CEPT Report 31

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

"Technical considerations regarding harmonisation options
for the digital dividend in the European Union"

"Frequency (channelling) arrangements for the 790-862 MHz band"
(Task 2 of the 2nd Mandate to CEPT on the digital dividend)

Final Report on 30 October 2009 by the

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

0 EXECUTIVE SUMMARY

WRC-07 allocated on a primary basis the 790 – 862 MHz band to mobile services throughout Region 1 as from 17 June 2015, and in some CEPT countries it is possible to utilise this band for mobile services before 2015, in accordance with the provisions of the Radio Regulations.

This CEPT Report provides information in response to Task 2 of the Mandate. The Report describes necessary technical conditions for the use of the band 790-862 MHz and benefits and risks of different options.

CEPT has developed one preferred harmonised frequency arrangement based on the FDD mode (section 0.1), but for Administrations that might wish to deviate from the preferred harmonised frequency arrangement some approaches to meet specific national circumstances and market demand are described in section 0.2.

The attached ECC Decision (ECC/DEC/(09)03) contains all required technical conditions for the harmonised use of the band 790-862 MHz (see Annex 6).

0.1 Preferred Harmonised frequency arrangement for the band 790-862 MHz

To meet the technical conditions defined under Task 1 of the Mandate a frequency separation is needed. Both 1 and 2 MHz are viable options for frequency separation at 790 MHz in the context of Base Station compliance with a regulatory BEM baseline of 0 dBm/(8 MHz), with the 1 MHz option implying larger filters.

There is a trade off between increasing the frequency separation at 790 MHz and reducing the duplex gap. In weighing up this trade off it has been decided that the frequency separation should be 1 MHz and the duplex gap 11 MHz.

It has been concluded that the preferred harmonised frequency arrangement is 2 x 30 MHz with a duplex gap of 11 MHz, based on a block size of 5 MHz, paired and with reverse duplex direction, and a guard band of 1 MHz starting at 790MHz. The FDD downlink starts at 791 MHz and FDD uplink starts at 832 MHz.

790-791	791-796	796-801	801-806	806-811	811-816	816-821	821-832	832-837	837-842	842-847	847-852	852-857	857-862
Guard band	**Downlink**						**Duplex gap**	**Uplink**					
1 MHz	**30 MHz (6 blocks of 5 MHz)**						**11 MHz**	**30 MHz (6 blocks of 5 MHz)**					

0.2 Approaches for individual administrations to meet specific national circumstances and market demand

Administrations which do not wish to use the preferred harmonised frequency arrangement or which do not have the full band 790-862 MHz available (e.g. cases, where an Administration cannot make all channels in the band available because they have already been allocated to other services or are not able to coordinate the use of frequencies with neighboring countries), may consider:

- partial implementation of the preferred harmonised frequency arrangements;
- the introduction of the TDD frequency arrangement in all or part of the frequency band 790 – 862 MHz, based on a block size of 5 MHz starting at 797 MHz;

790-797	797-802	802-807	807-812	812-817	817-822	822-827	827-832	832-837	837-842	842-847	847-852	852-857	857-862
Guard band	Unpaired												
7 MHz	65 MHz (13 blocks of 5 MHz)												

- a mixed introduction of TDD and FDD frequency arrangements;
- implementation of 1 MHz channel raster.

0.3 Use of the Duplex gap in a FDD arrangement or guard band in a TDD arrangement

Several uses could be considered in a FDD plan duplex gap or a TDD plan guard band on a national basis and compatibility studies are required to protect mobile usage (uplink and downlink) before a decision is made.

- Low power applications such as PMSE, especially radio microphones;
- Low power applications ("restricted blocks", taking into account protection of FDD);
- Low power IMT applications;
- Other national systems e.g. Defence systems.

Harmonised identification of a usage of the duplex gap could detract from the flexibility to support full use of the band for either FDD or TDD mobile usage in a technology neutral manner.

The ECC has concluded that studies in CEPT should assume the use of wireless microphones noting that the resulting technical framework might also be used by other applications.

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1 INTRODUCTION

The European Commission issued the second mandate to CEPT on technical considerations regarding harmonisation options for the digital dividend in the European Union. CEPT is mandated to carry out the technical investigations to define the technical conditions applicable for the sub-band 790-862 MHz optimised for, but not limited to, Fixed/Mobile Communications Networks (two-way).

The mandate comprises the following elements for study in the band 790 - 862 MHz:

(1) The identification of common and minimal (least restrictive) technical conditions. These conditions should be sufficient to avoid interference and facilitate cross-border coordination noting that certain frequencies used for mobile multimedia networks may be used primarily for mobile (downlink) in one country and broadcasting networks in another country until further convergence takes place. '

(2) The development of the most appropriate channelling arrangement: in addition to (1), the CEPT is requested to develop channelling arrangements that are sufficiently precise for the development of EU-wide equipment, but at the same time allow Member States to adapt these to national circumstances and market demand. The overall aim of a coordinated European approach should be considered, implemented through detailed national decisions on frequency rearrangements, while complying with the GE-06 framework.

(3) A recommendation on the best approach to ensure the continuation of existing Programme Making and Special Events (PMSE) services operating in the broadcasting band, including the assessment of the advantage of an EU-level approach as well as an outline of such an EU-level solution if appropriate.

This Report deals with the reply to the task 2 of the mandate.

2 CONSIDERATIONS ON FREQUENCY ARRANGEMENTS

2.1 Principles for the development of the frequency arrangement

To achieve a harmonised solution while maintaining the required flexibility for administrations regarding the non-mandatory introduction of mobile communication applications in these bands, the following principles have been applied:

1) Common frequency arrangements have been defined, to the greatest extent possible, to facilitate roaming, border coordination and to achieve economies of scale for equipment, whilst maintaining the flexibility to adapt to national circumstances and market demand;

2) All duplex methods TDD, FDD full duplex (FDD-FD) and FDD half duplex (FDD-HD) have been initially considered with the aim to define a solution to accommodate spectrum for operators who would wish to use different technologies, while paying due attention to coexistence issues and spectrum efficiency;

3) The time frame for availability of the band for mobile/fixed communications networks and future technology evolution has been taken into account to define location and size of the duplex gap.

4) Careful consideration has been given to the block sizes for the band plans.

5) Recognizing the advantage of a single harmonised frequency arrangement, the preferred frequency arrangement is based on FDD. TDD and other approaches can be used on a national basis.

6) The trade off between increasing the frequency separation at 790 MHz and reducing the duplex gap has been carefully studied. In weighing up this trade off it has been decided that the frequency separation should be 1 MHz and the duplex gap 11 MHz.

7) The implementation of the frequency arrangement by national administrations will require coordination with any other administration whose broadcasting service and/or other primary terrestrial

services are considered to be affected. For broadcasting, the coordination procedure would be pursuant to the GE-06 agreement.

2.2 Duplex Direction

In the conventional FDD terrestrial mobile systems, the mobile terminal transmits at the lower frequencies and the base station at the higher frequencies. This is because the system performance is generally constrained by the uplink link budget due to the limited transmit power of terminals. However, the compatibility studies between Mobile/Fixed Communications Networks and digital broadcast systems suggest that the reversed duplex direction results in better spectrum efficiency by minimising guard bands. Moreover, as the path loss difference between the highest frequency 862 MHz and the frequency 798 MHz is only about 0.6 dB (assuming free space propagation), the reversal of the duplex direction will not impact greatly the uplink coverage.

Therefore, it is proposed that the duplex direction for fixed/mobile applications in the 790 -862 MHz should be reversed, i.e. the uplink should be at the top of the harmonized sub-band.

2.3 Compatibility in adjacent band between Broadcasting and Mobile

Coexistence between broadcasting and mobile downlink

CEPT Report 21 has considered the operation of low power dense networks in channels adjacent to DVB-T and concluded that “co-existence of IMT/UMTS downlink with DVB-T fixed reception will require the application of the same available mitigation techniques and careful network planning as in the case of interference from downlink “cellular / low-power transmitter” networks and “larger coverage / high power/tower” type of networks”.

CEPT Report 21 only considered the worst-case situation of fixed DVB-T reception since, for coexistence, “a key issue is the large difference in field strength requirements between a DVB-T service and an interfering mobile multimedia application” so that “the potential interference is highly dependent on the DVB-T wanted signal level, thus it is mostly significant for fixed reception (i.e., RPC-1)”.

CEPT Report 22 concluded that “even without guard bands, the risk of adjacent channel interference (downlink) exists only in close vicinity of the interfering mobile/fixed base station, located within the broadcasting coverage area. Generally speaking, in order to avoid/minimize interference from IMT downlink into DVB-T reception some mitigation techniques as described in CEPT Report 21 can be applied together with careful planning of transmitter sites where the channel adjacent to the mobile/fixed downlink transmission is used for broadcasting. Where suitable and efficient mitigation techniques are not applicable, a guard band may be required for the DVB-T protection from fixed/mobile downlink paths”.

Coexistence between Broadcasting and mobile uplink

CEPT Report 23 concluded that “guard band widths to protect DVB-T fixed reception from IMT uplink interference on an adjacent channel, as suggested by studies using SEAMCAT simulation tool, are around 8 MHz. All studies took into account the specified emission mask of UMTS terminals and the protection ratio (specified or measured depending on the study). Even with 8 MHz guard band, the interference probability would be about 1% to 1.4 % based on Monte-Carlo simulations”. Concerns have been expressed about the protection of the DVB-T portable reception from a UMTS Mobile terminal located at few meters from the portable receiving antenna in domestic environment. Additional measurements have been carried out to assist administrations in determining the precise situation in terms of compatibility.

Measures to meet the technical conditions under Task 1 of the mandate

The table below shows the base station BEM out-of-block EIRP limits which have been defined under Task 1 of the mandate.

Case	Frequency range of out-of-block emissions	Condition on base station in-block E.I.R.P., P (dBm/10MHz)	Maximum mean out-of-block EIRP	Measurement bandwidth
A	For DTT frequencies where broadcasting is protected	P ≥ 59	0 dBm	8 MHz
		36 ≤ P < 59	(P-59) dBm	8 MHz
		P < 36	- 23 dBm	8 MHz
B	For DTT frequencies where broadcasting is subject to an intermediate level of protection	P ≥ 59	10 dBm	8 MHz
		36≤ P < 59	(P-49) dBm	8 MHz
		P < 36	-13 dBm	8 MHz
C	For DTT frequencies where broadcasting is not protected	No condition	22 dBm	8 MHz

Table 1: Baseline requirements – BS BEM out-of-block EIRP limits over frequencies occupied by broadcasting

To meet these limits a frequency separation is required at 790 MHz to allow extra base stations filtering. There is a trade off between having a frequency separation at 790 MHz to allow extra base stations filtering and having a smaller duplex gap (down to 10 MHz) in a terminal. The size of the duplex gap is described in the following section. This section describes the frequency separation required at 790 MHz.

Figure 1 illustrates the relationship between the BEM baseline limit, the spectrum emission mask (SEM) of Mobile/Fixed Communication Network BSs, and the requirement for a guard band at the 790 MHz boundary.

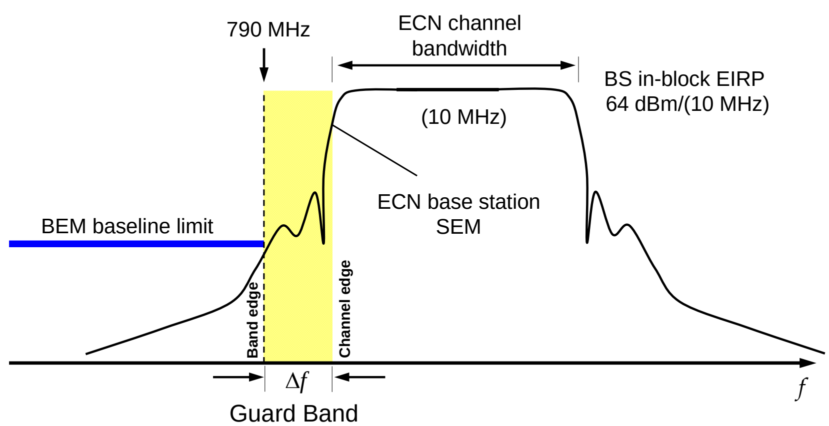

Figure 1: BEM and SEM

It is evident from Figure 1, that additional filtering and/or a guard band (i.e., frequency separation between Mobile/Fixed Communication Network channel edge and DTT band edge) are necessary if the specified BEM baseline limit is more stringent (lower) than the value of the Mobile/Fixed Communications Network BS SEM at the Mobile/Fixed Communications Network channel edge.

This is indeed the case in the 800 MHz band, where the proposed BEM baseline limit of

0 dBm/(8 MHz) is effectively 27 dB more stringent[1] than the LTE BS (10 MHz) SEM EIRP of +8 dBm/(100 kHz) at the LTE channel edge (15 dBi antenna gain including cable loss).

It is assumed that the LTE (10 MHz) SEM is already achieved through the BS drive circuits & power amplification, resulting in an EIRP level of +8dBm/(100 kHz) at the LTE channel edge. Additional RF filtering with sufficient attenuation would then be required to reduce the emissions from +8dBm/(100 kHz) down to the appropriate regulatory BEM baseline limit. Metallic cavity filters (also called combline filters) were considered.

One study on the characteristics of band pass filters for base stations indicates the following:

1) For a 0 MHz guard band at 790 MHz, BS compliance with the proposed BEM baseline of 0 dBm/(8 MHz) would result in a significant insertion loss at the LTE channel edge. This would implicitly imply the existence of an *internal* guard band of between 1 to 2 MHz within the lowest-frequency LTE (10 MHz) channel.

   One can therefore conclude that a 0 MHz guard band for the FDD band-plan is not a realistic option for consideration since it merely <u>internalises</u> the guard band needed to accommodate the required filter roll-off.

2) This study showed that for a 1 or 2 MHz guard band at 790 MHz, BS compliance with the proposed BEM baseline of 0 dBm/(8 MHz) can be achieved with a filter insertion loss of 1 dB or less at the LTE channel edge.

   The size (volume) of a filter for a 1 MHz guard band would be roughly twice that of a filter for a 2 MHz guard band. This may have implications in terms of housing the filters in BS equipment.

The study has only considered the case of a 10 MHz bandpass filter in series with 2x30 MHz duplex filter. Other implementations (such as a 2x10 MHz duplex filter or a band reject filter) may be possible.

In summary the study carried out shows that both 1 and 2 MHz are viable options for guard-band sizes at 790 MHz in the context of BS compliance with a regulatory BEM baseline of 0 dBm/(8 MHz), with the 1 MHz option implying larger filters.

Conclusions for the 790 MHz boundary

For FDD

To meet the technical conditions defined under Task 1 of the Mandate a frequency separation is needed. Both 1 and 2 MHz are viable options for frequency separation at 790 MHz in the context of Base Station compliance with a regulatory BEM baseline of 0 dBm/(8 MHz), with the 1 MHz option implying larger filters.

There is a trade off between increasing the frequency separation at 790 MHz and reducing the duplex gap. In weighing up this trade off it has been decided that the frequency separation should be 1 MHz and the duplex gap 11 MHz.

For TDD

For the TDD scenario, the frequency arrangement assumes a minimum guard band for the protection of broadcasting from the mobile uplink of 7 MHz. TDD arrangements can generally incorporate additional guard spectrum by taking out individual channels from the plan. Since TDD does not rely on a frequency pairing, the loss of one or more channels at one end does not affect the operation of the band and can be done on a national basis without requiring country-specific terminals. For example, removing a single TDD channel from the lower end of the band will increase the guard band to 12 MHz. CEPT Report 30 contains analysis of the TDD guard band considerations for fixed or portable DTT reception.

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[1] This should not be surprising, given that the LTE BS SEM is specified for the protection of adjacent-channel LTE TSs, while the BS BEM baseline is specified for the protection of the more susceptible adjacent-channel DTT receivers.

2.4 Size of Duplex Gap

The Duplex gap is related to full and half duplex FDD duplexing methods (FDD-FD and FDD-HD), therefore TDD is not addressed in this section. The conclusions in CEPT Report 23 indicate that the centre gap of the FDD frequency arrangement should not be less than 10 MHz.

The size of the duplex gap is subject to the following technical constraints:

- self-desensitization for FDD-FD terminals (does not apply to FDD-HD terminals),
- terminal to terminal interference, which applies to both FDD-FD and FDD-HD terminals,
- terminal front end performance.

These technical constraints are analysed in the following paragraphs based on current and expected future best filter and duplexer performance.

It is important that the addition of an extra band does not cause an undue increase in the cost of terminals. The addition of the 790-862 MHz band will impact on several components in the terminal, but only one is significantly influenced by the bandplan – the duplexer.

There are four main factors that influence the complexity of the duplexer:

1) The bandwidth of the filter, as a percentage of centre frequency (lower is easier);
2) The width of the gap between uplink and downlink, as a percentage of centre frequency (higher is easier);
3) The duplex direction (for some filter architectures, the reversed duplex direction is more difficult);
4) The technology – a filter for LTE or other OFDMA technologies is slightly more complex than one for WCDMA in the same band, because the frequency response needs to be flatter close to the band edges.

For 10 MHz LTE with 12 MHz centre gap, the bandwidth and duplex gap are less stringent than for UMTS900, for which duplex filters are already widely available, and the duplexer is likely to be about as complex as for UMTS900 after duplex reversal and technology requirements are taken into account.

For 10 MHz LTE with 10 MHz centre gap, the duplexer is likely to be more complex than for UMTS900. This is close to the limits of current technology, at least for the SAW technology that is presently used by the majority of duplexer vendors.

In addition to basic technical limitations for terminal implementation due to the narrow duplex gap, there are time-to-market considerations in the development of components like duplex filters. The narrower the duplex gap, the longer it will take duplexer manufacturers to develop components for the 790-862 MHz bandplan, and therefore the longer it will take to establish a competitive market for these components.

It is important that duplex filters are feasible:

- In a timescale consistent with the expected deployment in the first countries to assign digital dividend spectrum;
- Using the technologies presently used for terminal duplexers;
- Having a performance that does not significantly impair the overall system performance (for the expected network deployments in this band).

Self-desensitization

Receiver desensitisation is the result of out-of-band emissions from an FDD transmitter falling in its own receive channel. It is a significant factor for the 790-862 MHz band, because of the small separation between transmit and receive channels.

Self-desensitization corresponds to the interference from a terminal TX chain to its own RX chain and does not occur in FDD-HD terminals which do not transmit and receive at the same time. Self-desensitization can occur due to spectrum regrowth (i.e. power leakage in adjacent band due to PA non-linearity) and PA noise.

Spectrum regrowth is not directly linked to duplex gap as it is mainly influenced by channel width and duplex spacing. As such, it will be addressed in section 2.7.

Assuming spectrum regrowth requirements are fulfilled, the RX may still receive interference from the PA noise coming from the TX branch. Current PAs have an output noise level around -135 dBm/Hz, i.e. -68dBm/5MHz.

Therefore, based on the maximum acceptable interference levels given in Annex 3, the duplexer requirement for TX to RX isolation is 40dB for 0.4dB desensitization and 45dB for 0.1dB desensitization. This is in line with current design in other bands where 45dB TX to RX isolation over the DL band is usually the desired target of RF designers.

Terminal to terminal interference

Terminals receiving information (downlink) can receive interference from other terminals transmitting (uplink) in close proximity. ETSI Harmonized standards and 3GPP specifications impose a maximum emission level for terminals on the FDD downlink band, in order to avoid terminal to terminal interference which can depend upon operational scenario assumptions.

The 3GPP specifies maximum power levels in the downlink band to avoid terminal to terminal interference. These interference levels are specified at the antenna connector for several reasons including ease of testing of the devices. As such, these levels are derived to inherently protect other mobiles, taking into account several 3GPP hypotheses including hypotheses on terminal to terminal path loss, terminal density and terminal usage (3GPP 25.942). It should be noted that other assumptions may lead to other levels and other technologies may not be submitted to these levels. However, 3GPP compliant equipment would have to respect these levels.

For example, the 3GPP UMTS specifications (3GPP TS25.101) require that a maximum of -60dBm/3.84 MHz (equivalent to –66dBm/MHz) should be transmitted in the downlink band by a terminal. This specification results in a TX to Antenna isolation requirement for the filter/duplexer. The difficulty to achieve this mark is linked both to the channel bandwidth and to the duplex gap.

For example the LTE Out-of-Block emission requirements (3GPP36.101) are presented in the following Table.

ΔfOOB (MHz)	**5 MHz**	**10 MHz**	**15 MHz**	**20 MHz**	**Measurement bandwidth**
□ 0-1	-15 dBm	-18 dBm	-20 dBm	-21 dBm	30 kHz
□ 1-2.5	-10 dBm	-10 dBm	-10 dBm	-10 dBm	1 MHz
□ 2.5-5	-10 dBm	-10 dBm	-10 dBm	-10 dBm	1 MHz
□ 5-6	-13 dBm	-13 dBm	-13 dBm	-13 dBm	1 MHz
□ 6-10	-25 dBm	-13 dBm	-13 dBm	-13 dBm	1 MHz
□ 10-15	-30 dBm	-25 dBm	-13 dBm	-13 dBm	1 MHz
□ 15-20	-30 dBm	-30 dBm	-25 dBm	-13 dBm	1 MHz
□ 20-25	-30 dBm	-30 dBm	-30 dBm	-25 dBm	1 MHz
□ 25-band limit	-30 dBm	-30 dBm	-30 dBm	-30 dBm	1 MHz

Table 2: LTE Out-of-Block emission requirements

Depending on the channel bandwidth and on the size of the duplex gap, a specific filtering requirement will be induced for TX to Antenna isolation over the downlink band. For example, considering a 5 MHz bandwidth system and a 12 MHz duplex gap, the terminal will emit prior to filtering -30dBm/MHz in the DL band, requiring 36dB of TX to antenna isolation by the filter/duplexer to achieve the 3GPP UMTS specified –66dBm/MHz level.

Terminal front-end performance

The size of the duplex gap for FDD-FD and FDD-HD is also related to the selectivity of the receivers. Further studies are required to estimate the impact of terminal receiver front end performance on the size of the duplex gap.

Duplex gap conclusions

The conclusions in CEPT Report 23 indicate that the centre gap of the FDD frequency arrangement should not be less than 10 MHz. The analysis in this section confirms this conclusion and furthermore concludes that a 12 MHz gap would ease the implementation.

Taking into account requirements on self-desensitization and terminal to terminal interference as well as current performance of duplexing filters, the duplex gap should not be less than 10 MHz for FDD systems.

Specifically, when considering 5 MHz channel bandwidth systems, a duplexer for 2x 30 MHz for LTE in the 790-862 MHz frequency range and 10 MHz duplex gap is a slightly less stringent requirement than 2 x 35 MHz and 10 MHz duplex gap for LTE in the 900 MHz band. An 8 MHz duplex gap would be significantly more complex, perhaps impossible (because this reduces the frequency range for the filter to roll off from 7 MHz to 5 MHz, see Annex 3). A 12 MHz duplex gap for LTE would have comparable complexity to UMTS 900 duplexer.

Requirements for FDD-HD systems are based on terminal to terminal interference requirements. A duplex gap less than 10 MHz is likely to result in terminal to terminal interference. The amount of acceptable terminal to terminal interference should be carefully studied.

Finally, the size of the duplex gap for both FDD-FD and FDD-HD systems is related to channel bandwidth, as filtering requirements will increase with increasing channel bandwidth. This will be further addressed in the next section.

There is a trade off between increasing the frequency separation at 790 MHz and reducing the duplex gap. In weighing up this trade off it has been decided that the frequency separation should be 1 MHz and the duplex gap 11 MHz.

2.5 Block size

From the point of view of cross border coordination between broadcasting and mobile usage, the use of a block size of 8 MHz instead of 5 MHz could reduce the number of channels involved in each coordination. This would, however, require alignment of the channels. Such alignment would be difficult to achieve, in an efficient way, with the centre gap still being at least 10 MHz. The frequency arrangement which could be used for mobile system such as LTE should be defined by standardization bodies. With current LTE standard, a block of 8 MHz could be used for 2 channels, one of 5 MHz and one of 3 MHz (as specified by 3GPP), but the possibility to have 3.75 MHz and 7.5 MHz channels bandwidth may also be considered.

From an industry perspective, all of the mobile technologies that are likely to be deployed in the UHF band are designed to operate in block sizes of 5 MHz, paired as implemented in Europe in licensing regimes for the 2 GHz and 2.6 GHz bands. The terminals that will operate in the UHF band will also need to support these other bands. The block size for the UHF band should therefore also be 5 MHz.

Irrespective of duplexing mode, the current technologies are typically based on 5 MHz block size, and Mobile/Fixed Communications Networks operating in the UHF band are likely to use the same basis. Technologies like LTE, Mobile-WiMAX and their enhancements are, or are intended to be, developed using channel bandwidths of 5 MHz, 10 MHz, 15 MHz or 20 MHz, or even channel bandwidth well beyond 20 MHz, while offering scalability. All expected technologies could support an 8 MHz channel, but such requirement would significantly impact the duration of the product development process. Most importantly, 8 MHz blocks aligned on GE-06 blocks directly lead to a duplex gap of 8 or 24 MHz; neither option is desirable as 8 MHz is below the required duplex gap and 24 MHz is much larger than required, and therefore spectrally inefficient.

Therefore, using a channel bandwidth of 8 MHz may not allow the optimum use of the most up to date mobile technologies in these 72 MHz. If a centre gap between 8 and 24 MHz is used then an 8 MHz block raster wouldn't be aligned with the 8 MHz blocks for the broadcasting service. In that case the complexity of cross border coordination would be similar for 5 MHz and 8 MHz blocks.

Having a block size of 5 MHz does not preclude smaller bandwidth systems being deployed within a block. For example three carriers based on 1.4 MHz bandwidths could be deployed within a 5 MHz block.

For FDD, there is a relationship between channel width and uplink/downlink separation. The out of band terminal emissions are dominated by the so-called spectrum regrowth. Spectrum regrowth is generated by intermodulation due to non-linearity of the PA. The 3rd order spectrum regrowth dominates the out of band emission in the first adjacent channel (ACLR1 requirements), the 5th spectrum regrowth dominates the out of band emission in the second adjacent channel (ACLR2 requirements), the 7th spectrum regrowth dominates the out of band emission in the third adjacent channel (ACLR3 requirements) and so on. The approximate ACLRs corresponding to spectrum regrowth are presented in the following table.

ACLR1	ACLR2	ACLR3	ACLR4	ACLR5	ACLR6
38 dBc	53 dBc	67 dBc	73 dBc	88 dBc	103 dBc

Table 3: Approximate ACLRs

Spectrum regrowth requirements are generally derived by ensuring that ACLR falls below PA noise level in the desired RX channel. Assuming -68dBm/5MHz PA noise power and a 23dBm TX power, the simulations of OFDM spectrum regrowth demonstrate that the 13th order regrowth (ACLR6) is the first regrowth below the PA noise floor (23-103<-68dBm).

Therefore duplex spacing and duplex gap need to be wide enough to ensure that the desired RX channel is further away than the 5th adjacent channel. This corresponds to a duplex spacing of at least 30 MHz with 5 MHz channel bandwidth, 48 MHz with 8 MHz channel bandwidth and 60 MHz with 10 MHz channel bandwidth. Provided that the Mobile/Fixed Communications Network's resource management allows different resource allocations on the uplink and downlink, the 41 MHz duplex spacing in this band does not necessarily impose a constraint on the use of wide bandwidth channels. Individual terminals can use a reduced set of uplink resource blocks, if required, to mitigate the effects of spectrum regrowth, while still receiving over the full downlink channel bandwidth; across the cell as a whole, the Mobile/Fixed Communications Network would be using the full bandwidth of both the uplink and downlink channels.

Block size conclusions

It has been concluded that for FDD and TDD the block size should be 5 MHz. This does not preclude smaller bandwidth systems being deployed within a block.

2.6 Use of a Duplex gap in a FDD arrangement or guard band in a TDD arrangement

Several uses could be considered in a FDD plan duplex gap or a TDD plan guard band on a national basis. CEPT Report 30 includes compatibility studies to protect mobile usage (uplink and downlink). Examples of some uses that could be considered are:

- Low power applications such as PMSE, (especially radio microphones);
- Low power applications ("restricted blocks", taking into account protection of FDD);
- Low power IMT applications;
- Other national systems e.g. Defence systems.

Harmonised identification of a usage of the duplex gap could detract from the flexibility to support full use of the band for either FDD or TDD mobile usage in a technology neutral manner.

The ECC has concluded that studies in CEPT should assume the use of wireless microphones noting that the resulting technical framework might also be used by other applications.

2.7 Use of Band outside CEPT

A common CEPT frequency arrangement should preferably be also suitable for countries outside CEPT, mainly in Africa and the Middle East, where 790 – 862 MHz is also identified for IMT and available for new mobile networks. The following Figure shows the allocations globally following the decisions at WRC-07. As can be seen from the Figure, it would not be possible to have a common arrangement globally.

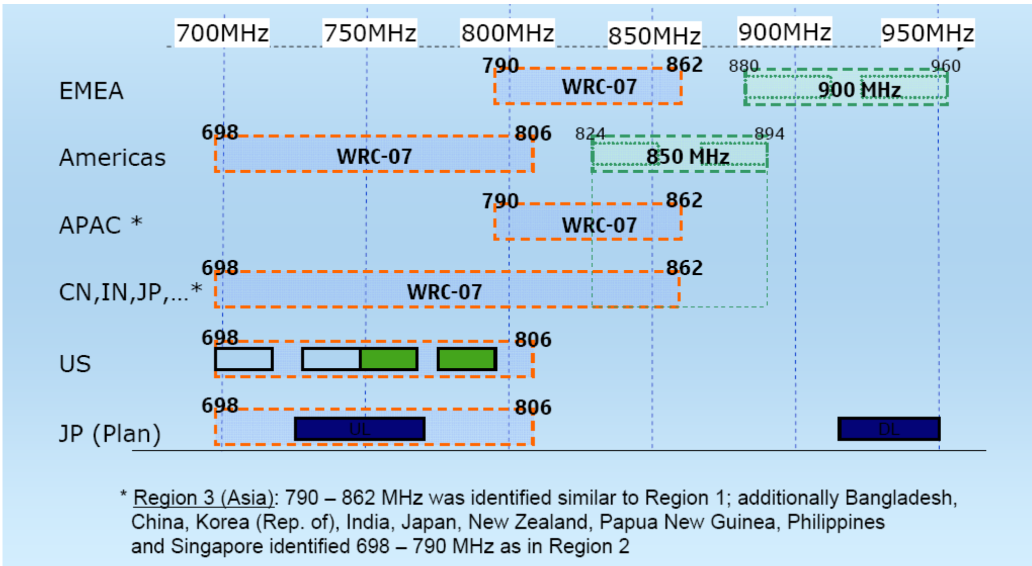

Figure 2: Use of 790 – 862 MHz globally

2.8 The GE-06 framework and cross border co-ordination

The second mandate to CEPT states that "The overall aim of a coordinated European approach should be considered, implemented through detailed national decisions on frequency rearrangements, while complying with the GE-06 framework. "

Current provisions in GE-06 Agreement require an administration wishing to implement mobile services to obtain prior agreement from the administration whose current and future broadcasting service may be affected by interference caused by the mobile service, but also by constraints which may arise from the need to protect the mobile service from interference caused by its current and future broadcasting services.

The GE-06 framework is addressed in CEPT Report 21, CEPT Report 22 and CEPT Report 29. Furthermore CEPT is developing a Report/Recommendation on rearrangement for broadcasting services in order to free the sub-band 790-862 MHz.

CEPT Report 21 states:

> "Flexibility is an integral part of GE-06. In other words, the Plan does permit assigned frequencies (digital entries) to be used for implementing broadcasting services with different characteristics or other applications, provided the interference and the protection requirements are kept within the envelope of the corresponding entry in the Plan. An administration can modify its entries in the Plan by applying the provisions of Article 4 of the GE-06 Agreement.
>
> The GE-06 Plan does permit assigned frequencies (digital entries) to be used for other services under the spectrum mask concept as long as they are notified under the envelope of broadcasting assignment and do not require more protection or cause more interference than is allowed according to the GE-06. Therefore the conclusion is valid that the GE-06 agreement already allows the introduction of mobile

multimedia applications. It is assumed that spectrum harmonised for these application will improve their introduction"

CEPT Report 22 states:

> "It should be noted that the level of interference likely to arise from the implementation of GE-06 plan entries makes it virtually impossible for any country to start using a harmonised sub-band for mobile communications applications without the agreement of neighbouring countries, noting that these may not be members of the CEPT or EU/EEC in all cases. Implementation of this harmonised sub-band will therefore require bilateral or multilateral negotiations, under the procedures of the GE-06 Agreement, which have been designed to ensure equitable access to spectrum by all administrations."

CEPT Report 29 "Guideline on cross border coordination issues between mobile services in one country and broadcasting services in another country" addresses cross border co-ordination for the 790 – 862 MHz band. The Report is aimed to help administrations establish a common methodology for coordination in the case where one country at the border wishes to use the band 790-862 MHz for mobile applications while the other country wishes to retain this band for broadcasting applications. It states:

> "CEPT is of the opinion that the GE-06 Agreement provides the necessary regulatory procedures to identify administrations to be involved in the coordination process between broadcasting service in one country and mobile service in another country. The identification is made by means of the coordination trigger field strength.
>
> CEPT further agrees that a detailed coordination methodology including a careful interference assessment may need to be developed by the administrations concerned during bilateral or multilateral discussions using the elements provided in CEPT Report 29 for guidance."

The provisions of GE-06 may not be suitable for cross-border coordination between countries that are members of GE-06 and countries that are outside of this Agreement. Moreover the issue of coordination between mobile service and services other than broadcasting (e.g. ARNS) are not covered in GE-06 and addressed in the studies under the preparation for WRC-12 Agenda Item 1.17.

Advantages of a preferred harmonised frequency arrangement based on FDD

CEPT has considered the benefits and risks of having two options (i.e. FDD and TDD) for frequency arrangement against having a single preferred frequency arrangement and came to the view that the advantages of a single preferred frequency arrangement for this band are:

- reduced development and operating costs for future radio infrastructure or terminal equipment to be used in the 790-862 MHz band by avoiding the fragmentation of the CEPT market in this frequency band that could occur with incompatible frequency arrangements. A CEPT-wide harmonisation focusing on a single frequency plan based on the FDD mode will benefit the industry and consumers,
- increased opportunity and reduced costs for roaming services within CEPT,
- simplified licensing process,
- Market certainty: Industry requires visibility to launch development of radio equipment to be ready on time according to the expectation of the future licensed operators in the 790-962 MHz band.

The appropriate mode (FDD or TDD) should respond to the market requirement. Today, industry is almost unanimously supporting FDD duplex mode in this frequency band.

In addition, it has been shown by CEPT that the protection of base station reception from TV emissions is much more challenging than the protection of terminal reception. Therefore, the TDD frequency arrangement, where base stations are receiving over the whole band, creates much more difficult coordination challenge than FDD in the case where a neighbouring country wishes to continue to use the band for broadcasting.

Therefore, CEPT has developed one preferred harmonised frequency arrangement based on the FDD mode.

3 CONCLUSIONS ON FREQUENCY ARRANGEMENTS

3.1 Preferred Harmonised frequency arrangement for the band 790-862 MHz

The harmonised frequency arrangement is 2 x 30 MHz with a duplex gap of 11 MHz, based on a block size of 5 MHz, paired and with reverse duplex direction, and a guard band of 1 MHz starting at 790 MHz. The FDD downlink starts at 791 MHz and FDD uplink starts at 832 MHz:

790-791	791-796	796-801	801-806	806-811	811-816	816-821	821 - 832	832-837	837-842	842-847	847-852	852-857	857-862
Guard band	Downlink						Duplex gap	Uplink					
1 MHz	30 MHz (6 blocks of 5 MHz)						11 MHz	30 MHz (6 blocks of 5 MHz)					

Figure 3: Preferred Harmonised frequency arrangement for the band 790-862 MHz

3.2 Approaches for individual administrations to meet specific national circumstances and market demand

Administrations might wish to use other arrangements such as TDD or they could consider adaptive approaches such as using the preferred harmonised arrangements as explained in the previous chapter only partly or making use of one of the adaptations to the frequency arrangements in the 790-862 MHz band described in this chapter.

There are some reasons why an administration would need to consider the flexible approaches:

1. Where an Administration cannot make all channels in the band available because they have already been allocated to other services (e.g. digital terrestrial television DTT, ARNS and programme-making and special events PMSE);

2. Where it wishes that channels in the band that can be made available may be used either for two-way services or for one way services such as mobile multimedia;

3. Where it cannot succeed with frequency coordination agreement to have access to the whole sub-band because of the constraint by another radio service in neighbouring countries.

It is noted that an operator has the flexibility to use the frequency block assigned to him providing he is compliant with the conditions to use the spectrum. For example, the operator can take extra measures to meet these technical measures such as adding extra filtering or offsetting from the nominal edge away from the block edge.

Administrations have full sovereignty to implement all or part of this frequency arrangement depending on market demand and on whether all or part of the sub-band is designated nationally for mobile services as well as taking into account compatibility with other services.

It is important to consider whether there will be any terminals available based on national band plans. Administrations wishing to use a frequency arrangement different from the CEPT-wide harmonised band plan will have to assess the cost and benefits of using a non harmonised band plan and the willingness of industry to design equipment based on national circumstances.

An analysis undertaken by the GSMA[2] shows the cost penalty in adopting a national approach:

- Having fragmented national bands for mobile will have a significant impact on handset costs, perhaps driving them up by 50% or more (depending on market size).

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2 http://www.gsmworld.com/documents/gsma_white_tech_note.pdf

- Country specific spectral allocations are intrinsically uneconomic and only a country with a market the size of China, where the annual volume of handsets is 80million, could economically warrant a specific national spectral allocation.

The GSMA analysis concludes that there are significant economies of scale to be achieved in the production of terminals with internationally identified common frequency bands. Without the identification of common bands, handset costs would be prohibitively high, and the effect will be a significant reduction in the take-up of any mobile service. This will harm not only consumers and industry directly, but also the benefits that mobile offers to economies as a vital infrastructure. Therefore, adequate consideration should be given to the European and worldwide situation with regards to the spectrum used for mobile services in order to ensure that this spectrum is available in the largest possible addressable market which would drive costs down.

3.2.1 TDD arrangement

Concerning TDD, the frequency arrangement includes a guard band with broadcasting at the bottom of the sub-band taking into account the issue of interference between broadcasting and uplink mobile service. The use of this guard band is to be considered at a national level.

For the TDD scenario, the frequency arrangement assumes a minimum guard band for the protection of broadcasting from the mobile uplink of 7 MHz. TDD arrangements can generally incorporate additional guard spectrum by taking out individual channels from the plan. Since TDD does not rely on a frequency pairing, the loss of one or more channels at one end does not affect the operation of the band and can be done on a national basis without requiring country-specific terminals. For example, removing a single TDD channel from the lower end of the band will increase the guard band to 12 MHz. CEPT Report 30 contains analysis of the TDD guard band considerations for fixed or portable DTT reception.

790-797	797-802	802-807	807-812	812-817	817-822	822-827	827-832	832 – 837	837 – 842	842 – 847	847-852	852-857	857-862
Guard band	**Unpaired**												
7 MHz	**65 MHz (13 blocks of 5 MHz)**												

Figure 4: TDD arrangement

3.2.2 Explanation of the terminology related to "flexibility" and "technology neutrality"

Flexibility
Administrations have full decision power and sovereignty to decide if the 790-862 MHz band would be used for broadcasting or mobile or some other service. This flexibility might be necessary if an Administration cannot relocate all of the services currently using the 790-862 MHz band, or for other national considerations. However, in doing this, the Administration is likely to lose the benefits of a common band plan, which include:

- economies of scale for affordable user equipment,
- wider choice of service providers and manufacturers of consumer devices,
- minimized risk of radio interference,
- maximized total economic value of spectrum,
- facilitating cross-border coordination and global roaming.

Technology neutrality
A regulation is technologically neutral if it neither imposes nor discriminates in favour of the use of a particular type of technology.

The technologies (like e.g. LTE and WiMAX) currently envisaged to be deployed in the 790-862 MHz band support both TDD and FDD modes. A single bandplan for the 790-862 MHz range (either paired FDD or unpaired TDD) would therefore not discriminate in favour of or against one of these currently envisaged technologies. However, there might be some implementation difficulty if multi-band terminals need to support a different duplex method in other bands.

3.2.3 Half-Duplex FDD (FDD-HD)

FDD-HD technology can be accommodated in the same band arrangement as full FDD duplex (FDD-FD) technology.

Half duplex FDD could accommodate different band plans, where transmit and receive bands overlap, different duplex spacings or uplink and downlink blocks falling outside the harmonised band plan as long as FDD-HD terminals do not require a bandpass filter to meet the block edge mask or to avoid receiver overload from broadcast transmitters.

RTT have carried out a study[3] on behalf of the GSMA to consider whether FDD-HD provides a technically and commercially viable and/or attractive solution for the digital dividend spectrum. The study concluded that this is not the case when terminals need to support FDD-FD in other frequency bands and that it is unlikely that terminals supporting FDD-HD in the 790-862 MHz band and FDD-FD in other bands would be produced for the European market.

However, the WiMAX Forum is of the view that when support for FDD-FD in other bands is not needed, there may be time to market advantages for products based on FDD-HD technology.

3.2.4 1MHz/2MHz raster

The possibility for administrations to shift the centre frequency of the block by 1 or 2 MHz, without changing the duplex gap and duplex spacing, might provide an opportunity for an administration which could not implement the whole frequency arrangement to increase the number of paired blocks for FDD.

Figure 5 illustrates how a country that cannot make channels 61, 62 and 69 available for two-way mobile communications could make use of one FDD channel (assuming 5 MHz block size and 12 MHz duplex gap) if the CEPT channel plan allows a 1 MHz or 2 MHz offset from the origin. This scenario maintains the fixed duplex spacing of 42 MHz but a 1 MHz or 2 MHz offset is needed. For the 1 MHz offset there is no guard block between FDD downlink and DTT.

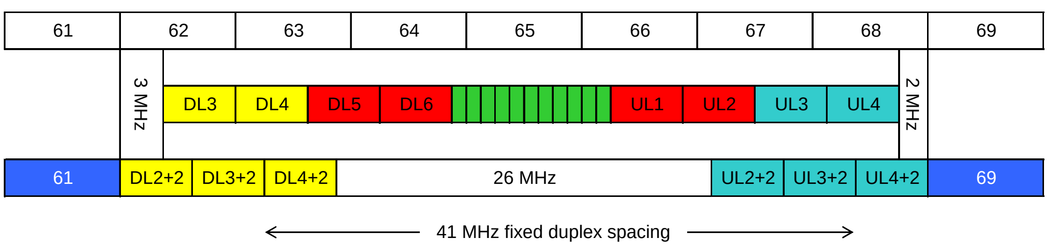

Figure 5: Making available 1 FDD channel by shifting the centre frequency of a block

This flexibility is not expected to incur significant additional cost for terminal implementation since WCDMA terminals in the UMTS core band support a raster of 200 kHz and Mobile WiMAX technology supports a 250 kHz raster. However, this flexibility is barely worthwhile if it can only provide a single paired channel of 2 x 5 MHz. A shift like this will complicate border coordination.

It has to be noted that the possibility to use only one FDD channel corresponds to a poor spectral efficiency given that only 10 MHz of spectrum is effectively used in a chunk of 48 MHz. Other possibility would be to use this available spectrum (48 MHz) for TDD.

3.2.5 Mixing FDD and TDD

Annex 5 compares the spectrum utilisation of mixed FDD/TDD frequency arrangements, compared with a FDD band plan containing only paired blocks and with band plans containing TDD only.

This Annex concludes that:

[3] http://www.rttonline.com/Research/V21 Halfduplexstudyfinaljuly08 .pdf

- In every considered mixed FDD/TDD band plan for the full 790 – 862 MHz band, there is less spectrum available compared with a FDD band plan or a TDD band plan and therefore spectrum is used more efficiently by Mobile/Fixed Communications Networks in a FDD bandplan or a TDD band plan than in the mixed bandplan examples. Additionally, the centre gap of a FDD bandplan and the guard band of a TDD bandplan are wide enough for use by other applications.
- In cases where the full band is not available, it is not efficient to leave FDD channels unused; mixed FDD/TDD arrangements can provide a means to utilise this spectrum.
- For two TDD networks and a 7 MHz[4] guard band at the 790 MHz boundary, the spectrum utilisation is equal to the FDD case, apart from the utilisation of the centre gap.
- For two TDD networks and a 12 MHz guard band, the spectrum utilisation is less than the FDD case but more than the mixed FDD/TDD case.
- For three TDD networks, the spectrum utilisation is comparable to the mixed TDD/FDD case.

The recent studies in CEPT for the 2500 – 2690 MHz band have highlighted some of the constraints in mixing FDD and TDD in close proximity. These would be magnified for the 790-862 MHz band, because the size of the available spectrum is limited and because the band is more important for coverage (i.e. there are likely to be larger cells, and no alternative band for handover if coverage holes are caused by interference). A 5 MHz restricted block was found necessary between TDD and FDD as well as between TDD licences in the 2.6 GHz band. For the likely number of licences in the 790-862 MHz band, this would result in more 'lost' spectrum than the centre gap needed for FDD. It is very unlikely that there will be sufficient spectrum for mobile in the 72 MHz to enable it to be efficiently and effectively used by both TDD and FDD.

It has been concluded that, in order to maximise the spectrum available, these duplex methods should not be mixed within the harmonised band plan. Recognizing the advantage of a preferred harmonised frequency arrangement, the proposed frequency arrangement is based on FDD.

4 CONCLUSIONS

This CEPT Report has considered the frequency arrangements for the 790 – 862 MHz band in response to the second mandate to CEPT on technical considerations regarding harmonisation options for the digital dividend.

CEPT has considered the benefits and risks of having two options (i.e. FDD and TDD) for frequency arrangement against having a single preferred frequency arrangement. CEPT has developed one preferred harmonised frequency arrangement based on the FDD mode.

Administrations might wish to use other arrangements such as TDD or they could consider adaptive approaches such as using the preferred harmonised arrangements only partly or making use of one of the adaptations to the frequency arrangements in the 790-862 MHz band described in section 3.2.

[4] The guard band could be decided on a national basis (see section 2.3). CEPT Report 30 contains analysis of the TDD guard band considerations for fixed or portable DTT reception.

4.1 Glossary of terms

Term	**Explanation**
3GPP	3rd Generation Partnership Project
ACLR1	Adjacent Channel Leakage Ratio – first adjacent channel
ACLRn	Adjacent Channel Leakage Ratio – n^{th} adjacent channel
APAC	Asia-Pacific
ARNS	Aeronautical Radio Navigation System
BAW	Bulk Acoustic Waves
BEM	Block Edge Mask
BS	Base station
CEPT	European Conference of Postal and Telecommunications
CN	China
DL	Downlink
DTT	Digital Terrestrial Television
DVB-T	Digital Video Broadcasting Terrestrial
EIRP	Equivalent Isotropically Radiated Power
EC	European Commission
ECA	European Common Allocation Table
ECC	Electronic Communications Committee
ECC PT1	ECC Project Team 1 on IMT matters
EMEA	Europe, the Middle East and Africa
ERO	European Radiocommunication Office
ETSI	European Telecommunications Standards Institute
EU	European Union
FDD	Frequency Division Duplex
FDD-FD	Full Duplex FDD
FDD-HD	Half Duplex FDD
GE-06	The Geneva 2006 Agreement and Plan
GSMA	GSM-Association
IMT	International Mobile Telecommunications
IN	India
JP	Japan
LTE	Long Term Evolution
OFDM	Orthogonal Frequency Division Multiplex
OFDMA	Orthogonal Frequency Division Multiple Access
OOB	Out of Band (Emissions)
PA	Power Amplifier
PMSE	Programme Making and Special Events
RF	Radio Frequency
RX	Receiver
SAW	Surface Acoustic Waves
SEM	Spectrum Emission Mask
TDD	Time Division Duplex
ECC TG4	ECC Task Group 4 “digital dividend”
TNF	Thermal Noise Floor
TS	Terminal Station
TX	Transmitter
UHF	Ultra High Frequency
UL	Uplink
UMTS	Universal Mobile Telecommunications System
US	United States of America
WCDMA	Wideband Code Division Multiple Access
WiMAX	Worldwide Interoperability for Microwave Access
WRC-07	World Radiocommunication Conference 2007

ANNEX 1: SECOND EC MANDATE TO CEPT ON TECHNICAL CONSIDERATIONS REGARDING HARMONISATION OPTIONS FOR THE DIGITAL DIVIDEND IN THE EUROPEAN UNION

EUROPEAN COMMISSION
Information Society and Media Directorate-General

Electronic Communications Policy
Radio Spectrum Policy

Brussels, 3 April 2008
DG INFSO/B4

ADOPTED

Second mandate to CEPT on technical considerations regarding harmonisation options for the digital dividend in the European Union

This mandate is issued to the CEPT without prejudice to the one-month right of scrutiny by the European Parliament, pursuant to Council Decision 1999/468/EC of 28 June 1999 (OJ L 184, 17.7.1999, p.23) on comitology procedure. This one-month period starts on 5 April 2008.

Purpose

This mandate intends to be **a follow-up** to the initial mandate on the digital dividend[5]. The main objective of this additional work is to ensure the continuation and timely development of the **technical conditions and arrangements** required to pave the way for non-mandatory, non-exclusive coordinated use of the digital dividend in Europe.

This mandate should provide further technical input to the political process ongoing at EU level[6]. The common exploitation of the result of this mandate does not entail the development of a technical implementation measure under the Radio Spectrum Decision. **Any common action will be guided by an eventual EU-level political agreement involving the Council and European Parliament and the work undertaken under this mandate should not prejudge the contents of any future European agreement**.

Justification

Pursuant to Article 4 of the Radio Spectrum Decision[7], the Commission may issue mandates to the CEPT for the development of technical implementing measures with a view to ensuring harmonised conditions for the

5 Mandate to CEPT on technical considerations regarding harmonisation options for the digital dividend, 30 January 2007 (RSCOM06-89).

6 Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions: *Reaping the full benefits of the digital dividend in Europe: a common approach to the use of the spectrum released by the digital switchover*, COM(2007) 700, 13.11.2007.

7 Decision 676/2002/EC of the European Parliament and of the Council of 7 March 2002 on a regulatory framework for radio spectrum policy in the European Community, OJ L 108 of 24.4.2002.

availability and efficient use of radio spectrum. Such mandates shall set the task to be performed and the timetable therefor.
A number of results from related activities justify the need to address an additional EC mandate to CEPT.

CEPT has delivered its final reports to the **WAPECS mandate**[8] and to the **initial digital dividend mandate**[9].

- The findings prepared under the **initial digital dividend mandate** (Report A) discuss two approaches to implement downlinks of mobile multimedia networks in the UHF-bands IV and V:

  - Approach 1: Implementation without a harmonized sub-band, based on the GE06 Plan entries
  - Approach 2: Implementation based on a harmonized sub-band

  It is concluded that for the deployment of mobile multimedia applications Approach 1 minimises the impact on the current status of the GE-06 Plan. Since this plan may evolve continuously through the application of its modification procedure, it is possible for it to evolve towards a harmonised sub-band for mobile multimedia applications, i.e. Approach 2.

- The CEPT Report B and its supplement have retained the upper part of the UHF band allocated to the mobile service at WRC-07 (790-862 MHz) while noting that further work is needed for the development of detailed technical usage conditions, including compatibility studies. It concluded, with a reservation from some administrations, that harmonisation of a sub-band of the UHF band is feasible from a technical, regulatory and administrative point of view provided that it is not made mandatory and any decision about the use of the harmonised sub-band is left to individual administrations within the framework of the GE-06 Agreement.

- For the envisaged sub-band accommodating broadcasting networks as protected by the GE-06 agreement, it is assumed that the GE-06 agreement provides the necessary technical usage condition specifications, and no further work is required under this mandate.

- **The WAPECS Mandate** has developed a mechanism for applying least restrictive technical conditions in specific frequency bands taking into account the most likely use or targeted network type. Concerning the UHF band this mandate confirmed the general feasibility of flexible use, but did not finalise its work on actual least restrictive technical conditions, due to missing basic assumptions that only now have become available through the finalisation of the initial digital dividend mandate.

In addition, WRC-07 allocated on a co-primary basis the upper part of the UHF band (790-862 MHz) to mobile services in Europe as from 2015, and allowed some EU countries to utilise this allocation before 2015, subject to technical coordination with other countries.

The Commission considers that the results of the two mandates mentioned above as well as the outcome of WRC-07 are compatible with the proposals set out in the Commission Communication on the digital dividend. Consequently, the **detailed technical feasibility of these results and proposals** ought to be further examined in a new mandate.

Main EU policy objectives

With this Mandate, the Commission issues guidance to the CEPT to continue developing technical conditions and studies serving policy objectives which the optimisation of the use of the digital dividend at EU level will contribute to, namely:

- strengthen the **Internal Market** dimension for potential mass-market services and equipment which will operate in the UHF band, including for applications related to broadcasting, broadband access, convergent services and "legacy" services such as Programme Making and Special Event (PMSE) applications. For these last applications, alternative common solutions outside the UHF band should be explored where needed;

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[8] Mandate to CEPT to develop least restrictive technical conditions for frequency bands addressed in the context of WAPECS, 5 July 2006

[9] CEPT Reports parts A, B and C in response to the Commission mandate to CEPT on the digital dividend issued on 30 January 2007.

- support the **development of the media sector** by promoting the emergence of new broadcasting and/or converging services taking advantage of the flexibility offered in the GE-06 agreement and by ensuring an appropriate level of protection of existing and innovative media services against interference from other spectrum uses;

- promote increased **broadband access** for all EU citizens as well as new services fostering growth and innovation, thereby supporting the objectives of the Lisbon agenda[10];

- exploit the socio-economic and cultural benefit of the digital dividend to the full by applying enabling a more **flexible use of spectrum**.

Task order and schedule

The Commission Communication has identified three clusters in relation to the digital dividend.
CEPT is mandated to carry out the technical investigations to define the technical conditions applicable for the sub-band 790-862 MHz optimised for, but not limited to, fixed/mobile **communications networks** (two-way). The CEPT is requested to study more specifically:

(1) The identification of common and minimal (least restrictive)[11] technical conditions. These conditions should be sufficient to avoid interference and facilitate cross-border coordination noting that certain frequencies used for mobile multimedia networks may be used primarily for mobile (downlink) in one country and broadcasting networks in another country until further convergence takes place.

(2) The development of the most appropriate channelling arrangement: in addition to (1), the CEPT is requested to develop channelling arrangements that are sufficiently precise for the development of EU-wide equipment, but at the same time allow Member States to adapt these to national circumstances and market demand. The overall aim of a coordinated European approach should be considered, implemented through detailed national decisions on frequency rearrangements, while complying with the GE-06 framework.

(3) A recommendation on the best approach to ensure the continuation of existing Programme Making and Special Events (PMSE) services operating in the broadcasting band, including the assessment of the advantage of an EU-level approach as well as an outline of such an EU-level solution if appropriate.

The Commission may provide CEPT with further guidance on this mandate or issue a new mandate dealing with accommodation of one-way multimedia networks and the impact of national demands for fixed/mobile communications networks that require use of adjacent frequencies below 790-862 MHz on the basis of political agreements with the European Parliament and the Council on the digital dividend, as well as the socio-economic impact assessment it is planning to undertake via an independent study on the digital dividend to be launched in 2008.

The main deliverable for this Mandate will be additional reports, subject to the following delivery dates:

Delivery date	Deliverable
26 Sept. 2008	First progress report for the RSC#25
1 Dec. 2008	For RSC#26: Draft final report on Task (1), Progress report on Tasks (2)
13 March 2009	For RSC#27: Final report on Task (1), Draft final report on Task (2) and

[10] Communication from the Commission to the Council and the European Parliament - Common Actions for Growth and Employment: The Community Lisbon Programme [SEC(2005) 981]. Full text available at: http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CELEX:52005DC0330:EN:NOT

[11] Such as the definition of appropriate BEMs (Block Edge Masks)

	Progress report on Task (3).
June 2009	For RSC#28: Final report on Task (2) and Task (3)

In implementing this mandate, the CEPT shall, where relevant, take the utmost account of Community law applicable and support the principles of technological neutrality, non-discrimination and proportionality insofar as technically possible.

* * *

ANNEX 2: DUPLEX METHODS (FDD FULL DUPLEX, HALF DUPLEX AND TDD)

There are three basic duplex methods to separate uplink and downlink channels in a mobile communications system:

Frequency Division Duplex (full duplex), or FDD-FD

The uplink and downlink are on different frequencies. FDD-FD arrangements are used to provide simultaneous transmission and reception by assigning paired frequencies that are sufficiently well separated. Self-interference in a terminal or base station is limited by the use of a duplex filter (also known as duplexer). In addition to limiting self-interference this arrangement helps facilitate inter operator interference when appropriate planning techniques are used. Inherently FDD is more suitable for coverage provision than TDD in mobile communication application.

Due to filter duplex implementation, FDD-FD need sufficient duplex gap space. The number of duplex filters implemented in a terminal (and therefore the number of frequency arrangements supported) needs to be limited due to the cost and complexity implications for the terminal.

Half Duplex FDD or FDD-HD

This is a combination of TDD and FDD, in which the terminal transmits and receives at different times, and on different frequencies (the base station is usually full duplex, but this need not be the case). A feature of this technique is that the terminal does not require a duplex filter because the terminal does not transmit and receive at the same time. GSM uses FDD-HD.

The size of the duplex gap is not constrained by the need for a duplex filter in terminals and therefore can often be smaller than in FDD-FD. The terminal still uses transmit and receive filters but the roll-off of these filters may not be as stringent as that for duplex filters because there is no need to isolate the terminal receiver from its own transmitter. This potential reduction in complexity of the filters could allow a terminal to operate even if the duplex gap is moved in a particular country as the terminal could support more than one set of filters.

FDD-HD can be used by terminals while the base station uses FDD-FD. This results in little capacity degradation compared to pure FDD-FD systems. Synchronisation requirements between the base station and terminal are normally needed for a number of reasons so there are no additional timing synchronisation requirements.

Time Division Duplex or TDD

In TDD arrangements the transmission and reception are separated in time on the same frequency so spectrum is not paired and a duplex filter is not needed. Interference between operators using adjacent frequencies in the same area needs to be managed by either synchronization techniques or the use of guard bands. Some TDD technologies are considered suitable for short range mobile applications with high capacity capabilities but if the multiple access system has been designed to take account of large cell ranges, TDD is not limited to short range applications only.

ANNEX 3: MAXIMUM ACCEPTABLE INTERFERENCE LEVEL

FDD-FD terminals require RX isolation from TX signal to avoid self-desensitization of the terminal RX during terminal transmission. The following formula:

$$SensitivityDegradation = 10 \cdot \log_{10}(1 + 10^{\frac{I_{rx} - TNF}{10}})$$

where I_{rx} is the interference power at the receiver and TNF is the Terminal Noise Floor.
Since

$$TNF = -174 \ \ dBm / Hz + 10 \cdot \log_{10}(C_{eff} MHz) + NF_{Rx}$$

where NF_{Rx} is the Noise Floor of the receiver and C_{eff} is the effective channel bandwidth. The terminal receiver noise floor, assuming a 5 MHz bandwidth and a 9 dB Noise Figure, can be estimated around -98 dBm. Under a 9 dB Noise Figure assumption, the terminal noise floor would be respectively -95 dBm and -92 dBm for respectively 10 MHz and 20 MHz bandwidth.

Considering a -98 dBm terminal noise floor, the interference level corresponding to a 0.4dB desensitization is I_{rx}= -108dBm, and the interference level corresponding to a 0.1dB desensitization is I_{rx}= -114dBm.

ANNEX 4: DUPLEXER PERFORMANCE

<u>Best current duplexer/filter performance</u>

Duplexers designed for UMTS 900 (WCDMA operating in the 880-915/925-960 MHz band) can be taken as performance requirement benchmark since the UMTS 900 band is very close in frequency and in size to possible band plans considered in this report - 2x35 MHz with a 10 MHz duplex gap. UMTS 900 is considered as a challenging band for duplexers.

A typical UMTS 900 band duplexer achieves 40-45dB TX to RX isolation, although 50dB or more is achievable by at least one manufacturer. This value is provided as the minimum performance, when average over the 3.84 MHz WCDMA bandwidth and would degrade LTE like systems which require specific attenuation at the border of the UL band.

The duplexer isolation together with the PA ACLR of the terminal in it's receive channel must together be sufficient to avoid desensitisation of the receiver. This sets an upper limit on the maximum simultaneous transmission bandwidth for a terminal. The analysis above is for a channel bandwidth of 5 MHz. However, a LTE network can still support a wider channel bandwidth, because several terminals can transmit simultaneously using different resource blocks within the uplink channel. For these wider channel bandwidth, there is no information on the expected degradation of the effective receiver sensitivity.

<u>Parameters relevant to estimation of future filter/duplexer performance</u>
The technologies currently used for filters/duplexers rely on the piezo-electric properties of materials (surface acoustic waves – SAW and bulk acoustic waves - BAW). No other technology is expected in the near-medium term future. Three factors must be taken into account to assess filter/duplexer performance:

- The shape of the filter, as predicted by filter design theory
- Temperature drift.
- Manufacturing tolerance.

Current technology (BAW or SAW) filters/duplexers are subject to temperature drift where their cut-off point drifts with the terminal temperature. The best temperature drift performance expected is around 20ppm/C, which translates into 790,000,000 x 0.00002 = 15.8 kHz/C, i.e. 1.1 MHz temperature drift for a thermal operating range of -20 to 50 Celsius degrees. This means that, when estimating filter/duplexer attenuation over a frequency separation F, the best case roll-off of the filter should be considered over F minus 2 MHz instead of the F to obtain the attenuation achievable by the filter/duplexer.

The minimum manufacturing tolerance for a mass production filter at 800 MHz is around 1 MHz.

ANNEX 5: SPECTRUM UTILISATION OF FDD, TDD AND MIXED FDD/TDD FREQUENCY ARRANGEMENTS

A5.1 Introduction

This annex considers the effectiveness of mixed FDD/TDD frequency arrangements, compared with a reference of an FDD bandplan containing only paired blocks and with band plans containing TDD only.

In the first step, the number of available 5 MHz blocks is calculated. However, a viable Mobile/Fixed Communication Network requires more than a single 5 MHz block. Therefore, in the second step, the amount of spectrum that can be fully utilised by Mobile/Fixed Communication Networks is calculated. However, the spectrum that cannot be fully utilised will not remain unused. Therefore, in the third step the overall effectiveness of potential spectrum use is estimated.

A5.2 Analysis of Number of available blocks

Figure A5.1 shows the eight most optimal frequency arrangements for FDD, TDD and mixed FDD/TDD for the frequency range 790-862 MHz. Table A5.1 shows the total number of available blocks plus the usable spectrum in the centre gap, for these options.

The following assumptions are made for the mobile service in the numerical calculations:

- Block size: 5 MHz
- Unsynchronised TDD operators
- Restricted –block between TDD and either uplink or downlink: 5 MHz
- Guard bands of 7 MHz and 12 MHz (however, note that the 7 MHz guard band is not consistent with the conclusions of ECC TG4)

The following assumptions are made for the use of spectrum within the bandplan by other applications:

- For the spectrum to be useful for another application, there has to be some consistency in the spectrum available across Europe:
  - For most potential applications, the practical tuning range of equipment is limited.
  - The FDD centre gap and the TDD guard band above 790 MHz would be consistent, but the restricted blocks would be country specific (and may be dependent on the result of the licence award process).
- A 5 MHz restricted block would not be useful for other applications:
  - There would not be sufficient useful spectrum (e.g. to create a viable market for equipment).
- The other applications will probably not use packet based transmission:
  - for full utilisation of the spectrum, the emissions limit for coexistence would therefore need to be for the scenario where probability of packet collisions cannot be taken into account (see ECC Report 131, section 4.1)
  - A typical FDD basestation and or terminal will meet this limit within the centre gap at an offset of around 4 MHz from the band edge (see PT SE 42 (09) 005).
  - A TDD basestation is also likely to need to meet this limit at an offset of 4 MHz from the channel in order to meet the likely block edge mask at 5 MHz offset (assuming that they are similar to the BEM for 2.6 GHz defined in CEPT Report 19).

<u>The term “guard block” does not preclude the use of such spectrum by other applications</u>

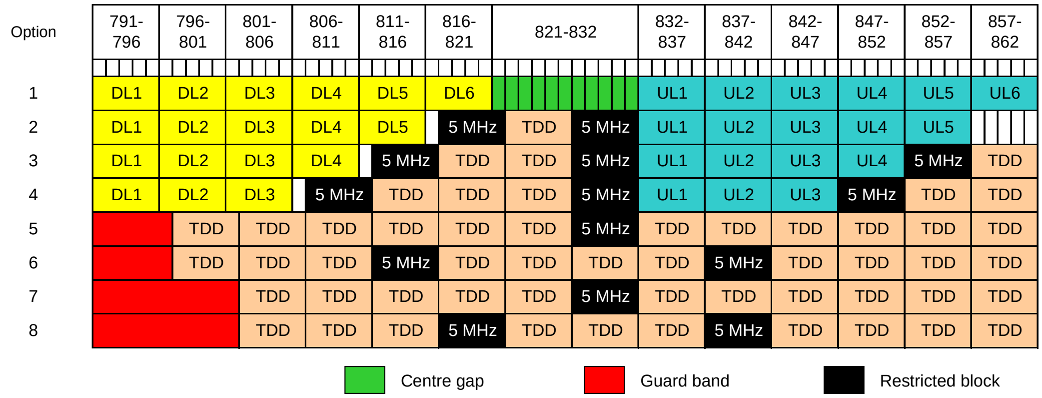


Figure A5.1 Possible bandplan options

Options 5 and 7 represent the best outcome for two TDD networks and options 6 and 8 represent the best outcome for three TDD networks (with 7 MHz and 12 MHz guard bands respectively). It is not possible to support more than three TDD networks within the 790-862 MHz band.

It is assumed that a centre gap or guard band of 8 MHz or more is suitable for other applications such as PMSE. However, this does not take account the impact of fragmentation of the spectrum across Europe on the viability of developing equipment.

Available spectrum																
(No. of blocks)	**Option 1 FDD**		**Option 2 Mixed**		**Option 3 Mixed**		**Option 4 Mixed**		**Option 5 TDD**		**Option 6 TDD**		**Option 7 TDD**		**Option 8 TDD**	
	No.	MHz	No.	MHz	No.	MHz	No.	MHz	No.	MHz	No.	MHz	No.	MHz	No.	MHz
FDD	12	60	10	50	8	40	6	30								
TDD	0		1	5	3	15	5	25	12	60	11	55	11	55	10	50
Useful Mobile Blocks	12		11		11		11		12		11		11		11	
Total Mobile Spectrum		**60**		**55**		**55**		**55**		**60**		**55**		**55**		**50**
Centre Gap		11														
Guard Band										7		7		12		12

Table A5.1: Available spectrum

A5.3 Amount of spectrum that can be fully used

Table A5.2 analyses the amount of useful spectrum for the eight options illustrated in Figure A5.1, with the following illustrative assumptions for the spectrum needed to support a Mobile/Fixed Communication Network in the UHF band:

FDD: Minimum of 2 X 10 MHz

TDD single frequency re-use (1-F): 20 MHz contiguous

TDD 2-frequency re-use (2-F): 2 X 10 MHz

TDD 3-frequency re-use (3-F): 3 X 5 MHz

Number of blocks that can be fully utilised																		
(Max no. of networks)	**Option 1 FDD**		**Option 2 Mixed**		**Option 3 Mixed**		**Option 4a Mixed**		**Option 4b Mixed**		**Option 5 TDD**		**Option 6 TDD**		**Option 7 TDD**		**Option 8 TDD**	
	No.	MHz	No.	MHz	No.	MHz	No.	MHz	No.	MHz	No.	MHz	No.	MHz	No.	MHz	No.	MHz
FDD	3	60	2	50	2	40	1	20	1	20	0		0		0		0	
TDD (1-F)	0		0		0		0		0		0		0		0		0	
TDD (2-F)	0		0		0		0		1	20	0		2	40	1	20	1	20
TDD (3-F)	0		0		1	15	1	15	0		4	60	1	15	2	30	2	30
Total fully utilised Spectrum		**60**		**50**		**55**		**35**		**40**		**60**		**55**		**50**		**50**
Guard band or centre gap	11											7		7		12		12

Table A5.2: Number of blocks that can be fully utilised

A5.4 Effectiveness of spectrum usage

The analysis in the previous section only considered spectrum that could be fully utilised by mobile broadband TDD and FDD networks. However, the spectrum that could not be fully utilised would not remain unused. The analysis in Table A5.3 is an assessment of the overall effectiveness of spectrum utilisation, if effectiveness is measured purely by the quantity of spectrum available. The following assumptions are made:
FDD, 2X10 MHz; TDD (1-F), 1 X 20 MHz; TDD (2-F), 2 X 10 MHz; TDD (3-F), 3 X 10 MHz: 100%

FDD, extra 2X5 MHz; TDD (3-F), 3X5 MHz: 67%
(5MHz channels have lower trunking efficiency and throughput)

Residual spectrum: 33%
(can only to provide extra capacity in certain sectors, not evenly across network).

Restricted blocks: 5%
(The main value of UHF spectrum is for wide area coverage, but restricted blocks can only be used for small coverage areas due to the power limitation).
Other applications in FDD centre gap: 50% for first 4 MHz and 100% above (see the assumptions in section A5.2).
Other applications in TDD guard band: 50% (see the assumptions in section A5.2).

The figures of 67%, 33% and 5% are examples, but are considered reasonable assumptions for the effectiveness of use of spectrum. Similar conclusions would be reached for a wide range of values.

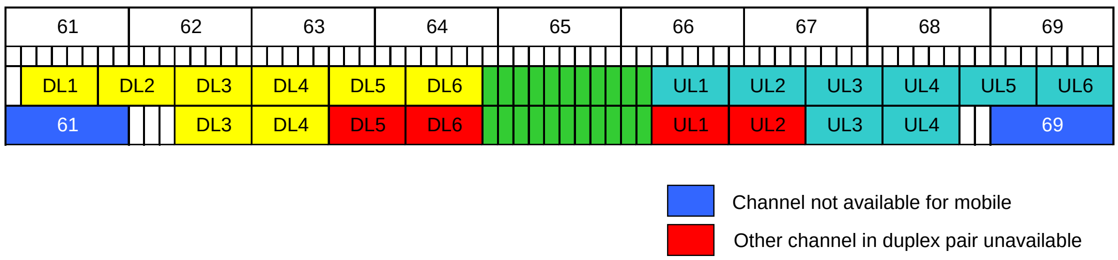
Effectiveness of spectrum utilisation (equivalent to MHz fully utilised)																		
(Max no. of networks)	**Option 1 FDD**		**Option 2 Mixed**		**Option 3 Mixed**		**Option 4a Mixed**		**Option 4b Mixed**		**Option 5 TDD**		**Option 6 TDD**		**Option 7 TDD**		**Option 8 TDD**	
	No.	MHz	No.	MHz	No.	MHz	No.	MHz	No.	MHz	No.	MHz	No.	MHz	No.	MHz	No.	MHz
FDD	3	60	2	40	2	40	1	20	1	20	0		0		0		0	
TDD (1-F)	0		0		0		0		0		0		0		0		0	
TDD (2-F)	0		0		0		0		1	20	0		2	40	1	20	1	20
TDD (3-F)	0		0		0		0		0		2	60	0		2	30	0	
TDD (3-F) (X 0.67)	0		0		1	10	1	10	0		0		1	10	0		2	20
Extra 2X5MHz (X 0.67)	0		1	6.7	0		1	6.7	1	6.7	0		0		0		0	
Residual Blocks (X 0.33)	0		1	1.6			2	3.3	1	1.6	0		0		1	1.6	0	
Restricted blocks (X 0.05)	0		2	0.5	3	0.75	3	0.75	3	0.75	1	0.25	2	0.5	1	0.25	2	0.5
Equivalent effectiveness of spectrum usage		**60**		**48.8**		**50.75**		**40.75**		**49.05**		**60.25**		**50.5**		**51.85**		**40.5**
PLUS effectively usable centre gap or guard band		**9**										**3.5**		**3.5**		**6**		**6**

Table A5.3: Effectiveness of spectrum utilisation (equivalent to MHz fully utilised)

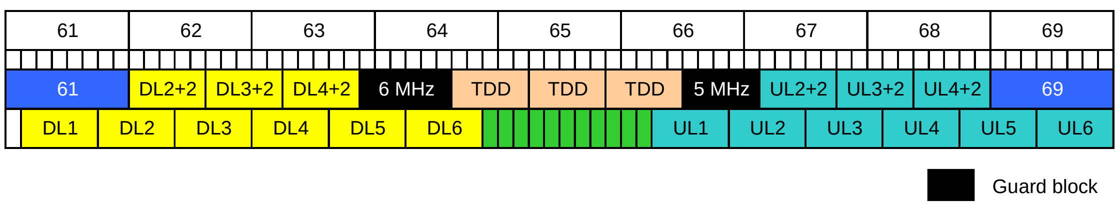
In the above analysis, the usable spectrum in the centre gap has not been added directly to the mobile spectrum, because it is not possible to directly compare the effectiveness of spectrum use of the two applications. Nevertheless, it is clear that the use of the centre gap increases the overall effectiveness of the use of the 790-862 MHz band.

A.5.5 Mixed FDD/TDD in the case that part of the band is not available within a country

Where part of the band is not available for two-way mobile, an FDD only arrangement might not be the optimal use of spectrum because each unused downlink FDD channel has a corresponding unused uplink FDD pair, as illustrated in the example below:

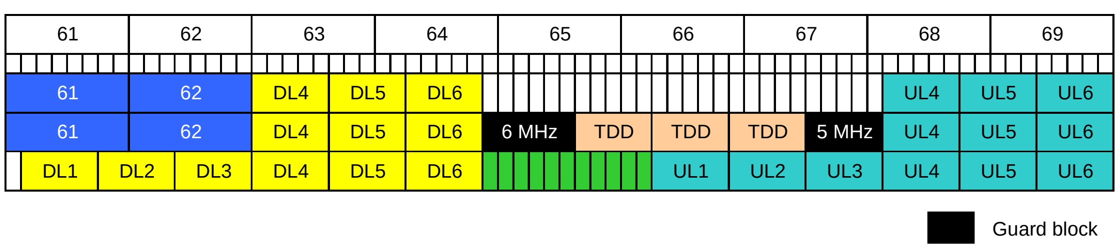


However, adding TDD could provide a means to utilise the spectrum that would otherwise be left empty. The following example is based on a 2 MHz offset for FDD channels and use of TDD in channels whose corresponding FDD pair is not available:



Different assumptions for the size of guard blocks would alter the number of TDD channels that could be included in such an arrangement. Decisions on guard blocks in these circumstances would be on a national basis

In cases where the unavailable channels are at one end of the band, there could be additional gains in efficiency from the use of a mixed FDD/TDD arrangement as shown in the following example:



In this example, using the above assumptions, the usable spectrum in the first row is 16 + (2×15) = 46 MHz and only one operator could be supported. In the second row the usable spectrum is 16 + (2×15) + 15 = 61 MHz and two operators could be supported. Without the flexibility for mixed FDD/TDD, the only efficient option in such cases is an all-TDD plan.

A.5.6 Conclusions

In every considered mixed FDD/TDD bandplan for the full 790 – 862 MHz band, there is less spectrum available compared with a FDD band plan or full TDD band plan and therefore spectrum is used more efficiently by Mobile/Fixed Communication Networks in a FDD bandplan or TDD band plan than in the mixed bandplan examples.

Additionally, the centre gap of a FDD bandplan and the guard band of a TDD bandplan are wide enough for use by other applications.

In cases where the full band is not available, it is not efficient to leave FDD channels unused; mixed FDD/TDD arrangements can provide a means to utilise this spectrum without forcing regulators to adopt a TDD-only arrangement.

For two TDD networks and a 7 MHz[12] guard band, the spectrum utilisation is equal to the FDD case, apart from the utilisation of the centre gap. For two TDD networks and a 12 MHz guard band, the spectrum utilisation is less than the FDD case but more than the mixed FDD/TDD examples. For three TDD networks, the spectrum utilisation is comparable to the mixed TDD/FDD examples.

12 The guard band could be decided on a national basis (see section 2.3). CEPT Report 30 contains analysis of the TDD guard band considerations for fixed or portable DTT reception.

ANNEX 6: TEXT OF ECC DECISION ECC/DEC/(09)03 ON HARMONISED CONDITIONS FOR MOBILE/FIXED COMMUNICATIONS NETWORKS OPERATING IN THE BAND 790-862 MHZ

ELECTRONIC COMMUNICATIONS COMMITTEE

ECC Decision
of 30 October 2009

on harmonised conditions for
mobile/fixed communications networks (MFCN)
operating in the band 790 - 862 MHz

(ECC/DEC/(09)03)

EXPLANATORY MEMORANDUM

1 INTRODUCTION

WRC-07 allocated on a primary basis the 790-862 MHz band to mobile services in Region 1 as from 17 June 2015, and in some CEPT countries it is possible to utilise this band for mobile services before 2015, in accordance with the provisions of the Radio Regulations.

The 22nd meeting of ECC (Vienna, March 2009) agreed to develop a Decision on harmonised technical and regulatory conditions in the band 790 - 862 MHz in order to meet the needs of industry and administrations.

This Decision, developed in response to this agreement, contains annexes defining the frequency arrangements and technical conditions for this band. These annexes are based on studies undertaken by ECC and described in CEPT Reports 30 and 31.

ECC has also undertaken studies on cross-border coordination, which are described in CEPT Report 29, and on the continuation of PMSE services operating in the band 470-862MHz, which are described in CEPT Report 32.

These CEPT Reports were produced in response to a mandate from the European Commission[13], which requested CEPT to carry out investigations to define the technical conditions applicable for the sub-band 790-862 MHz optimised for, but not limited to, mobile/fixed communications networks (two-way). In addition, CEPT Reports 21 to 25 have been produced in response to an earlier Mandate from the European Commission[14].

2 BACKGROUND

The CEPT has recognised the importance of the availability of common and minimal (least restrictive) technical conditions for the band 790-862 MHz. These technical conditions will provide significant economies of scale and facilitate the introduction of new applications depending on national decisions.

To maintain the required flexibility for administrations regarding the non-mandatory introduction of mobile/fixed communications networks in these bands, block edge masks have been developed without assuming full or partial implementation of the harmonised frequency (channelling) arrangements.

The following principles have been applied to define the frequency arrangements:

1) Common frequency arrangements have been defined, to the greatest extent possible, to facilitate roaming, border coordination and to achieve economies of scale for equipment, whilst maintaining the flexibility to adapt to national circumstances and market demand.
2) All duplex methods TDD, FDD full duplex (FDD-FD) and FDD half duplex (FDD-HD) have been initially considered with the aim to define a solution to accommodate spectrum for operators who would wish to use different technologies, while paying due attention to coexistence issues and spectrum efficiency.
3) The time frame for availability of the band for mobile/fixed communications networks and future technology evolution has been taken into account to define location and size of the duplex gap.
4) Careful consideration has been given to the block sizes for the band plans.
5) Recognizing the advantage of a single harmonised frequency arrangement, the preferred frequency arrangement is based on FDD. TDD frequency arrangements and other approaches can be used on a national basis.

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13 For the text of this Mandate, see Annex 1 of CEPT Report 31. This includes a description of the tasks undertaken by CEPT in response to the Mandate.

14 For the text of this Mandate, see Annex 1 of CEPT Report 25. This includes a description of the tasks undertaken by CEPT in response to the Mandate.

6) The trade off between increasing the frequency separation at 790 MHz and reducing the duplex gap has been carefully studied. In weighing up this trade off it has been decided that the frequency separation should be 1 MHz and the duplex gap 11 MHz.

7) The implementation of the frequency arrangement by national administrations will require coordination with any other administration whose broadcasting service and/or other primary terrestrial services are considered to be affected. For broadcasting, the coordination procedure would be pursuant to the GE-06 agreement.

3 REQUIREMENT FOR AN ECC DECISION

The ECC recognises that implementation of mobile/fixed communications networks in the band 790-862 MHz based on common and minimal (least restrictive) technical conditions and on harmonised frequency arrangements will maximise the opportunities and benefits for end users, will reduce capital expenditure for operators and cost of manufacturing equipment and will secure future investments by providing economy of scale. Access to the 790-862 MHz band will facilitate more complete coverage for mobile/fixed communications networks in particular in rural areas and allow improved in-building penetration (when compared to the use of higher frequencies).

The ECC recognises that for mobile/fixed communications networks to continue to develop successfully, industry stakeholders must be given the confidence and certainty to make the necessary investment. The ECC believes that the continued development of mobile/fixed communications services will be facilitated by the introduction of harmonised frequency arrangements across countries wishing to implement mobile/fixed communications networks in the band 790-862 MHz. However, ECC also recognises that administrations need flexibility to adapt their use of the band 790-862 MHz to national circumstances and that adopting common and minimal (least restrictive) technical conditions, without assuming full or partial implementation of the harmonised frequency arrangements would also be beneficial in specific national cases. A commitment by CEPT member countries to implement this Decision will provide a clear indication for manufacturers to develop equipment for this band and for operators to prepare for investment.

The ECC recognises that an ECC Decision harmonising the use of the frequency band 790 - 862 MHz leaves flexibility for administrations to retain broadcasting use in all or portions of this frequency band.

ECC Decision
of 30 October 2009

Harmonised conditions for mobile/fixed communications networks (MFCN)
operating in the band 790-862 MHz

(ECC/DEC/(09)03)

“The European Conference of Postal and Telecommunications Administrations,

considering

a) that the frequency band 790-862 MHz has been allocated to the mobile service on a primary basis in a number of countries in Region 1 for more than 20 years subject to provisions of RR 5.316;

b) that WRC-07 allocated the band 790-862 MHz to the mobile service on a primary basis in additional countries in Region 1 from 1 January 2009 subject to the provisions of RR 5.316A;

c) that WRC-07 allocated the band 790-862 MHz to the mobile service on a primary basis in the whole of Region 1 from 17 June 2015 subject to the provisions of RR 5.316B and identified this band for IMT (see RR 5.317A);

d) that “mobile/fixed communications networks” for the purpose of this Decision includes IMT and other communications networks in the mobile and fixed services;

e) that harmonised frequency arrangements facilitate economies of scale and availability of low-cost equipment;

f) that the designation of a frequency band for a specific application does not prevent the same frequency band from being designated for other applications;

g) that the band 470-862 MHz is widely used for the broadcasting service, and is also used by PMSE (SAB/SAP applications);

h) that there could be differences in the market demand for spectrum for mobile/fixed communications networks and different licensing schemes across CEPT countries could lead to different timescales concerning the introduction of mobile/fixed services in the band 790-862 MHz;

i) that global roaming is facilitated by harmonised frequency arrangements and circulation arrangements for the use of mobile/fixed communications networks terminals;

j) that some administrations may not make available all frequencies in the band 790-862 MHz because they have already been allocated to other services and applications;

k) that the block edge mask (BEM) concept has been developed by CEPT to facilitate implementation of spectrum rights of use which are as technology neutral as possible;

l) the need for protection of broadcasting service below 790 MHz or in TV channels above 790 MHz if an administration wishes to have broadcasting networks or both mobile/fixed communications networks and broadcasting networks in the frequency band 790-862 MHz;

m) that the protection of broadcasting may require adoption of additional measures at the national level to mitigate the possible remaining interference cases;

n) that the GE-06 Agreement provides the necessary regulatory procedures for co-ordination between countries that are members of the Agreement and to identify administrations to be involved in the coordination process between mobile service in one country and broadcasting service in another country;

o) that a detailed coordination methodology, including a careful interference assessment, may need to be developed by the administrations concerned during bilateral or multilateral discussions using the guidance provided in CEPT Report 29;

p) that this ECC Decision leaves flexibility to administrations to determine at a national level the use of this frequency band for broadcasting and/or other services;

q) that administrations may authorize low power applications such as Programme Making and Special Events (PMSE) in the duplex gap of the preferred harmonised frequency arrangement (821-832 MHz) or the guard band of the TDD frequency arrangement;

r) that CEPT Report 30 concludes a guard band of at least 7 MHz is required between TDD and broadcasting;

s) that for FDD and TDD networks the preferred block size is 5 MHz, which does not preclude smaller channel bandwidths within a block;

t) that coexistence between TDD and FDD networks and between unsynchronized TDD networks in adjacent blocks are in particular difficult;

u) that studies on sharing between mobile and other primary services are currently conducted in ITU-R, for WRC-12 to consider under agenda item 1.17 and take appropriate regulatory action;

v) that in accordance with RR 5.312 the band 645-862 MHz is allocated to the aeronautical radionavigation service on a primary basis in some CEPT countries;

w) that in some CEPT countries the implementation of this Decision is possible after concluding a bilateral agreement concerning the use of stations in the mobile service in one country and stations of other primary services in another country (e.g. stations of aeronautical radionavigation service);

x) that CEPT Report 30 addresses the common and minimal (least restrictive) technical conditions for the 790-862 MHz digital dividend;

y) that CEPT Report 31 addresses frequency arrangements for the 790-862 MHz band;

z) that in EU/EFTA countries the radio equipment that is under the scope of this Decision shall comply with the R&TTE Directive. Conformity with the essential requirements of the R&TTE Directive may be demonstrated by compliance with the applicable harmonised European standard(s) or by using the other conformity assessment procedures set out in the R&TTE Directive.

DECIDES

1. that the frequency band 790-862 MHz is designated to mobile/fixed communications networks, while enabling administrations to continue to use all or portions of the frequency band 790-862 MHz for broadcasting and other services;
2. that those administrations wishing to implement mobile/fixed communications networks based on FDD in the entire frequency band 790-862 MHz should adhere to the preferred harmonised frequency arrangement given in Annex 1;
3. that those administrations wishing to implement mobile/fixed communications networks in the frequency band 790-862 MHz with frequency arrangements other than the preferred harmonised arrangement in Annex 1 should follow Annex 2;
4. that administrations implementing mobile/fixed communications networks, in accordance with Decides 2 or 3, shall adopt the common and minimal (least restrictive) technical conditions specified in Annex 3 to this Decision;
5. that administrations wishing to implement low power applications and PMSE in the centre gap of the FDD frequency arrangement given in Annex 1 or PMSE in the guard band of the TDD frequency arrangement given in Annex 2 shall adopt the common and minimal (least restrictive) technical conditions specified in Annex 3 to this Decision;
6. that this Decision enters into force on 30 October 2009;
7. that the preferred date for implementation of the Decision shall be 1 May 2010;
8. that CEPT administrations shall communicate the national measures implementing this Decision to the ECC Chairman and the Office when the Decision is nationally implemented."

Note:
Please check the Office web site (http://www.ero.dk) for the up to date position on the implementation of this and other ECC Decisions.

ANNEX 1
Preferred harmonised frequency arrangement

The harmonised frequency arrangement is 2 x 30 MHz with a duplex gap of 11 MHz, based on a block size of 5 MHz, paired and with reverse duplex direction, and a guard band of 1 MHz starting at 790 MHz. The FDD downlink starts at 791 MHz and FDD uplink starts at 832 MHz.

790-791	791-796	796-801	801-806	806-811	811-816	816-821	821-832	832-837	837-842	842-847	847-852	852-857	857-862
Guard band	Downlink						Duplex gap	Uplink					
1 MHz	30 MHz (6 blocks of 5 MHz)						11 MHz	30 MHz (6 blocks of 5 MHz)					

ANNEX 2

Guidance for administrations not implementing the preferred frequency arrangement in Annex 1

Administrations which do not wish to use the preferred harmonised frequency arrangement as described in Annex 1 or which do not have the full band 790 – 862 MHz available (e.g. where an Administration cannot make all channels in the band available because they have already been allocated to other services or are not able to coordinate the use of frequencies with neighboring countries), may consider:

- partial implementation of frequency arrangement described in Annex 1;
- the introduction of TDD frequency arrangement in all or part of the frequency band 790 – 862 MHz, based on a block size of 5 MHz starting at 797 MHz, with a guard band of 7 MHz starting at 790 MHz;

790-797	797-802	802-807	807-812	812-817	817-822	822-827	827-832	832-837	837-842	842-847	847-852	852-857	857-862
Guard band	Unpaired												
7 MHz	65 MHz (13 blocks of 5 MHz)												

- a mixed introduction of TDD and FDD frequency arrangements as described in Annex 5 of CEPT Report 31;
- implementation of a 1 MHz channel raster.

It should further be noted that:

- filtering is required at the DTT receiver for TDD operation in the lowest 5 MHz block of the TDD frequency arrangement, as described in Annex 3 of CEPT Report 30;

- administrations who wish to protect portable-indoor DTT reception would need to adopt a guard band that is larger than 7 MHz, and may also require filtering at the DTT receiver, as described in Annex 3 of CEPT Report 30.

ANNEX 3

Technical conditions based on BEM approach

The technical conditions presented in this annex are in the form of block-edge masks (BEMs) as derived in CEPT Report 30. BEMs are related to spectrum licensing and the avoidance of interference between users of spectrum.

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 BEM levels are built up by combining the values listed in the tables 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 790-862 MHz band are optimised for, but are not limited to, FDD and TDD mobile/fixed communications networks (two-way). The least restrictive conditions given in this annex apply to the preferred harmonised frequency arrangement as described in Annex 1 and to the frequency arrangements as described in Annex 2.

In addition, a number of technical conditions have also been derived for Programme Making and Special Events (PMSE) equipments and low-power applications in the FDD duplex gap or PMSE in the TDD guard band. Therefore, the emission masks are derived for base stations (BS), terminal stations (TS), low-power applications and PMSE equipments.

The BEMs have been derived to allow coexistence between applications in the 790 - 862 MHz band and other applications in adjacent bands but in the same geographical area. The derived BEMs do not take account of coexistence with aeronautical radio navigation systems (ARNS) operating in some CEPT countries (RR 5.312). Therefore, the BEMs have to be associated with other requirements in such instances. This can be done at a national level or with cross-border coordination developed by bilateral or multilateral agreements.

BEMs shall be applied as an essential component of the technical conditions necessary to ensure coexistence between services at a national level. However, it should be understood that the derived BEMs do not always provide the required level of protection of victim services and additional mitigation techniques would need to be applied in order to resolve any remaining cases of interference.

Operators of mobile/fixed communications networks (MFCN) in the 790-862 MHz band may agree, on a bilateral or multilateral basis, less stringent technical parameters providing that they continue to comply with the technical conditions applicable for the protection of other services, applications or networks and with their cross-border obligations. Administrations should ensure that these less stringent technical parameters can be used, if agreed among all affected parties (e.g. between synchronised TDD operators[15]).

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. MFCN block or TV channel) specified in the following tables. 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 the tables. For requirements with a *measurement bandwidth* of 5 MHz, the measurement bandwidth is aligned within a block.

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.

[15] The BEMs for TDD devices are derived here with the assumption that TDD networks in adjacent frequencies are unsynchronised.

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 MFCN base station transition requirements which are specified per antenna.

The term *block edge* refers to the frequency boundary of spectrum licensed to a mobile/fixed communication network. The term *band edge* refers to the boundary of a range of frequencies allocated for a certain use (e.g., 790 MHz is the upper band edge for broadcasting, while 832 MHz is the lower band edge for FDD uplink).

Illustrative examples of emission masks can be found in Annex 4 of this Decision in relation with FDD and TDD frequency arrangements.

1. Technical conditions for FDD or TDD base stations

An administration may choose to specify an in-block EIRP limit for base stations. Such limit may range from 56 dBm/{5 MHz} to 64 dBm/{5 MHz} based on compatibility studies and deployment requirements in this band. It should be noted that administrations may consider authorising higher in-block EIRPs in specific circumstances, e.g. in rural deployments.

Tables 1 to 3 define the out-of-block BEM requirements for base stations within the spectrum allocated to mobile/fixed communications networks (MFCNs).

Frequency range of out-of-block emissions	Maximum mean out-of-block EIRP	Measurement bandwidth
Frequencies allocated to FDD uplink	–49.5 dBm	5 MHz
Frequencies allocated to TDD	–49.5 dBm	5 MHz

Table 1: Baseline requirements – BS BEM out-of-block EIRP limits

Frequency range of out-of-block emissions	Maximum mean out-of-block EIRP	Measurement bandwidth
–10 to –5 MHz from lower block edge	18 dBm	5 MHz
–5 to 0 MHz from lower block edge	22 dBm	5 MHz
0 to +5 MHz from upper block edge	22 dBm	5 MHz
+5 to +10 MHz from upper block edge	18 dBm	5 MHz
Remaining FDD downlink frequencies	11 dBm	1 MHz

Table 2: Transition requirements – BS BEM out-of-block EIRP limits per antenna[16] over frequencies of FDD downlink and TDD

Frequency range of out-of-block emissions	Maximum mean out-of-block EIRP	Measurement Bandwidth
Guard band between broadcasting band edge and FDD downlink band edge	17.4 dBm	1 MHz
Guard band between broadcasting band edge and TDD band edge	15 dBm	1 MHz
Guard band between FDD downlink band edge and FDD uplink band edge (duplex gap)	15 dBm	1 MHz
Guard band between FDD downlink band edge and TDD band edge	15 dBm	1 MHz
Guard band between FDD uplink band edge and TDD band edge	15 dBm	1 MHz

Table 3: Transition requirements – BS BEM out-of-block EIRP limits per antenna[4] over frequencies (e.g. above 790 MHz) used as guard band

[16] For one to four antennas.

Table 4 shows the out-of-block BEM baseline requirements for MFCN base stations within the spectrum allocated to the broadcasting (DTT) service.

Case	Frequency range of out-of-block emissions	Condition on base station in-block EIRP, P dBm/{10 MHz}	Maximum mean out-of-block EIRP	Measurement bandwidth
A	For DTT frequencies where broadcasting is protected	P ≥ 59	0 dBm	8 MHz
		36 ≤ P < 59	(P-59) dBm	8 MHz
		P < 36	-23 dBm	8 MHz
B	For DTT frequencies where broadcasting is subject to an intermediate level of protection	P ≥ 59	10 dBm	8 MHz
		36 ≤ P < 59	(P-49) dBm	8 MHz
		P < 36	-13 dBm	8 MHz
C	For DTT frequencies where broadcasting is not protected	No conditions	22 dBm	8 MHz

Table 4: Baseline requirements – BS BEM out-of-block EIRP limits over frequencies occupied by broadcasting

The three different cases A, B, and C listed in Table 4 can be applied on a per-channel and/or per-region basis, i.e. for the same channel different cases can be applied in different geographic areas (e.g. area related to DTT coverage) and different cases can be applied to different channels in the same geographic area. For the protection of digital terrestrial broadcasting channels in use at the time of deployment of MFCNs, the baseline requirement in case A shall be applied. In circumstances where the relevant broadcasting channels are not in use at the time of deployment of MFCNs, an administration may choose between the baseline requirements in cases A, B and C (illustrative examples of emission masks can be found in Annex 4 of this Decision in relation with FDD and TDD frequency arrangements). An administration may choose baseline requirement in case A where it intends to bring the relevant broadcasting channels into use in the foreseeable future and the administration wishes to provide these with the same level of protection as other broadcasting channels already in use. The baseline requirement in case B may be used where an administration wishes to reserve the option of bringing the relevant broadcasting channels into use at a future date, but can accept a lower level of protection for these channels. Baseline requirement in case C may be used where an administration does not intend to bring the relevant broadcasting channels into use.

Other baseline requirements can be applied in specific circumstances subject to agreements between the broadcasting authority, MFCN operators and the administration if required.

2. Technical conditions for FDD or TDD terminal stations

In Tables 5 to 9, 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.

2.1 In-block requirements for all terminal stations

Table 5 defines the maximum value of the in-block emission level for FDD or TDD terminal stations (TS). Administrations may relax this limit in certain situations, for example fixed TS in rural areas, providing that protection of other services, networks and applications is not compromised and cross-border obligations are fulfilled.

Maximum mean in-block power	23 dBm[17]

Table 5: FDD or TDD TS in-block emission limit

2.2. Out-of-band requirements for 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)[18]. The technical conditions for these terminals are defined relative to the channel edge to enable them to be taken into account by the SDOs.

The term *channel edge* refers to the lowest and highest frequency of the occupied bandwidth.

2.2.1. Out-of-band requirements for FDD terminal stations for the preferred harmonised frequency arrangement

Table 6 defines the out-of-band emission requirements for FDD TS for the preferred harmonised frequency arrangement.

Frequency range of out-of-band emissions	Maximum mean out-of-band power	Measurement bandwidth
Below 790 MHz	-65dBm*	8 MHz
790 to 791 MHz	–44 dBm	1 MHz
791 to 821 MHz	-37 dBm	5 MHz
821 to 822 MHz	–13 dBm	1 MHz
822 MHz to –5 MHz from FDD uplink lower channel edge	-6 dBm	5 MHz
–5 to 0 MHz from FDD uplink lower channel edge	1.6 dBm	5 MHz
0 to +5 MHz from FDD uplink upper channel edge	1.6 dBm	5 MHz
+5 MHz from FDD uplink upper channel edge to 862 MHz	-6 dBm	5 MHz

Table 6: Out-of-band requirements for FDD TS

* Full duplex FDD terminal stations designed to operate in the preferred harmonised FDD channelling arrangement are expected to be inherently compliant with this out-of-band emission level.

2.2.2. Out-of-band requirements for other FDD terminal stations and for TDD terminal stations

Tables 7 to 9 define the out-of-band requirements for FDD and TDD terminal stations, except FDD terminal stations for the preferred harmonised frequency arrangement.

Frequency range of out-of-band emissions	Maximum mean out-of-band power	Measurement bandwidth
Frequencies allocated to FDD downlink	-37 dBm	5 MHz

Table 7: Out-of-band requirements for TS over frequencies of the FDD downlink

[17] It is recognised that this value is subject to a tolerance of up to +2 dB, to take account of operation under extreme environmental conditions and production spread.
[18] The CEPT recommended spurious emission limits given in ERC Recommendation 74-01.

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 TDD frequencies	-37 dBm	5 MHz
Remaining FDD uplink frequencies	-13 dBm	1 MHz
Frequencies allocated to broadcasting	-65 dBm	8 MHz

Table 8: Out-of-band requirements for TS over frequencies of TDD, FDD uplink and broadcasting

Frequency range of out-of-band emissions	Maximum mean out-of-band power	Measurement bandwidth
Guard band between broadcasting band edge and FDD downlink band edge	–44 dBm	1 MHz
Guard band between broadcasting band edge and TDD band edge	–5.4 dBm	1 MHz
Guard band between FDD downlink band edge and FDD uplink band edge (duplex gap)	–5.4 dBm	1 MHz
Guard band between FDD downlink band edge and TDD band edge	–5.4 dBm	1 MHz
Guard band between FDD uplink band edge and TDD band edge	–5.4 dBm	1 MHz

Table 9: Out-of-band requirements for TS over frequencies used as guard band

3. Technical conditions for PMSE and low-power (LP) applications within the duplex gap of the FDD frequency arrangement or the guard band of the TDD frequency arrangement

PMSE devices (channel bandwidth ≤ 200 kHz) and low-power (LP) applications (channel bandwidth ≥ 5 MHz) are allowed on a non-protected, non-interfering basis within the duplex gap of a FDD frequency arrangement. PMSE devices (channel bandwidth ≤ 200 kHz) are also allowed on a non-protected, non-interfering basis within the guard band of the TDD frequency arrangement.

The technical conditions in this section can be relaxed at a national level subject to specific restrictions (e.g., minimum spatial distance between interferer and victim), or where it is judged that no material interference would arise.

In Tables 10, 11, 14 and 15, the power limits are specified as TRP for PMSE equipment and low power TS. Note that EIRP and TRP are equivalent for isotropic antennas.

3.1 Technical conditions for PMSE equipment

Table 10 defines the maximum permitted in-band emission level for PMSE equipment operating within the duplex gap of the FDD frequency arrangement or within the guard band of the TDD frequency arrangement.

Frequency range of in-band emissions	Maximum mean in-band TRP
+5 MHz from FDD downlink upper band edge to FDD uplink lower band edge	20 dBm
From broadcasting upper band edge to -5 MHz from TDD lower band edge	
+5 MHz from TDD upper band edge to broadcasting lower band edge	
+2 to +5 MHz from FDD downlink upper band edge	13 dBm handheld terminals 20 dBm bodyworn terminals
-5 to -2 MHz from TDD lower band edge	
+2 to +5 MHz from TDD upper band edge	

Table 10: In-band requirements – PMSE equipment

Table 11 defines the out-of-band BEM requirements for PMSE equipment within the spectrum allocated to MFCNs.

Frequency range of out-of-band emissions	Maximum mean out-of-band TRP	Measurement bandwidth
Frequencies allocated to FDD downlink	-43 dBm	5 MHz
0 to +2 MHz from FDD downlink upper band edge	-20.6 dBm	2 MHz
Frequencies allocated to FDD uplink	-25 dBm	5 MHz
-2 to 0 MHz from the TDD lower band edge	-20.6 dBm	2 MHz
Frequencies allocated to TDD	-43 dBm	5 MHz
0 to +2 MHz from TDD upper band edge	-20.6 dBm	2 MHz

Table 11: Out-of-band requirements – PMSE equipment

3.2 Technical conditions for low-power applications

3.2.1 Technical conditions for low-power base stations (LP base stations)

Table 12 defines the maximum permitted in-block EIRP for LP base stations operating within the duplex gap of the FDD frequency arrangement.

Frequency range of in-block emissions	Maximum mean in-block EIRP	Measurement bandwidth
+5 MHz from FDD downlink upper band edge to FDD uplink lower band edge	13dBm	5 MHz

Table 12: In-block requirements – LP base stations

Table 13 defines the out-of-block BEM requirements for LP base stations within the spectrum allocated to mobile/fixed communication networks and broadcasting.

Frequency range of out-of-block emissions	Maximum mean out-of-block EIRP	Measurement bandwidth
Frequencies allocated to FDD downlink	-43dBm	5 MHz
0 to +5 MHz from FDD downlink upper band edge	-9 dBm	5 MHz
Frequencies allocated to FDD uplink	-43 dBm	5 MHz
Frequencies allocated to TDD	-43 dBm	5 MHz
Frequencies allocated to broadcasting	-65 dBm	8 MHz

Table 13: Out-of-block requirements – LP base stations

The above BEM specifications for LP base stations have been derived based on a LP base station antenna height of 4 metres. Administrations who wish to authorise deployment of LP base stations with antenna heights that are greater than 4 metres may need to apply more restrictive BEM requirements.

3.2.2. Technical conditions for low-power terminal stations

Table 14 defines the maximum permitted in-block TRP for LP TS operating within the duplex gap of the FDD frequency arrangement.

Frequency range of in-block emissions	**Maximum mean in-block TRP**
+5 MHz from FDD downlink upper band edge to FDD uplink lower band edge	20 dBm

Table 14: In-block requirements –LP TS

Table 15 defines the out-of-band BEM requirements for LP terminal stations within the spectrum allocated to mobile/fixed communication networks and broadcasting.

Frequency range of out-of-band emissions	**Maximum mean out-of-band TRP**	**Measurement bandwidth**
Frequencies allocated to FDD downlink	-43 dBm	5 MHz
0 to +5 MHz from FDD downlink upper band edge	1.6 dBm	5 MHz
Frequencies allocated to FDD uplink	-25 dBm	5 MHz
Frequencies allocated to TDD	-43dBm	5 MHz
Frequencies allocated to broadcasting	-65dBm	8 MHz

Table 15: Out-of-band requirements –LP TS

ANNEX 4

Illustrations of emission masks for different frequency arrangements

Figures 1 to 8 illustrate the base station block edge masks and terminal station emission masks which are defined in sections 1 and 2 of Annex 3. These are shown in the context of the preferred harmonised frequency arrangement (Annex 1) and examples of other frequency arrangements (Annex 2). Cells marked in uniform grey represent out-of-block requirements for BS and out-of-band requirements for TS.

4.1. BS emissions for the preferred harmonised frequency arrangement

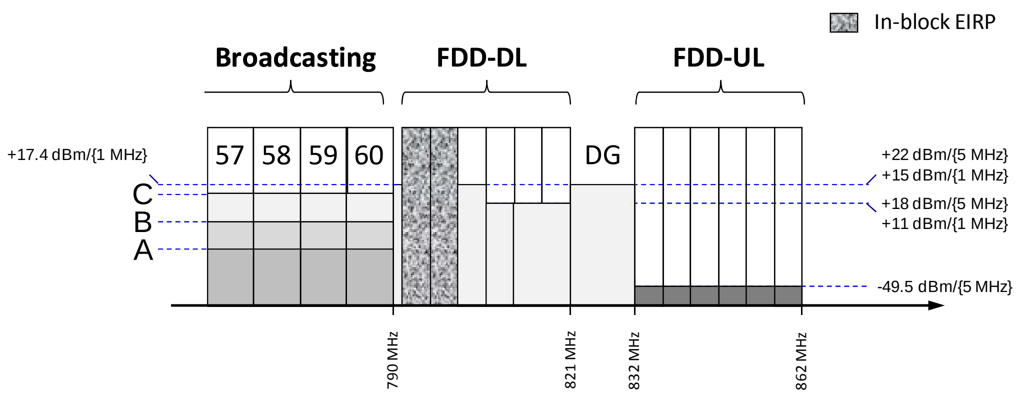

Figure 1: BS BEM for a FDD operator in the lowest two 5 MHz blocks in the preferred harmonized frequency arrangement

The baseline requirement A shall be systematically applied for the protection of digital terrestrial broadcasting channels in use at the time of deployment of MFCNs.

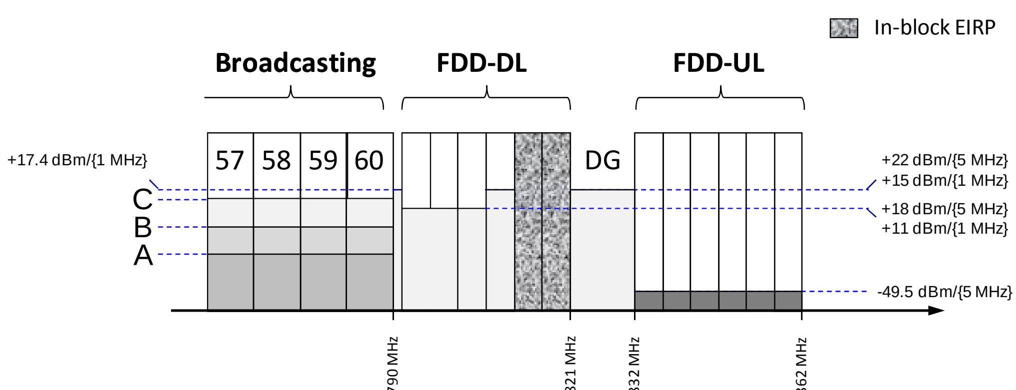

Figure 2: BS BEM for a FDD operator in the upper two 5 MHz blocks in the preferred harmonized frequency arrangement

4.2. BS emissions for the examples of other frequency arrangements

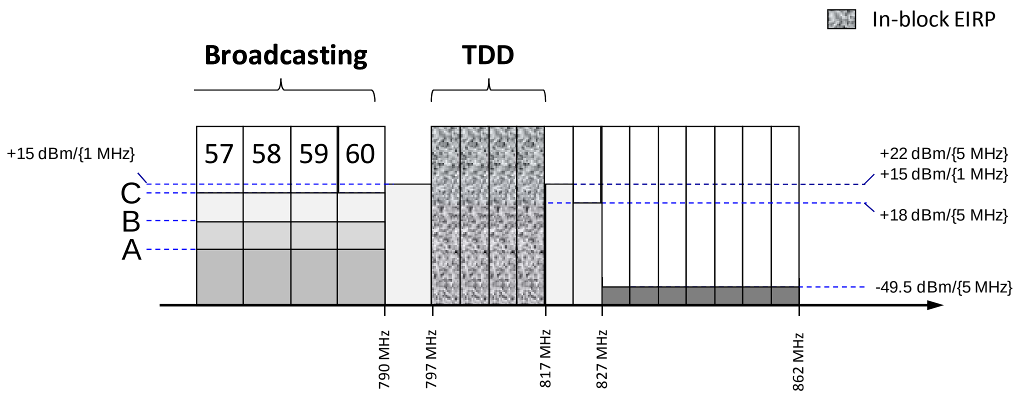

Figure 3: BS BEM for a TDD operator in the lowest four 5 MHz blocks where the 790-862 MHz band is allocated to TDD MFCN

The baseline requirement A shall be systematically applied for the protection ofdigital terrestrial broadcasting channels in use at the time of deployment of MFCNs.

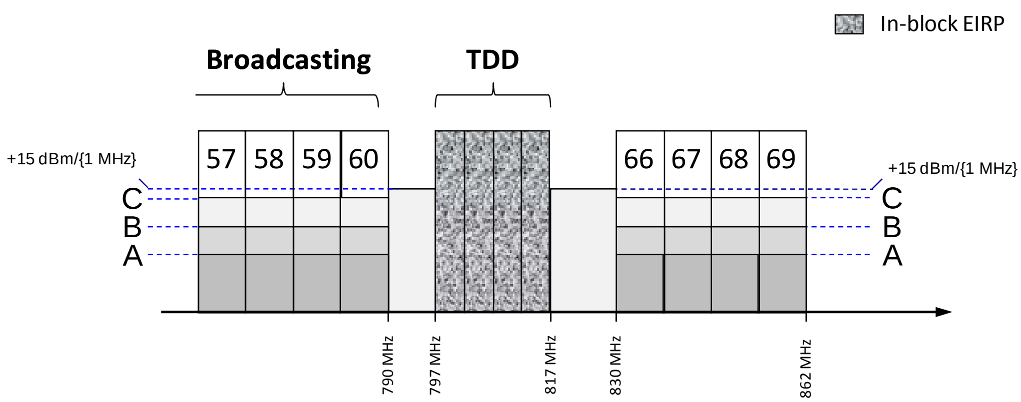

Figure 4: BS BEM for a TDD operator in the lowest four 5 MHz blocks where the 790-862 MHz band is used by a mixture of TDD MFCN and DTT

The baseline requirement A shall be systematically applied for the protection ofdigital terrestrial broadcasting channels in use at the time of deployment of MFCNs.

4.3. TS emissions for the preferred harmonised frequency arrangement

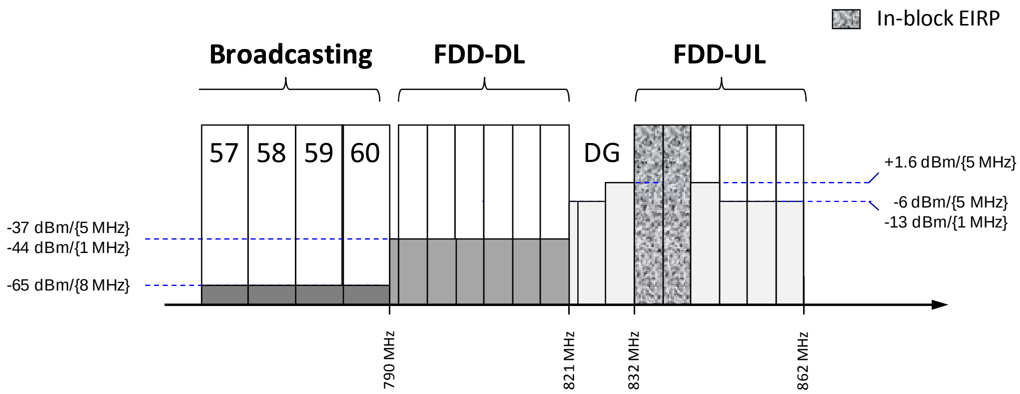

Figure 5: TS emission mask for a FDD operator in the lowest two 5 MHz blocks in the preferred harmonized frequency arrangement

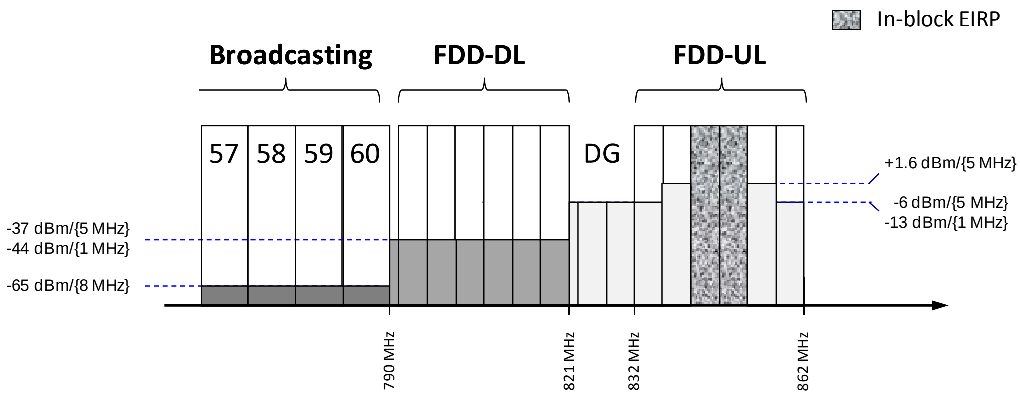

Figure 6: TS emission mask for a FDD operator in the middle two 5 MHz blocks in the preferred harmonized frequency arrangement

4.4. TS emissions for the examples of other frequency arrangements

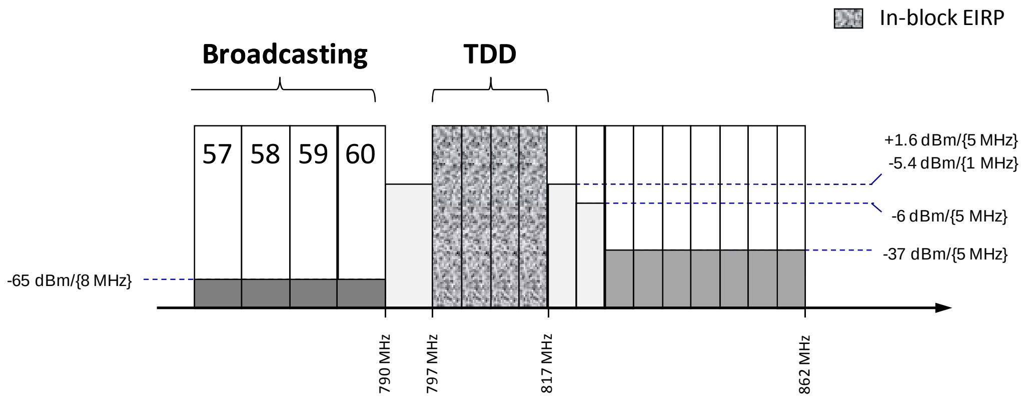

Figure 7: TS emission mask for a TDD operator in the lowest four 5 MHz blocks where the 790-862 MHz band is allocated to TDD MFCN

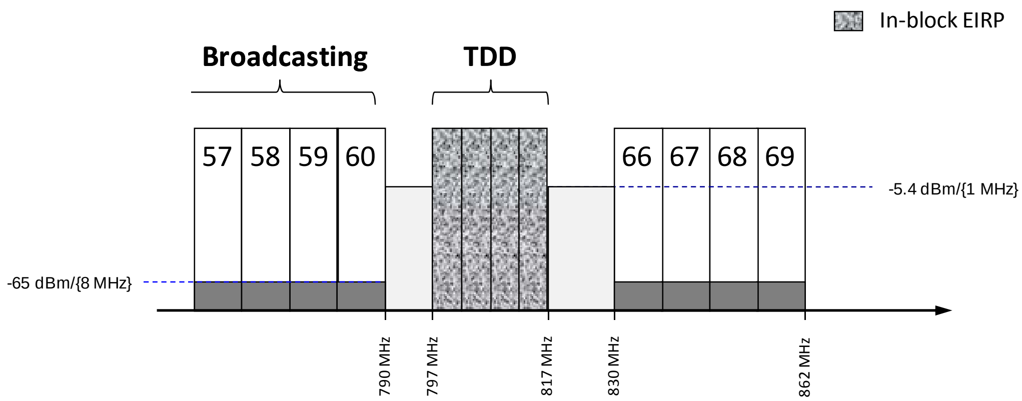

Figure 8: TS emission mask for a TDD operator in the lowest four 5 MHz blocks where the 790-862 MHz band is used by a mixture of TDD MFCN and DTT