks in the FDD paired spectrum of the 2 GHz band.

The remaining 14.8 MHz duplex is currently auctioned. In fact, in a first step, an application procedure has been launched to assign a block of 2x5 MHz for a new entrant. The fourth 3G license has been delivered on 12 January 2010 to Free Mobile. In a second step, the remaining spectrum will be considered for a new application procedure planned in 2010. It has to be noted that Free Mobile, the winner of this 2x5 MHz in the 2 GHz band will also be awarded with 2x5 MHz of refarmed GSM 900MHz spectrum taken from the existing operators to leave them with approximately 2x10 MHz each.

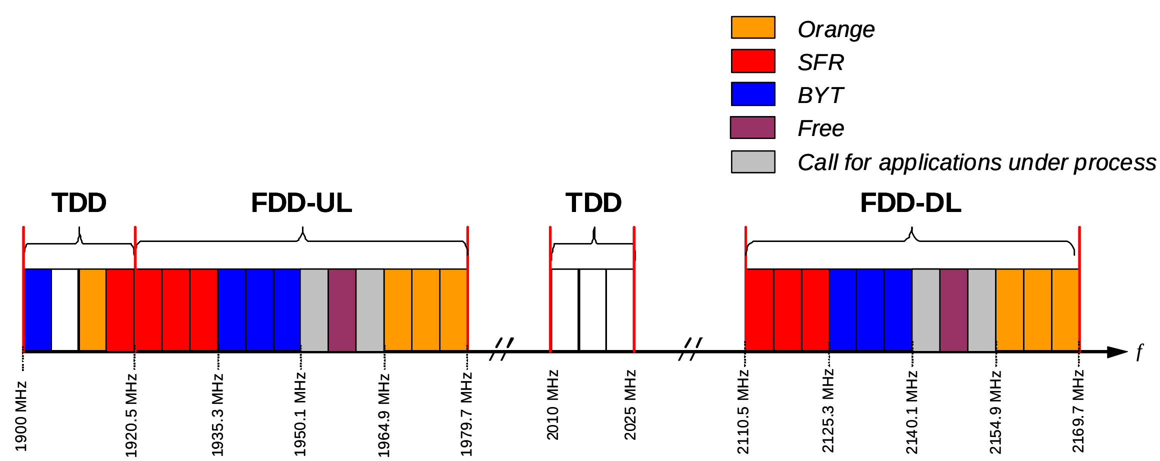

Figure 27: French spectrum allocation in 2 GHz band

A1.3 Germany (May 2010)

Note: The following tables (Table 13 and Table 14) represent the current channel and license arrangements of the 2 GHz bands in Germany. The Frequency usage in Germany after the auction in April/May 2010 is shown in Figure 28

Frequency range in MHz	Service/System	License/Comment
< 1900	DECT	
1900.0 – 1900.1	TDD	Guard band
1900.1 – 1905.1		O2
1905.1 – 1910.1		E-Plus
1910.1 – 1915.1		T-Mobile
1915.1 – 1920.1		Vodafone
1920.1 – 1920.3	FDD UL paired with 2110-2170 MHz	Guard band, under consideration
1920.3 – 1930.2		Vodafone
1930.2 – 1935.15		Vodafone
1935.15 – 1940.1		E-Plus
1940.1 – 1950.0		E-Plus
1950.0 – 1954.95		E-Plus
1954.95 – 1959.9		O2
1959.9 – 1969.8		O2
1969.8 – 1979.7		T-Mobile
1979.7 – 1980.0		Guard band
1980.0 – 2010.0	MSS	Service links

Table 13: Current channel and license arrangements in the 1900 to 2010 MHz band in Germany

Frequency range in MHz	Service/System	License/Comment
2010.0 – 2010.5	TDD / FDD UL	Guard band
2010.5 – 2024.7		O2
2024.7 – 2025.0		Guard band
2025.0 – 2110.0	EESS	
2110.0 – 2110.3	FDD DL paired with 1920-1980 MHz	Guard band
2110.3 – 2120.2		Vodafone
2120.2 – 2125.15		Vodafone
2125.15 – 2130.1		E-Plus
2130.1 – 2140.0		E-Plus
2140.0 – 2144.95		E-Plus
2144.95 – 2149.9		O2
2149.9 – 2159.8		O2
2159.8 – 2169.7		T-Mobile
2169.7 – 2170.0		Guard band
> 2170	MSS	Service links

Table 14: Current channel and license arrangements in the 2010 to 2170 MHz band in Germany

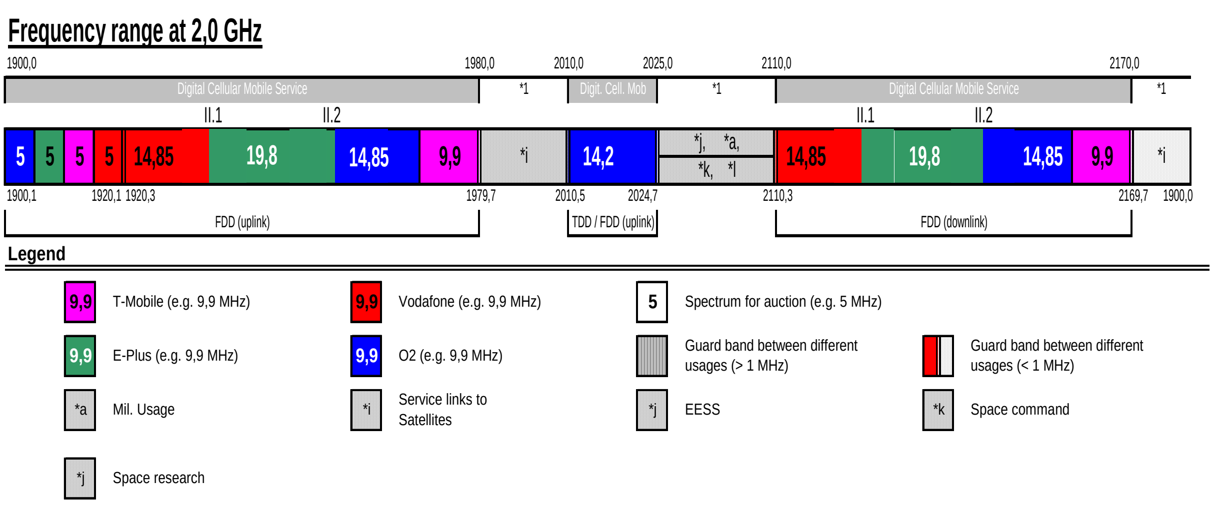

Figure 28: Frequency usage in Germany

A1.4 Italy (May 2010)

Table 15 to Table 17 represent the current channel and license arrangements in the 2 GHz band in Italy. Moreover, the current allocation of the 2 GHz UMTS band is shown in Figure 29.

It can be seen that, in Italy, the 2 GHz WAPECS bands are almost entirely allocated to IMT-2000/UMTS system.

The current UMTS licenses will expire at the end of 2021. To date only UMTS FDD has been deployed, whereas the UMTS TDD 1900 – 1920 MHz band is assigned but not used so far. The IMT-2000/UMTS TDD 2010 -2025 MHz band is not even assigned.

No guard bands are foreseen, neither between TDD and FDD boundaries nor between in- and out of-IMT-2000/UMTS bands.

The non WAPECS band 1980 – 2010 MHz is allocated for UMTS-S/MSS, but it is not currently used.

Some trials of DVB-SH mobile services have been locally performed in Italy in the non WAPECS band at 2170 – 2200 MHz.

Frequency Band	**Service/System**	**License/comment**
< 1900 MHz	DECT	
1900 – 1905 MHz	UMTS TDD	H3G
1905 – 1910 MHz		Vodafone
1910 – 1915 MHz		TIM
1915 – 1920 MHz		Wind
1920 – 1925 MHz	UMTS FDD UL (paired with 2110-2170 MHz)	Wind
1925 – 1930 MHz		Tim
1930 – 1935 MHz		Vodafone
1935 – 1945 MHz		Tim
1945 – 1955 MHz		Wind
1955 – 1970 MHz		H3G
1970 – 1980 MHz		Vodafone
> 1980 MHz	UMTS-S /MSS	Not assigned

Table 15: Channel and license arrangements in the 1900 – 1980 MHz band in Italy

Frequency Band	**Service/System**	**License/comment**
< 2010 MHz	UMTS-S/MSS	Not assigned
2010 – 2025 MHz	IMT 2000 TDD	Not assigned

Table 16: Channel and license arrangements in the 2010 – 2025 MHz band in Italy

Frequency Band	Service/System	License/comment
2110 – 2115 MHz	UMTS FDD DL (paired with 1920-1980 MHz)	Wind
2115 – 2120 MHz		Tim
2120 – 2125 MHz		Vodafone
2125 – 2135 MHz		Tim
2135 – 2145 MHz		Wind
2145 – 2160 MHz		H3G
2160 – 2170 MHz		Vodafone
> 2170 MHz	UMTS-S/MSS	Not assigned

Table 17: Channel and license arrangements in the 2110 – 2170 MHz band in Italy

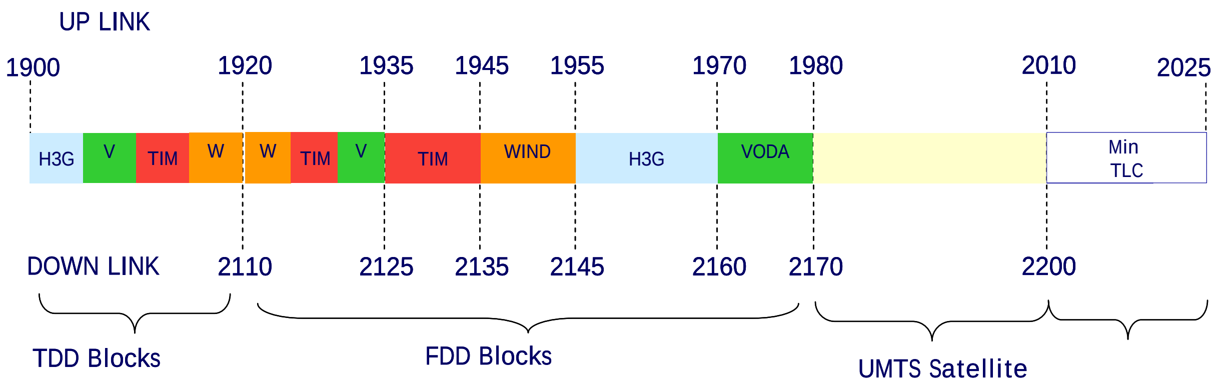

Figure 29: UMTS band allocation at 2 GHz: current situation in Italy

A1.5 Portugal (January 2010)

Table 18 presents the current usage and assignments in the 1900-1920MHz/ 1920-1980 MHz / 2110-2170 MHz band in Portugal.

Frequency range in MHz	Service/System	License/Comment
< 1900	DECT	
1900.0 – 1900.1	IMT-2000/ UMTS TDD	Guard band
1900.1 – 1905.1		No license
1905.1 – 1910.1		No license
1910.1 – 1915.1		TMN
1915.1 – 1920.1		Vodafone
1920.1 – 1920.3	IMT-2000/ UMTS FDD UL paired with 2110-2170 MHz	Guard band,
1920.3 – 1940.1		Vodafone
1940.1 – 1959.9		Optimus
1959.9 – 1979.7		TMN
1979.7 – 1980.0		Guard Band
2010.0 - 2025.0		No license
2025.0 – 2110.0	Space Operation Fix Link SAP/SAB	
2110.0 – 2110.3	IMT-2000/ UMTS FDD DL paired with 1920-1980 MHz	Guard band
2110.3 – 2130.1		Vodafone
2130.1 – 2149.9		Optimus
2149.9 – 2169.7		TMN
2169.7 – 2170.0		Guard Band
> 2170	MSS	Service links

Table 18: Usage and assignments in the 1900-1920MHz/ 1920-1980 MHz / 2110-2170 MHz band in Portugal

ANNEX 2: INTERFERERS DENSITY CALCULATION

Detailed analysis of TS to TS interference in 2.6 GHz band was presented in ECC Report 131 [6]. Similar approach was taken in this analysis noting the difference between the spectrum bands. Table 19 shows the user density derivation for this study, comparing with user density derived in 2.6 GHz study from ECC Report 131.

2.6 GHz band	**2 GHz band**
Spatial density = 1 person in $3m^2$	
10% of the users are considered to be using their wireless device.	
Of those 10 %, 50 % of the terminals operate in the 2.6 GHz band (the rest operating in other frequency bands).	Of those 10 %, 39 % [6] of the terminals operate in the 2 GHz band (the rest operating in other frequency bands). (100/39=2.6)
50 % of the users in 2.6 GHz band users FDD (rest uses TDD)	15 % of the users use TDD and 85 % uses FDD (FDD=2x59.4 and TDD=20.1, assuming UL:DL=1:1) (100/85=1.18)
TDD terminals are assumed to be uniformly distributed across a total of 10 available unpaired (TDD) 5 MHz blocks	All terminals are assumed to be uniformly distributed in 138.9 MHz, 12*5 MHz + (4x5)/2 (for UL and DL) MHz14x5MHz bands
User density = (1/3)/(10*2*2*10) = 8.3 * 10-4 m-2 (≈2 interferers in 25 m radius hotspot)	User density = (1/3)/(10*2.5*1.18*14) = 7.8 * 10-4 m-2 (≈2 interferer in 25 m radius hotspot)

Table 19 : User density derivation for 2100 MHz band comparing with 2.6 GHz study

Analysis suggests that hot spot user density assumed in 2.6 GHz band is of the same order of the density in a hotspot in 2 GHz band. Therefore, the BEM values from 2.6 GHz are translated into 2 GHz.

It should be noted that these user density calculations were carried out on the assumption that all bands have matured networks operating and providing services to large number of users.

ANNEX 3: COMPLEMENTARY STUDIES BETWEEN ECN TDD SYSTEMS AND DECT SYSTEMS

Sharing scenarios to be considered have been already considered in ERC Report 065 [9] when adjacent band compatibility between UMTS and other 2 GHz services have been studied.

Regarding DECT and UMTS, 30 different scenarios were defined. Of those were only four critical. These four can be included in two main scenarios:

a) Mutual interference between a UMTS Macro BTS and above roof-top a DECT WLL system, and
b) Mutual interference between an indoor DECT system and an indoor TS belonging to a UMTS Macro cell system.

These scenarios relate directly to the scenario of two unsynchronised TDD ECNs operating on adjacent bands. Case a) corresponds to mutual BS-BS interference and case b) to mutual TS-TS interference.

Regarding a), ERC Report 065, section 3.1.7 concludes:

> *"UMTS TDD Macro BTS systems should not be applied on the band 1900 –1910 MHz in areas where DECT WLL systems are installed (Eastern Europe), unless special measures are taken."*

This conclusion will not be affected by introduction of WAPECS, and thus no further analysis is required for this report.

Regarding b), ERC Report 065, section 3.1.7 concludes:

> *"No additional guard bands are needed between DECT and UMTS TDD if UMTS TDD is deployed indoors"*

This conclusion in ERC Report 065 is however made with the assumption that certain mutual mitigation techniques are applied on the DECT side and also for UMTS, for which the specification was not finalised when ERC Report 065 was written. One of the described anticipated mitigation technique for UMTS has never been introduced and another one (isochronous TDMA burst TS transmissions with 10 ms repetition rate) will be lost by introducing WAPECS.

Therefore scenario b) has to be analysed given the new conditions related to the introduction of WAPECS systems.

This scenario b) relates to the main DECT market consisting of residential and enterprise systems deployed within the band 1880-1900 MHz (several 100 million units through out Europe).

A clear guide in this report on compatibility and the necessary conditions for coexistence between DECT private indoor systems and ECN TS is most essential, due to the absence in this case of any practical possibility of bilateral agreements between the neighbouring network owners.

The study in this report is focussed on coexistence between an indoor DECT system and an indoor TS belonging to an outdoor ECN system.

Therefore, this annex is intended to access and understand the practical implications (including limitations) when introducing WAPECS systems in the 2 GHz band. Studies show the results of the basic Minimum Coupling Loss, MCL, and Minimum Separation Distance, MSD, calculations, as well as results from a simplified statistical analysis.

Consider an interferer ECN TDD TS and a victim DECT TS as shown in Figure 30 below.

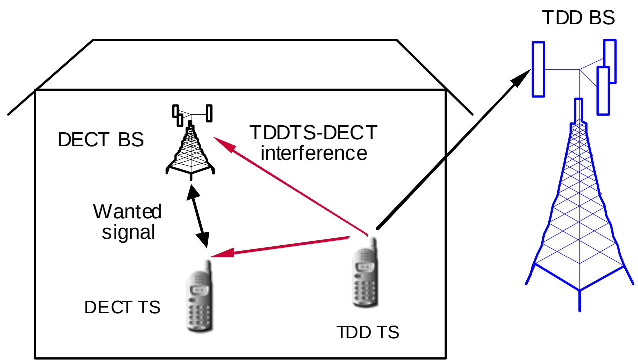

Figure 30: Illustration of interference between TDD TS and DECT TS and BS

A3.1 Description of DECT system

A3.1.1 DECT Carrier Positions

Ten RF carriers, as shown in Figure 31, are defined in the frequency band 1 880 MHz to 1 900 MHz with centre frequencies Fc given by:

Fc = F0 - c x 1.728 MHz where: F0 = 1 897.344 MHz; and c = 0, 1, ..., 9.

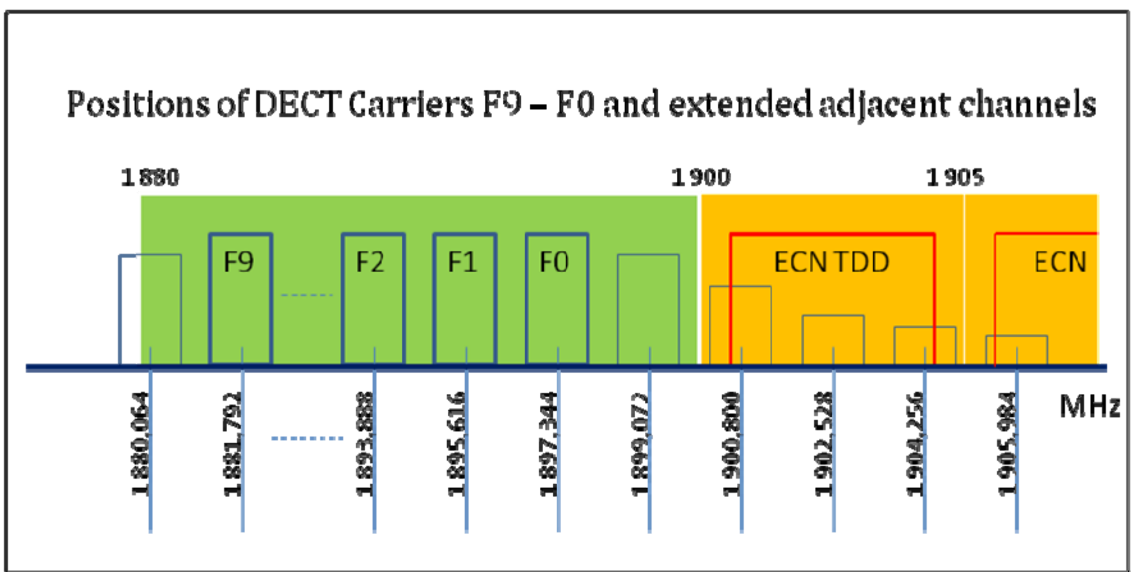

Figure 31: Positions of DECT carriers and adjacent channels extended outside the DECT band.

The carrier spacing is 1752 MHz and the transmit bandwidth about 1 MHz (1152 Mbps).

A3.1.2 Calculation of ACS for DECT

ACS for DECT is derived by combining clause 6.4 “Radio receiver interference performance” and clause 6.5 “Radio receiver blocking” of [26].

Radio receiver interference performance

With a received signal strength of -73 dBm (i.e. 70 dBµV/m) on RF channel M, the BER in the D-field shall be maintained better than 0.001 when a modulated, reference DECT interferer of the indicated strength is introduced on the DECT RF channels shown in Table 20.

Interferer on RF channel "Y":	**Interferer signal strength (dBµV/m)**	**(dBm)**
Y = M	59	-84
Y = M ± 1	83	-60
Y = M ± 2	104	-39
Y = any other DECT channel	110	-33
NOTE: The RF carriers "Y" shall include the three nominal DECT RF carrier positions immediately outside each edge of the DECT band.		

Table 20: Receiver interference performance

ACS (N^{th} adj. ch.) = Interferer signal strength (Y=M) - Interferer signal strength (Y=M+N).

C/I = Received signal strength - Interferer signal strength (Y=M) = -73 + 84 = 11 dB.

ACS for the 4^{th} adjacent channels is calculated from the blocking requirements.

Radio receiver blocking

With the desired signal set at -80 dBm, the BER shall be maintained below 0,001 in the D-field in the presence of any one of the signals shown in Table 21.

The receiver shall operate on a frequency band allocation with the low band edge F_L MHz and the high band edge F_U MHz.

Frequency (f)	**Continuous wave interferer level** For radiated measurements dB µV/m	For conducted measurements dBm
25 MHz $\leq f < F_L$ - 100 MHz	120	-23
F_L - 100 MHz $\leq f < F_L$ - 5 MHz	110	-33
$\lvert f - F_C \rvert$ > 6 MHz	100	-43
F_U + 5 MHz $< f \leq F_U$ + 100 MHz	110	-33
F_U + 100 MHz $< f \leq$ 12,75 GHz	120	-23

Table 21: Receiver blocking

For the basic DECT frequency band allocation F_L is 1 880 MHz and F_U is 1 900 MHz. Receivers may support additional carriers, e.g. up to F_U = 1 920 MHz.

Thus for F_U = 1900 MHz the blocking level -33 dBm applies for the frequency range 1905<f≤2000 MHz.

The blocking figure -33 dBm can be translated into an ACS figure:

ACS (1905 MHz) = Blocking level – Desired signal + C/I = -33 + 80 + 11 = 58 dB.

Related to the DECT carrier F0, 1905 MHz falls between the 4^{th} and 5^{th} adjacent carrier.

Thus it is possible to complement the ACS above table for the 4^{th} and 5^{th} adjacent carrier, where the value for the 4^{th} adjacent carrier is derived through best guess interpolation:

Adjacent channel #	ACS
1st adj. ch	24 dB
2nd adj. ch.	45 dB
3rd adj. ch.	51 dB
4th adj. ch.	55 dB
5th & higher adj. ch.	58 dB

Table 22: ACS for DECT-like interferer

Table 22 formally applies for DECT carrier F0, but at 1905 MHz, just 5 MHz outside of the DECT band, the main attenuation comes from the IF-filter, and very little from the RF-filter, and thus the table is supposed to be relevant for all DECT carriers F0 to F9.

The next step is to relate the DECT ACS table to a broadband adjacent interferer with about 4 MHz bandwidth operating in the block 1900-1905 MHz. As an approximation the ACS related to a 4 MHz interferer is calculated as the sum of the weighted average linear attenuation (times not dB) of the three adjacent channels falling within the 4 MHz interfering channel. (The centre channel is given the weight 0.5 and the two other channels the weight 0.25.) Figure 32 shows which three adjacent channels that shall be used, depending on the interfered DECT carrier FX, X = 0, 1, …, 9.

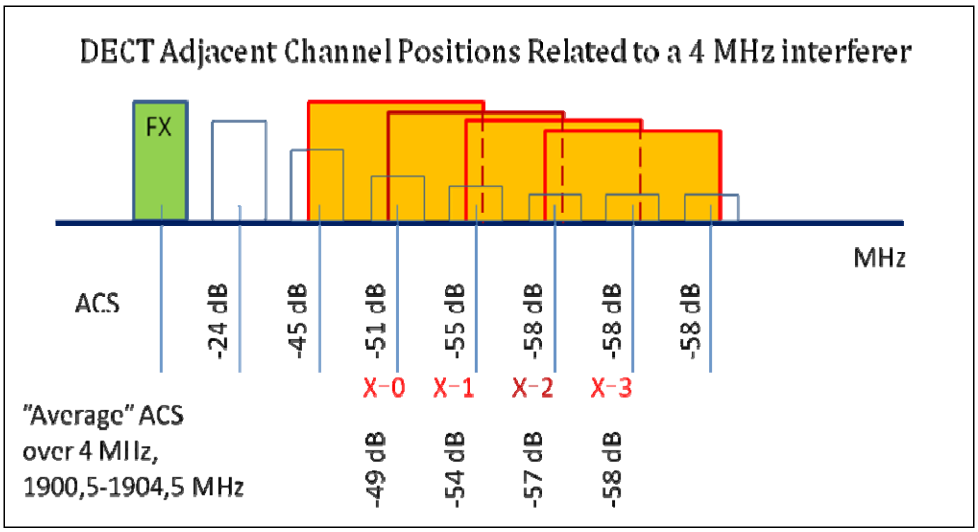

Figure 32: Estimated ACS related to a 4 MHz wide interferer at 1902,5 MHz, for DECT carriers F0-F9.

The DECT ACS related to a 4 MHz interferer in the block 1900 – 1905 MHz becomes:

DECT Carrier	ACS	Interference level for 3 dB desensitization (-103 dBm)
F0	49 dB	-54 dBm
F1	54 dB	-49 dBm
F2	57 dB	-46 dBm
F3 – F9	58 dB	-45 dBm

Table 23: DECT ACS for a 4 MHz interferer within 1900,5 – 1904,5 MHz

A3.1.3 ACLR for broadband technologies operating on the band 1900-1905 MHz

ACLR for the broadband technologies are calculated below, related to the DECT carriers F0-F9. Table 24 shows the frequency separation between DECT carriers and the broadband centre carrier 1902.5 MHz respectively the band edge frequency 1900 MHz.

DECT Carrier	DECT carrier frequency, MHz	Broadband carrier (1902.5 MHz) to DECT carrier separation, Δf MHz	Band edge (1900 MHz) to DECT carrier separation, Δf_{OOB} MHz
F0	1897.344	5.2	2.7
F1	1895.616	6.9	4.4
F2	1893.888	8.6	6.1
F3	1892.160	10.3	7.8
F4*	1890.432	12.1	9.6*
F5	1888.704	13.8	11.3
F6	1886.876	15.6	13.1

Table 24: Frequency separation between DECT carriers and the broadband centre carrier 1902.5 MHz respectively the band edge frequency 1900 MHz.

*) When calculating ACLR for frequencies below 1890 MHz, the spurious requirements have to be used. When calculating below ACLRs related to F4, the spurious requirement is supposed to apply, since F4 is very close to the 1890 MHz limit.

Below the broadband adjacent channel positions are shown in relation to the DECT carriers.

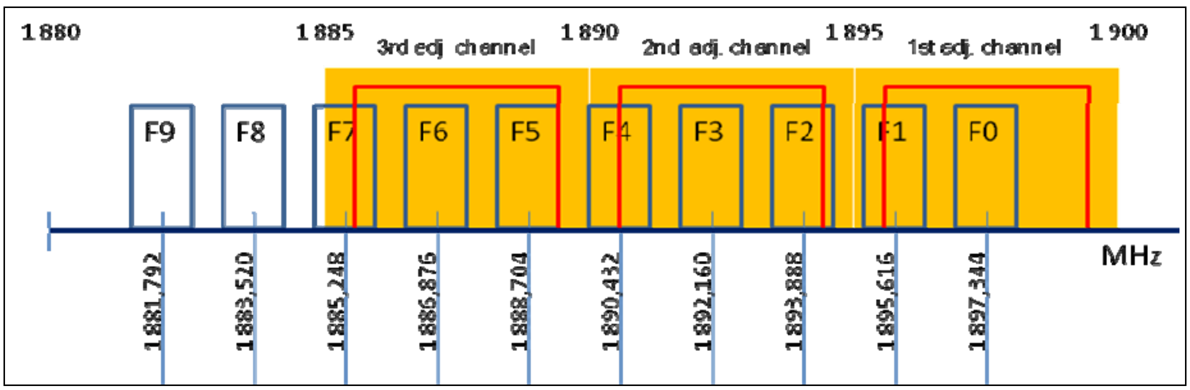

Figure 33: Broadband adjacent channel positions within the DECT band 1880-1900 MHz

A3.1.3.1 UMTS TDD 3.84 Mcps option

For UMTS TS transmit power 24 dBm (Power Class 2) has been selected. For UMTS BS transmit power 43 dBm has been selected.

A3.1.3.2 UMTS TDD ACLR

The Table below indicates in bold the ACLR figures related to a DECT receiver (1 MHz). They are derived either from the spurious emission limits (SP) and out-of-band emission limits (OOB) or ACLR values (4 MHz). ACLR value for F1 is derived by interpolation between the values for F0 and F2 for TS.

DECT Carrier	TS (24 dBm Tx power)			BS (43 dBm Tx power)		
	OOB/SP dBm/MHz	ACLR dB 4 MHz RX	ACLR dB 1 MHz RX	OOB/SP dBm/MHz	ACLR dB 4 MHz RX	ACLR dB 1 MHz RX
F0	-	-	**40**	-13 (-35*)	-	**56** (78*)
F1	-	-	**44**	-13 (-35*)	-	**56** (78*)
F2	-25	-	**49**	(-35*)	55 (72*)	**61** (78*)
F3	-25	-	**49**	(-35*)	55 (72*)	**61** (78*)
F4	-30	-	**54**	30 (-35*)	67 (72*)	**73** (78*)
F5-F9	-30	-	**54**	-30	67	**73**

Table 25: ACLR for UMTS TDD 3.84 Mcps Option [27]. Bold figures relate to DECT receivers.*) These values relate to unsynchronized UMTS TDD systems on the adjacent channel.

DECT Carrier	TS OOB dBm/MHz			BS OOB dBm/MHz		
	UMTS	LTE	WiMAX	UMTS	LTE	WiMAX
F0	16***	-13**	-13	-13 (-25*)	-13	-13
F1	-20***	-13**	-13	-13 (-35*)	-13	-13
F2	-25	-25	-25	-18 (-35*)	-13	-13
F3	-25	-25	-27**	-18 (-35*)	-13	-13
F4-F9	-30	-30	-30	-30	-30	-30

Table 26: Comparison of OOB emission figures of UMTS TDD, LTE and WiMAX. *) These figures relate to unsynchronized UMTS TDD systems on the adjacent channel.) Derived from ACLR with Tx 23 dBm. ***) Derived from ACLR with Tx 24 dBm**

A3.1.4 Quality requirements and spectrum occupancy of DECT services

The DECT technology and services are since many years already deployed within the band 1880-1900 MHz (several 100 million units through out Europe).

The quality requirement on the DECT radio link is > 0,1 % bit error rate corresponding to < 1% slot error rate for the dominate speech service.

The DECT carriers are accessed randomly. A duplex single bearer connection uses one carrier.

In a home, one carrier is active for an external call and for an internal “intercom” call normally two carriers are active. In an enterprise, typical average load on a base station is 2-3 simultaneous calls (maximum 12).

Regarding the Grade of Service (GOS), dense traffic enterprise applications may locally utilise up to the entire DECT spectrum, while one residential system normally only occupies a small fraction of the DECT spectrum.

Regarding quality, it is most essential that DECT in an orderly way can escape interference from adjacent band technologies (broadband technologies on the 1900-1905 MHz block), and quickly find a “free” DECT channel.

Various obstacles to find a “free” channel in the presence of interference are:

- An enterprise system utilizes almost all capacity of the DECT spectrum.
- The interference is intermittent and stochastic in relation to an isochronous DECT slot transmission repeated every 10 ms. (This severely decreases the probability of timely access to a high quality DECT channel, and decreases the link and service quality).

- A large portion of the DECT spectrum is blocked by interference from adjacent block.

It is important to realize that DECT for the telephony service does not implement error correction nor interleaving, but only error detection. This implies that a partial interference of a slot results in a lost slot. Furthermore, to combat Rayleigh fading, antenna diversity is implemented, and a 10 dB fade margin is needed to maintain the required < 1% slot error rate. The C/I threshold is 11 dB, so the call set-up threshold including a 10 dB fading margin is C/(I+N) = 21 dB.

A shadowing margin could be modelled with a log-normal law with zero mean and a standard deviation of 8 dB.

Intra-system interference power, could be set to 0, or a very low figure, because a DECT always make a bearer set up on the least interfered channel, and DECT systems are normally not capacity limited (due to intra-system interference), but range limited.

Cellular systems are normally planned for 5 % outage. DECT telephony services have to be planned for < 1% outage, and < 1% slot error rate, as explained above.

The radio propagation properties for short range indoor cells in homes and enterprises are very variable. So variable that traditional frequency planning becomes very difficult and inefficient. The unique DECT instant Dynamic Channel Selection procedure avoids any need for planning of frequencies and/or (control) channels.

In a home, one single cell covers a flat, or a house with may be basement, a second floor and garden. The maximum sensitivity (full range) of a DECT single cell is sometimes utilized.

The propagation loss L has been approximated to:

$L = 38 + 30\log(d)$ [dB], where d is the distance in meters.

This formula is relevant for d >= 4 m, since some kind of wall is in the path.

For d < 4 m "line-of-sight" $L = 38 + 20\log(d)$ applies.

A3.2 Calculations on coexistence between an indoor DECT system and an indoor TS belonging to an ECN outdoor BS system

The study in this paragraph is related to the coexistence of an indoor DECT system with an indoor TS belonging to an ECN system. It uses UMTS TDD parameters as a reference, supposing continuous transmissions (disregarding any time component).

ACS figures for DECT and ACLR for ECN TS related to the different DECT carriers have been calculated above, and are used in the tables below. Furthermore, adjacent channel leakage power ratio and adjacent channel selectivity are combined to give an adjacent channel interference ratio (ACIR) according to the following equation:

$ACIR^{-1} = ACLR^{-1} + ACS^{-1}$ (for ACIR, ACLR and ACS as linear ratios)

The ECN TS transmit power is P_{TxECN} = 24 dBm.

The DECT interference target level (3 dB desensitization) is $P_{I,target}$ = -103 dBm.

The minimum separation distances, MSDs, have been calculated from the formula:

$P_{TxECN} - ACIR - L = P_{I,target}$, equal to $24 - ACIR - 38 - 30\log(d) = -103$; $30\log(d) = 89 - ACIR$;

DECT Carrier #	DECT ACS dB	UMTS ACLR (into a 1 MHz channel) dB	ACIR dB	Minimum separation distance, MSD
F0	49	40	39	46 m
F1	54	44	44	32 m
F2	57	49	49	23 m
F3	58	49	49	23 m
F4-F9	-	54	53	16 m

Table 27: Minimum Separation Distances, MSD, between a DECT receiver and ECN TS

The above table applies for the worst case when the ECN TS transmits at maximum power and the DECT link operates at maximum range ($P_{I,target}$ = -103 dBm).

The table below gives an overview of how much the interference exceeds $P_{I,target}$ = -103 dBm for separation distances 2, 5, 15, 20 and 30 m.

Separation distance DECT TS ECN TS	Interfering power exceeding -103 dBm. Factor in dB for different DECT carries									
	F9	**F8**	**F7**	**F6**	**F5**	**F4**	**F3**	**F2**	**F1**	**F0**
2 m	30	30	30	30	30	30	35	35	39	44
5 m	15	15	15	15	15	15	20	20	24	29
10 m	6	6	6	6	6	6	11	11	15	20
15 m	1	1	1	1	1	1	6	6	10	15
20 m	-3	-3	-3	-3	-3	-3	2	2	6	11
30 m	-8	-8	-8	-8	-8	-8	-3	-3	1	6

Table 28: Interfering power exceeding -103 dBm. Factor in dB for different DECT carries

Separation distance DECT TS DECT BS	(C/(I+N) – 21) dB margin for DECT link (with no interference)
2 m	61 dB
5 m	49 dB
10 m	40 dB
15 m	31 dB
20 m	24 dB
30 m	22 dB

Table 29: Interference margins for a DECT link for different distances between DECT TS and BS

In the second column of the Table 29 above has been added information on the C/I margin that is available until the interference from the UMTS TS reduces C/(I+N) for the DECT link below 21 dB. The margin has been calculated for distances 2 m to 30 m. 21 dB is the required C/(I+N) for DECT in Rayleigh fading environment.

It should be noted that while the victim DECT receiver seems desensitized in excess, it is only when the ECN TS is very close to the DECT receiver and at the same time the DECT TS is relative far from the DECT BS.

Below is shown a simplified statistical analysis of the case when the ECN TS transmit power will be close to maximum, which will occur when the enterprise or home is located close to the UMTS macro cell range. 19 % or 36 % of all DECT systems will be positioned within the range 90% -100% or 80% - 100% of the UMTS radius. There (incl. 12 dB extra outdoor to indoor loss) the ECN TS transmit power will be close to maximum.

To calculate the probability p that a DECT link to the DECT BS is interfered, it assumed that the interfering ECN TS is at a distance d_I from the DECT BS, and the DECT TS is at a distance d_D from the DECT BS. Then the following equation expresses the relation between d_I and d_D when the DECT C/I requirement just is met.

P_{ECN} –ACIR -38 – 30logd_I = P_{DECT} – 38 – 30 logd_D –C/I, this leads to

30log(d_I /d_D) = P_{ECN} –ACIR - P_{DECT} + C/I = - ACIR + 21, call d_I /d_D = k.

The formula for deriving k can be generalized to

$$k = 10^{-\frac{PDECT - PECN + ACIR - C/I}{10n}},$$

where n is the decay index in propagation model L = 38 + 10n logd dB.

For the specific case of this report, where P_{ECN} = P_{DECT} , C/I = 21 and n=3, k is derived from

$$k = 10^{-\frac{ACIR-21}{30}}$$

The probability for interference, p, to the DECT BS from one active ECN TS within the DECT cell with radius R is calculated in the figure below. Note, that for this calculation, the ECN TS Tx power is constant (at maximum level), and that the distance kr is supposed to be the limit where the DECT C/I requirement of 21 dB just is met.

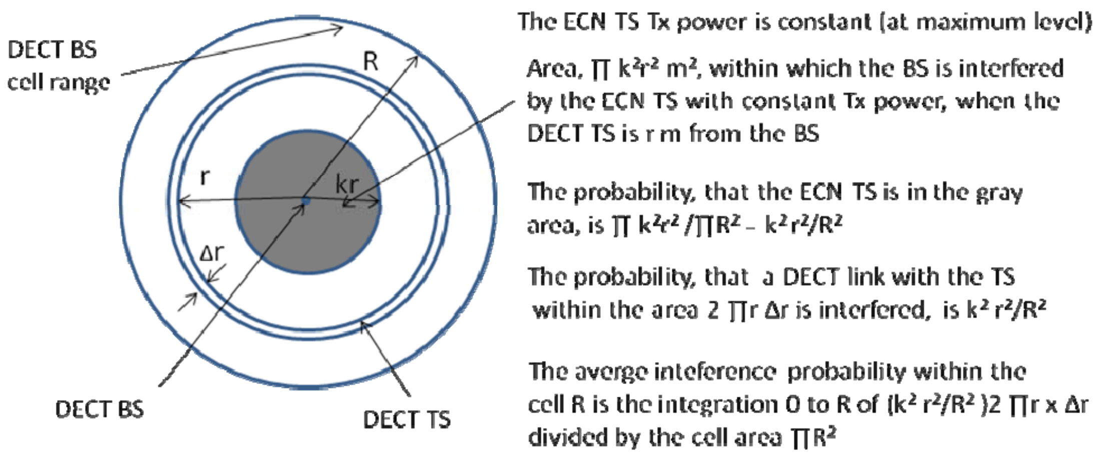

Figure 34: Illustration of the probability for interference to the DECT BS within a DECT cell

The probability becomes $p = 2k^2 \int_0^R \frac{r^3}{R^4} dr = \frac{k^2}{2}$

Taking into account that any of the DECT UL or DL may be interfered, p for a DECT duplex link is approximately k^2.

p(duplex link) = k^2.

In the Table below, probability of interference for the carriers F9-F0 and the average probability over 10 carriers is shown:

DECT Carrier number	OOB or SP emissions level dBm/MHz	ACIR – 21 dB	**Probability of interference k^2 for n=3**
F0	-16	18	6.3 %
F1	-20	23	2.9 %
F2-F3	-25	27	1.6 %
F4-F9	**-30**	32	**0.7 %**
Average probability			1.7 %

Table 30: Probability of interference for different DECT carriers with an ECN interferer complying with the UMTS TS mask and related spurious emissions requirement

The Table above shows an average probability of interference of 1.7 % for ECN complying with the UMTS TS mask and spurious emissions.

The average probability of interference with an LTE or WiMAX TS interferer becomes 2.4 %.

The calculations show that UMTS TDD TS OOB emissions are -30 dBm/MHz (TS spurious requirements below 10 MHz from 1900 MHz) for F9-F4, 6 of the 10 DECT carriers. If the ECN TS has a BEM of -30 dBm/MHz, this will include all DECT carriers and the blocking probability will be less than the wanted 1 %.

The 1% limit is also met if the DECT system can orderly escape from interference on carriers F3-F0 to any of the carriers F9-F4. The DECT instant Dynamic Channel Selection (DCS) procedure creates the necessary 5-10 MHz guard band within the DECT band, at the expense of capacity loss.

DL only ECN continuous transmission in the band 1900 – 1905 MHz, not ease the requirements on the ECN TS, but DECT will have no problem to orderly escape from high interfered carriers to less interfered carriers.

Although the average probability of interference will be close to the wanted level, specific cases can suffer considerably higher probabilities, therefore mitigation technique below is important, since some technologies will have it inherently, or can select a scheduling mode supporting it.

A3.2.1 Mitigation for ECN TS using isochronous bursts repeated with the same length every 10/n ms, n = 1or 2

This case applies if the physical layer access technique of the ECN TS provides for a TS uplink connection with an isochronous burst sequence with a fixed repetition rate of 5 ms or 10 ms. The interference from such an ECN TS is DECT-like and provides time domain spectrum sharing with a DECT burst sequence. For this case an ECN TS, with an emission mask and spurious emissions similar to UMTS TDD TS, is not expected to cause interference even for the worst case scenarios for DECT indoor systems.

The spectrum 1900-1905 MHz was once allocated without any guard band, based on the fact that UMTS TDD has DECT-like burst transmissions, which DECT (below 1900 MHz) could detect and avoid in an orderly way.

A3.3 Conclusions

It is shown that coexistence between ECN TS and DECT TS can be fulfilled if the ECN TS can meet an emission level of -30dBm/MHz below 1900 MHz. If the ECN TS cannot achieve this emission level below 1900 MHz then an alternative way to achieve compatibility is to introduce a 5 MHz guard band (1895-1900 MHz) within the DECT band. This is currently achieved by the DECT DCS mechanism when ECN TS emissions can be properly detected by DECT. Another alternative way to achieve compatibility is given by UMTS TDD that can co-exist with DECT in the sub-band 1895-1900 MHz, because the same slot repetition rate and length of time frame is used by both systems (i.e. 10 ms).

It has also to be noted that further calculations could refine these compatibility studies by assessing more explicitly the impact of typical ECN TS on the DECT system by taking into account the specific characteristics of ECN and DECT systems.

Therefore, studies have shown that it is possible for ECN TS to achieve compatibility with DECT by complying with an emission level of -30dBm/MHz below 1900 MHz. When this level cannot be fulfilled compatibility can be achieved by ECN TS using a time frame that is detectable by DECT DCS mechanism. In addition compatibility can be achieved if the ECN TS uses the same slot repetition rate as DECT.

ANNEX 4: REFERENCES

[1] EC Mandate to CEPT on the 2 GHz bands, (http://ec.europa.eu/information_society/policy/ecomm/radio_spectrum/manage/eu/rsc/rsc_subsite/mandates/index_en.htm)

[2] ERC/DEC/(99)25 of 29 November 1999 on the harmonised utilisation of spectrum for terrestrial Universal Mobile Telecommunications System (UMTS) operating within the bands 1900 - 1980 MHz, 2010 - 2025 MHz and 2110 - 2170 MHz, www.ecodocdb.dk

[3] EC Decision 128/1999/EC of the European Parliament and of the Council on the coordinated introduction of a third-generation mobile and wireless communications system (UMTS) in the Community.

[4] ECC/DEC/(06)01 of 24 March 2006 on the harmonised utilisation of spectrum for terrestrial IMT-2000/UMTS systems operating within the bands 1900-1980 MHz, 2010-2025 MHz and 2110-2170 MHz, www.ecodocdb.dk

[5] CEPT Report 19, 'Least restrictive technical conditions for WAPECS frequency bands', 2008, www.ecodocdb.dk

[6] ECC Report 131, 'the derivation of a Block Edge Mask (BEM) for terminal stations in the 2.6 GHz frequency band (2500-2690 MHz)', www.ecodocdb.dk

[7] ETSI TS 36.101, 'LTE;Evolved Universal Terrestrial Radio Access (E-UTRA);User Equipment (UE) radio transmission and reception (3GPP TS 36.101 version 9.1.0 Release 9)', Oct. 2009, http://portal.etsi.org

[8] CEPT Report 30, 'The identification of common and minimal (least restrictive) technical conditions for 790 - 862 MHz for the digital dividend in the European Union', 2009, www.ecodocdb.dk

[9] ERC Report 065,' Adjacent band compatibility between UMTS and other services in the 2 GHz band', www.ecodocdb.dk

[10] ITU-R Report M.2039, 'Characteristics of terrestrial IMT-2000 systems for frequency sharing/interference analyses', www.itu.int

[11] ITU-R Recommendation M.1457, 'Detailed specifications of the radio interfaces of International Mobile Telecommunications-2000 (IMT-2000)', www.itu.int

[12] ETSI EN 301 908-1, 'Electromagnetic compatibility and Radio spectrum Matters (ERM);Base Stations (BS), Repeaters and User Equipment (UE) for IMT-2000 Third-Generation cellular networks; Part 1: Harmonized EN for IMT-2000, introduction and common requirements, covering essential requirements of article 3.2 of the R&TTE Directive', http://portal.etsi.org

[13] ETSI EN 301 908-2, 'Electromagnetic compatibility and Radio spectrum Matters (ERM);Base Stations (BS), Repeaters and User Equipment (UE) for IMT-2000 Third-Generation cellular networks; Part 2: Harmonized EN for IMT-2000, CDMA Direct Spread (UTRA FDD) (UE) covering essential requirements of article 3.2 of the R&TTE Directive', http://portal.etsi.org

[14] ETSI EN 301 908-3, 'Electromagnetic compatibility and Radio spectrum Matters (ERM);Base Stations (BS), Repeaters and User Equipment (UE) for IMT-2000 Third-Generation cellular networks; Part 3: Harmonized EN for IMT-2000, CDMA Direct Spread (UTRA FDD) (BS) covering essential requirements of article 3.2 of the R&TTE Directive', http://portal.etsi.org

[15] ETSI EN 301 908-11, 'Electromagnetic compatibility and Radio spectrum Matters (ERM);Base Stations (BS), Repeaters and User Equipment (UE) for IMT-2000 Third-Generation cellular networks; Part 11: Harmonized EN for IMT-2000, CDMA Direct Spread (UTRA FDD) (Repeaters) covering essential requirements of article 3.2 of the R&TTE Directive', http://portal.etsi.org

[16] ERC Report 064, 'Frequency sharing between UMTS and existing fixed services', 2001, www.ecodocdb.dk

[17] ECC/DEC/(06)09 of 1 December 2006 amended 5 September 2007 on the designation of the bands 1980-2010 MHz and 2170-2200 MHz for use by systems in the Mobile-Satellite Service including those supplemented by a Complementary Ground Component (CGC) , www.ecodocdb.dk

[18] ETSI/3GPP TS 25.101, 'Universal Mobile Telecommunications System (UMTS); User Equipment (UE) radio transmission and reception (FDD) (3GPP TS 25.101 version 8.8.0 Release 8)', http://portal.etsi.org

[19] ETSI TS 36.104, 'LTE; Evolved Universal Terrestrial Radio Access (E-UTRA); Base Station (BS) radio transmission and reception (3GPP TS 36.104 version 9.1.0 Release 9)', Oct 2009, http://portal.etsi.org

[20] ERC/REC/(01)01, 'Border coordination of UMTS', www.ecodocdb.dk

[21] Directive 99/5/EC of the European Parliament and of the Council on radio equipment and telecommunications terminal equipment and the mutual recognition of their conformity (RTTE Directive)

[22] RSPG, *Opinion on Wireless Access Policy for Electronic Communications Services*, RSPG05-102final, Brussels, Belgium, Nov. 2005.

[23] EC Decision 2009/766 on the harmonisation of the 900 MHz and 1800 MHz frequency bands for terrestrial systems capable of providing pan-European electronic communications services in the Community'

[24] EC Directive 2009/114 of the European Parliament and of the Council of 16 September 2009 amending Council Directive 87/372/EEC on the frequency bands to be reserved for the coordinated introduction of public pan-European cellular digital land-based mobile communications in the Community

[25] ERC/REC 74-01, 'Unwanted Emissions in the Spurious Domain', www.ecodocdb.dk

[26] ETSI EN 300 175-2, 'Digital Enhanced Cordless Telecommunications (DECT); Common Interface (CI); Part 2: Physical Layer', http://portal.etsi.org

[27] 3GPP TS 25.102, 'Universal Mobile Telecommunications System (UMTS);User Equipment (UE) radio transmission and reception (TDD)(3GPP TS 25.102 version 7.8.0 Release 7)' http://portal.etsi.org

[28] ECC/DEC/(05)05 of 18 March 2005 on harmonised utilisation of spectrum for IMT-2000/UMTS systems operating within the band 2500-2690 MHz, www.ecodocdb.dk

[29] EC Decision 2008/411/EC on the harmonisation of the 3400 - 3800 MHz frequency band for terrestrial systems capable of providing electronic communications services in the Community

[30] ECC/DEC/(07)02 of 30 March 2007 on availability of frequency bands between 3400-3800 MHz for the harmonised implementation of Broadband Wireless Access systems (BWA), www.ecodocdb.dk

[31] ECC/REC/(04)05, 'Guidelines for accommodation and assignment of Multipoint Fixed Wireless systems in frequency bands 3.4-3-6 GHz and 3.6-3-8 GHz', www.ecodocdb.dk

[32] EC Decision 2008/477/EC on the harmonisation of the 2 500-2 690 MHz frequency band for terrestrial systems capable of providing electronic communications services in the Community

[33] ETSI EN 301 908-13, 'Electromagnetic compatibility and Radio spectrum Matters (ERM);Base Stations (BS), Repeaters and User Equipment (UE) for IMT-2000 Third-Generation cellular networks; Part 13: Harmonized EN for IMT-2000, Evolved Universal Terrestrial Radio Access (E-UTRA) (UE) covering the essential requirements of article 3.2 of the R&TTE Directive', http://portal.etsi.org

[34] ECC Report 119,'Coexistence between mobile systems in the 2.6 GHz frequency band at the FDD/TDD boundary', www.ecodocdb.dk