CEPT ECC
Electronic Communications Committee

Recommendation T/R 25-08

Planning criteria and cross-border coordination of frequencies for land mobile systems in the range 29.7-470 MHz

Approved 15 January 1990

Amended 28 September 2018

INTRODUCTION

The Recommendation T/R 25 08 was approved in Lecce 1989, and subsequently revised in Vienna 1999, in Utrecht 2005, in Brussels 2008, and in Helsinki 2016 by the Working Group Frequency Management of the ECC.

This Recommendation contains provisions for the planning and cross-border coordination of frequencies for land mobile systems in the range 27.9-470 MHz for various analogue and digital land mobile applications, e.g. PMR (Professional (Private) Mobile Radio), PAMR (Public Access Mobile Radio), PPDR (Public Protection Disaster Relief), etc., and systems with various channel spacing[1], e.g. 25 kHz, 1.25 MHz, 5 MHz, etc. The focus is on the interference-free co-existence of systems with different channel spacing on both sides of a border.

Such land mobile systems typically can support the industrial sector, transportation sector (including airports and railways) and governmental sector (blue light forces, but also e.g. embassies), life-saving services, the energy/utilities sector (smart metering/smart grids), hotels/tourism sector, financial sector, the agricultural and forestry sector, the retail sector, or electronic communications for the public, e.g. Mobile/Fixed Communications Networks (MFCN).

In order to avoid harmful interference, indicative coordination threshold levels (see Annex 1) triggering the coordination between neighbouring countries are established at the border-line with regard to a reference bandwidth of 25 kHz.

In addition, for systems using a channel bandwidth greater than 1 MHz, field strength triggers are also established that can ensure coverage in border areas (see Annexes 3 and 4).

In cases where bilateral or multilateral coordination agreements already exist, for example in which levels are agreed in line with a previous version of Recommendation T/R 25-08 or other agreed values, these agreements are still relevant.

[1] Channel spacing refers to the distance between the nominal centre frequencies of adjacent channels. Channel bandwidth is most commonly understood as the bandwidth which is used by the system as defined in the respective standards.

RECOMMENDATION T/R 25-08 ON PLANNING CRITERIA AND CROSS-BORDER COORDINATION OF FREQUENCIES FOR LAND MOBILE SYSTEMS IN THE RANGE 29.7-470 MHZ (AMENDED 28 SEPTEMBER 2018)

"The European Conference of Postal and Telecommunications Administrations,

considering

a) that coordination between neighbouring countries should be triggered by common threshold levels;

b) that each new frequency assignment above the defined coordination threshold level must be coordinated with frequencies already assigned in the same geographical area for use by the stations of neighbouring administration(s);

c) that to balance interference-free frequency usage and service coverage needs in border areas, coordination or bilateral agreements are likely to be required;

d) that the probability of obtaining a successful cross-border coordination diminishes rapidly as a function of the number of radio stations;

e) that the difficulties encountered with cross-border coordination depend on a great number of parameters (technical, operational or topographical);

f) that agreements have successfully been concluded between some administrations concerning coordination of frequencies for the land mobile service, notably the "HCM Agreement" [7] which also contains details of propagation issues and coordination procedures;

g) that in order to facilitate cross-border coordination, a large number of parameters (technical and operational) need to be presented in an agreed format;

h) that it is desirable that channelling arrangements for the land mobile services be harmonised;

i) that in order to reduce the risks of harmful interference and facilitating cross-border coordination, the lowest possible antenna height and the lowest possible radiated power, and wherever possible, directional antennas should normally be used;

j) that ECC Report 97 [1] contains a study of methods required to carry out the calculations of interference across a border for a number of technologies, but not used for broadband technologies. Administrations may consider using the methods and the results described in ECC Report 97 in their bilateral or multilateral agreements;

k) that ECC Report 108 [2] contains a study and proposes the method of Border Code Coordination between CDMA-PAMR Systems in the 450 MHz band. Administrations may consider using the methods and the results described in ECC Report 108 in their bilateral or multilateral agreements;

l) that ECC Report 276 [4] provides the technical background for the coordination of land mobile systems with channel bandwidth greater than 1 MHz in situations where no or some overlap with systems with channel bandwidth up to 25 kHz occurs across the border;

m) that European common frequency allocations and applications are given in the latest version of ERC Report 25;

n) that there are ERC and ECC Decisions, Recommendations and Reports concerning the use of frequencies in the range 29.7-470 MHz;

o) that the definitions used in this Recommendation shall be those of Article 1 of the Radio Regulations, unless otherwise specified herein;

recommends

1. that CEPT administrations should enter into coordination agreements with their neighbouring countries. The “HCM Agreement”[7] or parts of it may be used as a basis for these agreements, if applicable provisions are given in the "HCM Agreement";

2. that CEPT administrations should endeavour to comply with the provisions in Annex 1 and in Annex 2 when assigning frequencies to land mobile systems in border areas, where coordination with neighbouring countries is necessary;

3. that bilateral or multilateral agreements should be established for frequency coordination in the 400 MHz range between land mobile systems using preferential channels based on the 25 kHz channel plan on one side and land mobile systems with channel bandwidth greater than 1 MHz on the other side of the border, based on the principles and provisions provided in Annex 3;

4. that bilateral or multilateral agreements should be established for frequency coordination in the 400 MHz range between neighbouring land mobile systems with channel bandwidth greater than 1 MHz, based on the principles and provisions provided in Annex 4;

5. that frequency coordination between neighbouring land mobile systems with channel bandwidth greater than 1 MHz in border areas should be based on the codes and Physical-Layer Cell Identities (PCI) provided in Annex 5 when channel centre frequencies are aligned;

6. that other radio parameters for LTE (besides Physical-Layer Cell Identities) may need to be coordinated on a bilateral or multilateral basis based on the guidance provided in Annex 6;

7. that CEPT administrations may diverge from the technical parameters, propagation models and procedures described in this Recommendation subject to bilateral / multilateral agreements;

8. that administrations should encourage and facilitate the establishment of arrangements between operators of different countries with the aim to enhancing the efficient use of the spectrum and the coverage in the border areas.

ANNEX 1: PROVISIONS RELATED TO OPERATING CONDITIONS AND CHOICE OF FREQUENCIES

A1.1 USE OF FREQUENCIES

A1.1.1 Harmonised use of frequency bands in different countries

Whenever practicable, frequency bands should be assigned for harmonised frequency use by land mobile systems according to Annex 2.

For this purpose, relevant ERC/ ECC Decisions and Recommendations, which designate and identify certain frequency bands or their parts for some particular application, should be used as a primary guidance for transnational harmonisation of frequency use.

A1.1.2 Use of frequencies in border area

In border areas, a set of frequencies may be shared between certain user groups in adjacent countries in order to make the most effective use of the frequency spectrum. Such shared frequencies shall be frequencies assigned in a particular region, by a bilateral or multilateral agreement of administrations concerned, to users with similar traffic conditions and using comparable equipment. The number of stations per channel might also be coordinated in the same agreement. Administrations may also conclude bilateral or multilateral agreement in order to improve the service coverage in border areas (e.g. preferential use of frequencies, code / pseudo-noise (PN) or PCI coordination, methods presented in Annexes 3 and 4 etc.).

A1.2 PROVISIONS OF A TECHNICAL NATURE

A1.2.1 Channelling

A1.2.1.1 Analogue and digital narrowband land mobile systems using a channel spacing up to 25 kHz

Administrations should select channel centre frequencies (hereinafter called centre frequencies) using the following preferred formula. This preferred formula should be used whenever possible, but at least in new and re-farmed bands.

$$FCH = \text{Band Edge} - (\text{Channel Spacing}/2) + n^*\text{Channel Spacing}$$

where

$$F_{CH} = \text{channel centre frequency}$$

n = 1, 2, 3,… - channel number;

Band Edge is lower edge of allocated frequency band, MHz, e.g. 29.7, 54, 68, 146, 174, 380, 406.1, and 440 (see Annex 2)

Note: Before 1999 the following old formula was used:

$$F_{CH} = \text{Band Edge} + n^*\text{channel spacing}$$

Channelling arrangements based on this old formula are still in use in some bands in some countries but the usage should be aligned with the preferred formula whenever possible.

A1.2.1.2 Digital land mobile systems using a channel spacing greater than 25 kHz

Administrations should select centre frequencies as follows:

- For systems using a channel spacing of 50 kHz, 100 kHz or 150 kHz the centre frequencies should be selected according to the preferred formula in section A1.2.1.1.
- For systems using a channel spacing of 200 kHz the centre frequencies should be selected according to the preferred formula in section A1.2.1.1 with an option to offset these centre frequencies by 100 kHz.
- For systems using a channel spacing of 1.25 MHz the centre frequencies should be selected according to the preferred formula in section A1.2.1.1 with an option to offset these centre frequencies by multiples of 12.5 kHz, in order to provide flexibility to locate the centre frequencies in the optimum position within the band.
- For systems using a channel spacing of 1.4 MHz, 3 MHz, or 5 MHz, the centre frequencies should be selected according to the preferred formula in section A1.2.1.1 with an option to offset these centre frequencies by multiples of 100 kHz.

A1.2.2 Duplex or two-frequency simplex channel separation, location of sub-bands and guard bands

In so far as administrations are in a position to define the duplex separation, its values and the respective positions of the sub-bands as given in Annex 2 should be taken into consideration. A sub-band can be simplex or duplex. The lower and upper part of a duplex sub-band should be in the same allocated band. For instance, MS2 in the 146-174 MHz allocated band cannot be paired with BS2 in the 174-230 MHz allocated band.

The frequencies of emissions of base or repeater stations should be placed in the upper band and those of mobile stations in the lower band. The same positions of upper and lower bands should be selected for bordering/adjacent countries (see examples in Annex 2).

The channel centre frequency of a digital land mobile system using a channel spacing greater than 25 kHz may be selected in a way that the channel pertaining to the centre frequency with its nominal channel spacing falls entirely into a sub-band given in Annex 2 and does not overlap the guard band necessary around the edges of simplex sub-bands and the edges of the lower parts and upper parts of duplex sub-bands.

A1.2.3 Indicative coordination thresholds for analogue or digital land mobile systems

The aim of coordination thresholds is to avoid harmful interference between stations located in neighbouring countries. In order to achieve this, indicative coordination thresholds are established which should not be exceeded without coordination between neighbouring countries.

Indicative coordination thresholds for land mobile systems (co-channel, 50% locations, 10% time[2], 10 m receiving antenna height, within a reference bandwidth of 25 kHz, at the border-line) are:

0 dB(µV/m) for frequencies between 29.7 and 47 MHz;

6 dB (µV/m) for frequencies between 47 and 108 MHz;

12 dB (µV/m) for frequencies between 108 and 380MHz;

18 dB (µV/m) for frequencies between 380 and 400 MHz;

20 dB (µV/m) for frequencies between 400 and 470 MHz.

For systems using a channel spacing greater than 25 kHz, the following bandwidth conversion formula can be used provided that the spectral power distribution within this channel spacing is uniform within the channel.

BC = 10 x log10 (channel spacing / 25 kHz) dB

The value (BC) resulting from the formula should be added to the indicative coordination threshold as listed above.

For all other spectral power distributions, indicative coordination threshold levels should be applied within every 25 kHz bandwidth within the channel spacing.

A1.2.4 Planning characteristics in border areas

The location, the power and the antenna heights of all stations in the network should be selected in such a way that their range is confined, as far as possible, to the zone to be covered by the intended service.

Excessive antenna heights and transmitter outputs should be avoided, by using several locations of reduced height wherever possible. In border areas directional antennas should be used in order to minimise the interference potential.

The effective radiated power and the height of the antenna should be as low as possible in relation to the area to be served.

[2] In certain situations, the 1% time curves should be used for digital systems, e.g. to better protect analogue systems.

ANNEX 2: RECOMMENDED DUPLEX SEPARATION, USE AND LOCATION OF SIMPLEX AND DUPLEX BANDS INCLUDING THE UPPER AND LOWER PARTS OF DUPLEX BANDS (BASED ON THE EUROPEAN COMMON ALLOCATIONS TABLE; ERC REPORT 25)

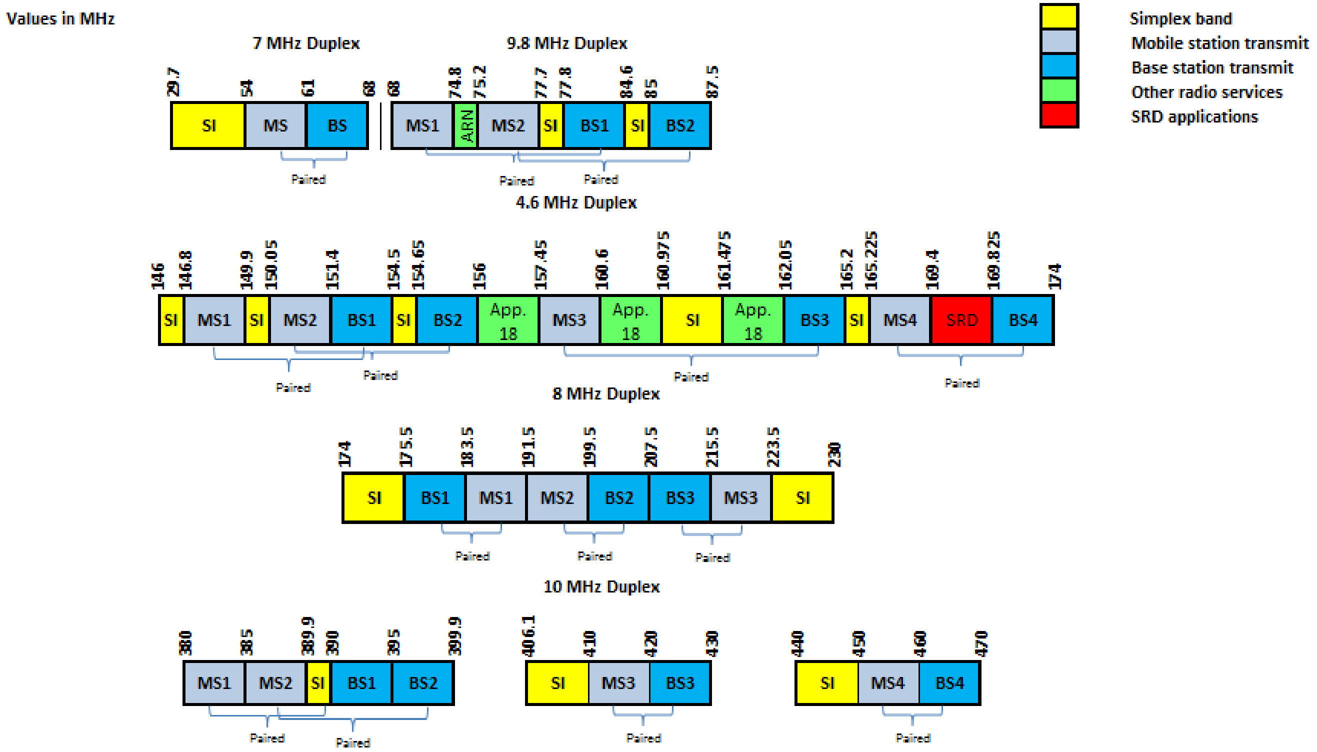

Figure 1: Recommended frequency bands

App. 18: RR Appendix 18 for VHF maritime communications

ARN: Aeronautical radio navigation (ILS/marker beacons)

In paired bands, the figure above indicates the duplex separation for the individual bands for the pairing of the respective MS (mobile station transmit band) and BS (base station transmit band), e.g. MS1 with BS1 within one frequency range.

ANNEX 3: FIELD STRENGTH LEVELS FOR CROSS-BORDER COORDINATION BETWEEN FDD LAND MOBILE SYSTEMS USING PREFERENTAL CHANNELS UP TO 25 KHZ AND SYSTEMS USING A CHANNEL GREATER THAN 1 MHZ WITHIN THE 410-430 MHZ AND 450-470 MHZ FREQUENCY BANDS

This Annex considers the coordination between preferential channels of land mobile systems up to 25 kHz on one side and land mobile systems with a channel greater than 1 MHz on the other side of the border, for operation within the 400 MHz frequency bands.

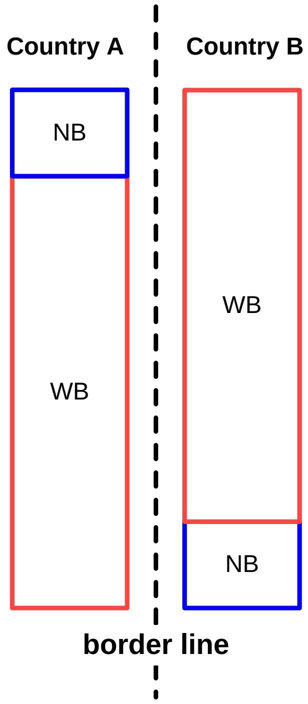

Figure 1: Overlapping narrower channel and wider channel land mobile systems across the border

According to recommends 3, the following should be taken into account:

- ECC Report 276 [4] provides a technical background for cross-border coordination of systems with a channel greater than 1 MHz in the 400 MHz band (410-430 MHz and 450-470 MHz) and proposes a method which can be applied in bilateral or multilateral agreements that allow for higher cross-border coordination thresholds for wideband systems in the 400 MHz band in situations where no or some overlap of narrowband and wideband allocations across the border occurs. In consequence, it means that land mobile systems up to 25 kHz keep their existing preferential rights and may extend them to all non-preferential channels in the overlapping range, if preferential rights of other administrations involved are not affected;
- The overlap is typically as small as a few hundred kilohertz. ECC Report 276 does not cover the case of full overlap between land mobile systems up to 25 kHz on one side and land mobile systems with a channel greater than 1 MHz on the other side of the border;
- In the situation where land mobile systems up to 25 kHz use preferential rights not to the full extent, i.e. they do not generate the maximum allowed field strength at a distance of 40 or 50 km in the territory of the neighbouring administration, solutions should be found between administrations or operators. One possible solution would be to increase the radiated power of the preferential system to the extent possible under preferential rights conditions. If not possible, a reduction of the radiated power of the system with a channel bandwidth > 1 MHz within the preferential frequency of the system with channel bandwidth up to 25 kHz may be considered;
- The two most common preferential regimes for narrowband systems were considered, both defined as the field strength threshold of 20 dB µV/m at 10 m height in 25 kHz at a distance inside the neighbouring country: Preferential Regime a) at 40 km distance and Preferential Regime b) at 50 km distance. The

proposed coordination thresholds for a partial overlap of land mobile systems up to 25 kHz on one side and land mobile systems with a channel greater than 1 MHz on the other side of the border are given in Table 1:

Table 1: Trigger values for partial overlap between narrowband system and wideband systems at a height of 10 m above ground

	Field strength at 10 m height	
	Regime a)	Regime b)
System up to 25 kHz **using preferential frequency**	20 dBµV/m/25 kHz@**40 km beyond the borderline**	20 dBµV/m/25 kHz@**50 km beyond the borderline**
System up to 25 kHz **using NON-preferential frequency**	20 dBµV/m/25 kHz@**0 km (on the borderline)**	20 dBµV/m/25 kHz@**0 km (on the borderline)**
System with a channel greater than 1 MHz	41 dBµV/m/25 kHz@**0 km (on the borderline)**	48 dBµV/m/25 kHz@**0 km (on the borderline)**
Note 1: Predictions for calculations: 50% location probability, 10% time probability **Note 2:** If a channel bandwidth other than 25 kHz is used, then a bandwidth conversion factor of 10 x Log10 (channel bandwidth/25 kHz) should be added to the field strength values. **Note 3:** For narrowband land mobile systems using preferential frequencies and bandwidth greater than 25 kHz (e.g. 50 kHz, 100 kHz, 150 kHz or 200 kHz), indicative coordination threshold levels should be applied within every 25 kHz bandwidth within the channel spacing.		

Note: @ stands for “at a distance inside the neighbouring country”.

For practical purposes, an antenna height correction factor of 10 dB from 10 m to 3 m height may be used. Other examples are the Okumura-Hatta model [6] that provides 15.6 dB, the ITU-R Recommendation P.1546 [8] that provides 10.3 dB or HCM that provides 9 dB.

ANNEX 4: FIELD STRENGTH LEVELS FOR CROSS-BORDER COORDINATION BETWEEN FDD LAND MOBILE SYSTEMS WITH CHANNELS GREATER THAN 1 MHZ IN THE FREQUENCY BANDS 410-430 MHZ AND 450-470 MHZ

This Annex considers the coordination between land mobile systems with channel bandwidths greater than 1 MHz on both sides of the border, for operation within the 400 MHz ranges. ECC Report 276 [4] provides technical background information. The deployment mode considered is FDD in the frequency bands 410-420 MHz (duplex with 420-430 MHz) and 450-460 MHz (duplex with 460-470 MHz).

1. Field strength trigger values for LTE vs LTE and CDMA vs. CDMA systems

Case A

Base stations using the same technologies on both sides of the borderline with centre frequencies not aligned, or using preferential PCIs or PN (Pseudo-Noise) codes given in Annex 5 with centre frequencies aligned may be used without coordination between neighbouring countries if the mean field strength produced by the cell (all transmitters within the sector) does not exceed the value of 55 dBμV/m/5MHz at a height of 3 m above ground at the borderline between neighbouring countries and does not exceed a value of 37 dBμV/m/5MHz at a height of 3 m above ground at a distance of 10 km inside the neighbouring country.

Case B

Base stations using the same technologies on both sides of the borderline with centre frequencies aligned and using non-preferential PN codes or PCIs given in Annex 5 may be used without coordination between neighbouring countries if the mean field strength produced by the cell (all transmitters within the sector) does not exceed the value of 37 dBμV/m/5MHz at a height of 3 m above ground at the borderline between neighbouring countries.

2. Field strength trigger values between LTE and CDMA

Case A

In case of different technologies used on both side of the borderline, with centre frequencies aligned or not aligned, base stations may be used without coordination with a neighbouring country if the mean field strength produced by the cell (all transmitters within the sector) does not exceed the value of 55 dBμV/m/5MHz at a height of 3 m above ground at the borderline between neighbouring countries and does not exceed a value of 37 dBμV/m/5MHz at a height of 3 m above ground at a distance of 10 km inside the neighbouring country.

3. Overview of the trigger values

For land mobile systems with channel bandwidth greater than 1 MHz, an overview of the trigger values of the field strength and the relevant paragraphs of this Annex are given in Table 2.

Table 2: Field strength triggers for FDD LTE/CDMA systems at a height of 3 m above ground

<table>
<tr><th></th><th colspan="3">Non-Preferential frequency usage</th></tr>
<tr><td></td><td colspan="2">Centre frequencies aligned</td><td>Centre frequencies not aligned</td></tr>
<tr><td></td><td>Preferential codes</td><td>Non-preferential codes</td><td>All codes</td></tr>
<tr><td>LTE vs. LTE
or
CDMA vs. CDMA</td><td>55 dBµV/m/5 MHz@0 km and 37 dBµV/m/5 MHz@10 km
Case A</td><td>37 dBµV/m/5 MHz@0km
Case B</td><td>55 dBµV/m/5 MHz@0 km and 37 dBµV/m/5 MHz @10 km
Case A</td></tr>
<tr><td>LTE vs. CDMA</td><td colspan="3">55 dBµV/m/5 MHz@0 km and 37 dBµV/m/5 MHz@10 km
Case A</td></tr>
<tr><td colspan="4">Note 1: Predictions for calculations: 50% location probability, 10% time probability
Note 2: If a channel bandwidth other than 5 MHz is used, then a bandwidth conversion factor applies: 10 x Log10 (channel bandwidth /5 MHz)</td></tr>
</table>

Note: @ stands for “at a distance inside the neighbouring country”.

4. Preferential frequencies for LTE/CDMA

Administrations may agree in bilateral or multilateral agreements/arrangements on preferential usage of frequencies, while ensuring a fair treatment of different operators.

ANNEX 5: PREFERENTIAL PHYSICAL-LAYER CELL IDENTITIES (PCI) FOR LTE AND CODES FOR CDMA

1. PCI coordination for LTE

PCI coordination is only needed when channel centre frequencies are aligned independent of the channel bandwidth.

ETSI TS 136 211 [5] defines 168 “unique physical-layer cell-identity groups” in §6.11, numbered 0…167, hereafter called “PCI groups”. Within each PCI group there are three separate PCIs giving 504 PCIs in total.

Administrations should agree on a repartition of these 504 PCI’s on an equitable basis when channel centre frequencies are aligned as shown in Table 3. It has to be noted that dividing the PCI groups or PCI’s is equivalent. Each country should only use its own preferential PCI’s close to the border.

As shown in Table 3, the PCI’s should be divided into 6 sub-sets containing each one sixth of the available PCI’s. Each country is allocated three sets (half of the PCI’s) in a bilateral case, and two sets (one third of the PCI’s) in a trilateral case.

Four types of countries are defined in a way such that no country will use the same code set as any one of its neighbours. The following lists describe the distribution of European countries:

Type country 1: AZE, BEL, CVA, CYP, CZE, DNK, E, FIN, GRC, IRL, ISL, LTU, MCO, SMR, SUI, SRB, SVN, and UKR.

Type country 2: AND, BIH, BLR, BUL, D, EST, G, GEO, HNG, I, MDA, and RUS (Exclave).

Type country 3: ALB, AUT, F, HOL, HRV, MLT, POL, POR, ROU, RUS, and S.

Type country 4: LIE, LUX, LVA, MKD, MNE, NOR, SVK, and TUR.

For each type of country, the following tables and figure describe the sharing of the PCI’s with its neighbouring countries, with the following conventions of writing:

(black)	Preferential PCI
(white)	Non-preferential PCI

The 504 physical-layer cell identities should be divided into the following 6 sub-sets when the carrier frequencies are aligned in border areas:

Table 3: PCI sub-sets

PCI	Set A	Set B	Set C	Set D	Set E	Set F
Country 1	0..83	84..167	168..251	252..335	336..419	420..503
Border 1-2	■	■				■
Zone 1-2-3	■	■				
Border 1-3	■	■	■			
Zone 1-2-4	■					■
Border 1-4	■		■			■
Zone 1-3-4	■		■			

PCI	Set A	Set B	Set C	Set D	Set E	Set F
Country 2	0..83	84..167	168..251	252..335	336..419	420..503
Border 2-1			■	■	■	
Zone 2-3-1			■	■		
Border 2-3		■	■	■		
Zone 2-1-4			■	■		
Border 2-4			■	■		■
Zone 2-3-4			■	■		

PCI	Set A	Set B	Set C	Set D	Set E	Set F
Country 3	0..83	84..167	168..251	252..335	336..419	420..503
Border 3-2	■				■	■
Zone 3-1-2					■	■
Border 3-1				■	■	■
Zone 3-1-4					■	■
Border 3-4			■		■	■
Zone 3-2-4					■	■

PCI	Set A	Set B	Set C	Set D	Set E	Set F
Country 4	0..83	84..167	168..251	252..335	336..419	420..503
Border 4-1		■		■	■	
Zone 4-1-2		■			■	
Border 4-2	■	■			■	
Zone 4-2-3	■	■				
Border 4-3	■	■		■		
Zone 4-3-1		■		■		

Notes

1) In certain specific cases (e.g. AUT/HRV) where the distance between two countries of the same type number is very small (< few 10s km), it may be necessary to address the situation in bilateral or multilateral coordination agreements as necessary, and may include further subdivision of the allocated codes in certain areas.

2) The country type map is given in section 3.

2. Code coordination for CDMA

For code coordination each base station shall use a unique time offset of the pilot pseudo-noise (PN) sequence to identify a Forward CDMA Channel. Time offsets may be reused within a CDMA cellular system. Distinct pilot channels shall be identified by an offset index (0 through 511 inclusive). This offset index specifies the offset time from the zero offset pilot PN sequence in multiples of 64 chips. The same pilot PN sequence offset shall be used on all CDMA frequency assignments for a given base station. To distinct signals with PN sequence offsets all base stations should be time synchronised but such synchronisation is mandatory requirement for CDMA2000 standard.

Administrations should agree on a repartition of these offset indexes on an equitable basis. Each country should only use its own codes close to the border.

In border areas, codes will be divided into 6 "index sets" containing each one sixth of the available offset indexes. Each country is allocated three index sets (half of the indexes) in a bilateral case, and two index sets (one third of the indexes) in a trilateral case.

Four types of countries are defined in such a way that no country will use the same index set as any one of its neighbours. The following lists describe the distribution of European countries:

Type country 1: AZE, BEL, CVA, CYP, CZE, DNK, E, FIN, GRC, IRL, ISL, LTU, MCO, SMR, SRB, SUI, SVN and UKR;

Type country 2: AND, BIH, BLR, BUL, D, EST, G, GEO, HNG, I, MDA, and RUS (Exclave);

Type country 3: AUT, F, HOL, HRV, MLT, MKD, POL, POR, ROU, RUS, and S;

Type country 4: ALB, LIE, LUX, LVA, MNE, NOR, SVK and TUR.

For each type of country, the following tables and figure describe the sharing of the indexes with its neighbouring countries, with the following conventions of writing:

■	Preferential index
	non-preferential index

Table 4: Sharing of the indexes

	Set A	Set B	Set C	Set D	Set E	Set F
Country 1	2..83	88..168	173..253	258..338	343..423	428..509
Border 1-2	■	■				■
Zone 1-2-3	■	■				
Border 1-3	■	■	■			
Zone 1-2-4	■					■
Border 1-4	■		■			■
Zone 1-3-4	■		■			

	Set A	Set B	Set C	Set D	Set E	Set F
Country 2	2..83	88..168	173..253	258..338	343..423	428..509
Border 2-1			■	■	■	
Zone 2-3-1			■	■		
Border 2-3		■	■	■		
Zone 2-1-4			■	■		
Border 2-4			■	■		■
Zone 2-3-4			■	■		

	Set A	Set B	Set C	Set D	Set E	Set F
Country 3	2..83	88..168	173..253	258..338	343..423	428..509
Border 3-2	■				■	■
Zone 3-1-2					■	■
Border 3-1				■	■	■
Zone 3-1-4					■	■
Border 3-4			■		■	■
Zone 3-2-4					■	■

	Set A	Set B	Set C	Set D	Set E	Set F
Country 4	2..83	88..168	173..253	258..338	343..423	428..509
Border 4-1		■		■	■	
Zone 4-1-2		■			■	
Border 4-2	■	■			■	
Zone 4-2-3	■	■				
Border 4-3	■	■		■		
Zone 4-3-1		■		■		

Because of the time shifting mechanism for code generation, the situation can appear that propagation delay may lead to the synchronisation of two different base stations signals occurring in some parts of the service area. The average diameter of such correlation areas could be up to 245 meters (one chip duration multiplied on light speed). To prevent such situations in border areas it is recommended not to use some codes and to introduce 4 exclusion codes between neighbouring index sets what gives 78.125 km propagation path before a possible correlation area appears. This precludes any real synchronisation and will not affect network planning, causing a reduction of code space less than on 5% only in border areas.

Code sharing between two countries should be applied or used by base stations that exceed the relevant trigger level (Annex 4 Table 2) of only one neighbouring country. Code sharing between three countries should be applied or used by base stations that exceed the relevant trigger level (Annex 4 Table 2) of two neighbouring countries.

Notes

1) In certain specific cases (e.g. AUT/HRV) where the distance between two countries of the same type number is very small (< few 10s km), it may be necessary to address the situation in bilateral or multilateral coordination agreements as necessary, and may include further subdivision of the allocated codes in certain areas.

2) The country type map is given in section 3.

3. Country type map (see next page)

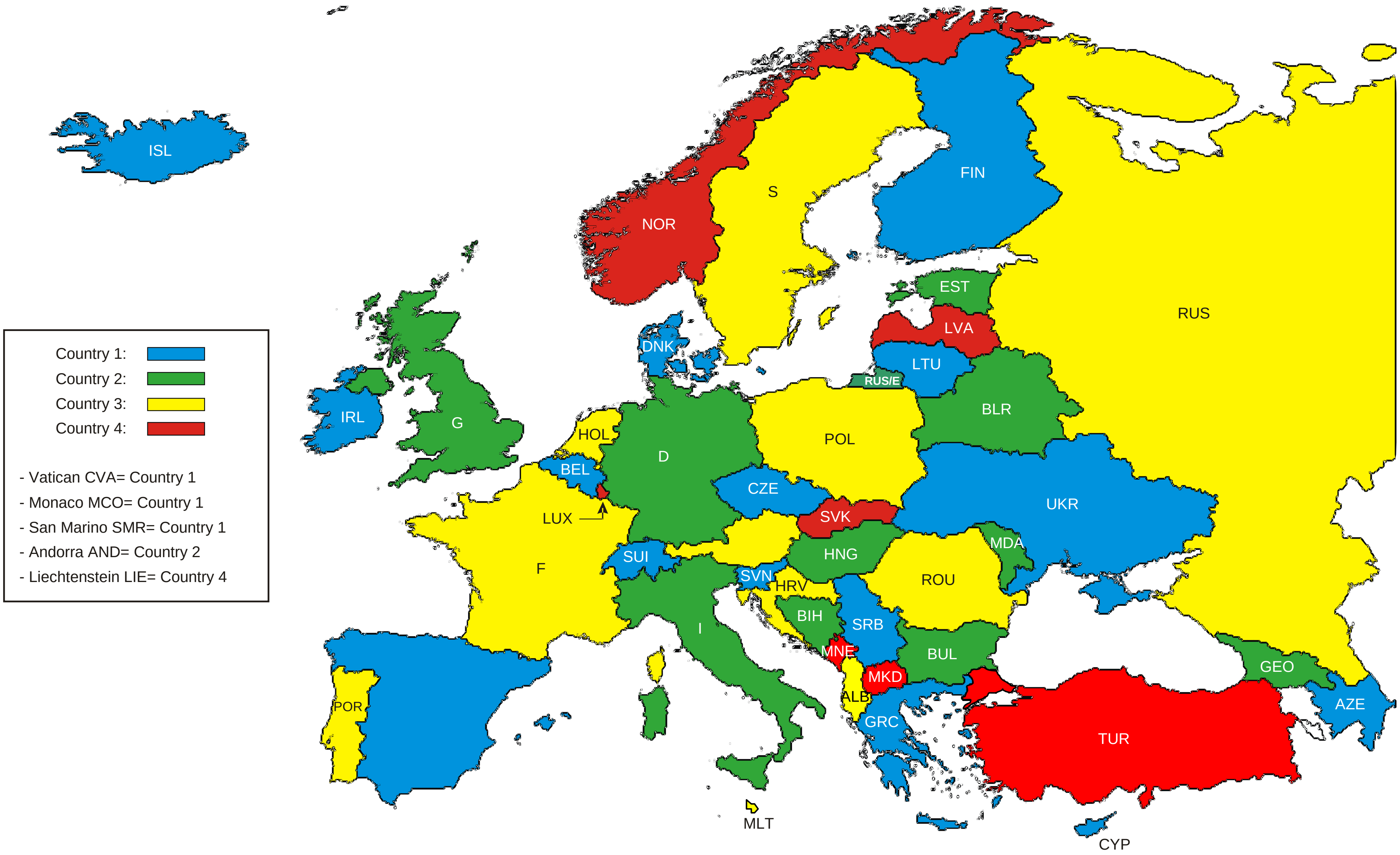

Figure 2: Country type map

ANNEX 6: GUIDANCE ON THE CONSIDERATION OF LTE RADIO PARAMETERS FOR USE IN BILATERAL AND MULTILATERAL AGREEMENTS

This Annex is provided for guidance purposes for use in bilateral and multilateral discussions. For LTE, it may be beneficial to coordinate other radio parameters besides PCI (which is covered by the previous Annex) in order to minimise deteriorating effects of uplink interference.

The parameters described in this Annex are usually optimised during LTE radio network planning of an operator's network. The idea of optimisation is to plan the parameters taking into account specific correlation properties of the uplink control signals which enable more stable and predictable operation of the network. In the cross-border scenario the optimisation of parameters among neighbouring operators could provide better control of uplink interference. However because of the difference between intra-network and inter-network interference and due to limited experience in the LTE cross-border deployment, it is difficult to assess the benefits of such optimisation. Operators should consider the following guidance for high levels of uplink interference in border areas.

1. Demodulation Reference Signal coordination

Demodulation Reference Signals (DM RS) are transmitted in the uplink and used for channel estimation. There is a risk of intercell interference between neighbouring cells even in case of no frame synchronisation. That is why special measures for DM RS allocation between networks in neighbouring countries occupying the same channel may need to be applied.

The case of partial channel overlap has not been studied but due to DM RS occupying resource blocks of separate users there is a risk of DM RS collisions between neighbouring networks when the subcarriers positions coincide (the frequency offset between central carriers of neighbouring networks is multiple of 300 kHz). Some minor benefits from DM RS coordination in these particular cases could be expected.

There are a number of possible approaches to the coordination of DM RS:

- In basic planning procedure only 30 DM RS sequence groups with favourable correlation characteristics are available, numbered {0…29}. In this case each cell could be assigned one of the 30 DM RS sequence groups providing cluster size of 30.
- It is possible to extend each DM RS sequence group to generate up to 12 time shifted sequence groups by applying the cyclic shift parameter stated in ETSI TS 136 211 [5]. For example each tri-sector site could be assigned one DM RS sequence group with each co-sited cell having its own cyclic shift of 2π/3 which provides cluster size 30 only with 10 DM RS sequence groups. The latter case corresponds well to the case of DM RS sequence groups repartition between neighbouring countries when only limited number of groups is available for network planning. The drawback of DM RS sequence group cyclic shift is a loss of orthogonally of DM RS due to fading channels which has been found only recently during first trials of LTE and caused throughput loss as well as time alignment problems.
- Another approach for DM RS coordination is to implement dynamic DM RS sequence group allocation also called pseudo-random group hopping. In this method nearby cells are grouped into clusters up to 30 cells and within each cell cluster the same hopping-pattern is used. At the border of two clusters inter-cell interference is averaged since two different hopping patterns are utilised. There are 17 defined hopping patterns, numbered {0…16}, which leads to some minor unfairness in case of apportioning these patterns between neighbouring countries. Even in a trilateral case each operator will have at least 5 hopping patterns available near the border which should be enough for planning purposes. It should be noted the pseudo-random group hopping option could be absent in the first generations of LTE equipment.

The decision which of these methods should be used in cross-border coordination should be agreed by the interested parties. Specific DM RS sequence groups or hopping patterns repartition is not provided in the text of this Recommendation but could be deduced in a similar manner to the PCI repartition shown in the previous Annex.

2. Physical Random Access Channel (PRACH) coordination

Another radio network parameter which is considered during radio network planning is PRACH configuration which is needed to distinguish random access requests addressed to different cells. PRACH resources are allocated by specifying the PRACH Resource Blocks time positions within the uplink frame, their frequency position within the LTE channel bandwidth and by apportioning cell-specific root sequences. During radio network planning these parameters are usually used in the following way:

- time positions for PRACH resource allocations are usually used to create time collision of PRACH resources of co-sited/frame synchronised cells because PRACH-to-PRACH interference is usually less severe than PUSCH (Physical Uplink Shared Channel)-to-PRACH interference;
- frequency positions within the LTE channel bandwidth is usually the same for all cells, again because PRACH-to-PRACH interference case is more favourable one;
- cell-specific root sequences are used to distinguish between PRACH requests addressed to different cells.

For cross-border coordination it is proposed to use frequency position offsets to exclude the possibility of so-called “ghost” PRACH requests caused by neighbouring networks. The PRACH is configured in LTE to use only 6 Resource Blocks or 1.08 MHz of the LTE channel bandwidth except in regions used by PUCCH (Physical Uplink Control Channel). In case of overlapping or partially overlapping channel bandwidths of neighbouring networks it is enough to establish non-overlapping PRACH frequency blocks to perform coordination. Because it is difficult to establish an implementation dependent procedure for such allocation it will be the responsibility of operators to manage such frequency separation during coordination discussions.

In early implementation it is possible that very limited number of frequency positions will be supported by LTE equipment which will not be enough to coordinate in the trilateral case. In such cases root-sequence repartition could be used. There are 838 root sequences in total to be distributed between cells, numbered {0..837}. There are two numbering schemes for PRACH root sequences (physical and logical) and only the logical root sequence numbering needs to be used for coordination. Unfortunately the process of root sequence planning does not involve direct mapping of root sequences between cells because the number of root sequences needed for one cell is dependent on the cell range. Table 5 shows such interdependency.

Table 5: Number of root sequences

PRACH Configuration	Number of root sequences per cell	Cell Range (km)
1	1	0.7
2	2	1
3	2	1.4
4	2	2
5	2	2.5
6	3	3.4
7	3	4.3
8	4	5.4
9	5	7.3
10	6	9.7

PRACH Configuration	Number of root sequences per cell	Cell Range (km)
11	8	12.1
12	10	15.8
13	13	22.7
14	22	38.7
15	32	58.7
0	64	118.8

Thus, in the case of root sequence repartition, it will be the responsibility of radio network planners to assign the correct number of root sequences in order to not overlap with the root sequence ranges of other operators. It also should be noted that different root sequences have different cubic metrics and correlation properties which affect PRACH coverage performance and planning of so-called high-speed cells. For simplicity of cross-border coordination it is proposed to ignore these properties.

In summary it should be stipulated that frequency separation of PRACH resources should be used as the main coordination method. PRACH root sequences repartition should be avoided and used only in exceptional cases. Specific PRACH root sequences repartition is not provided in this Recommendation but could be deduced in a similar manner to the PCI repartition shown in Annex 5.

ANNEX 7: LIST OF REFERENCES

[1] ECC Report 97 - Cross Border Interference for Land Mobile Technologies

[2] ECC Report 108 - Border Code Coordination between CDMA-PAMR Systems

[3] ERC Report 25 - The European table of frequency allocations and applications in the frequency range 8.3 kHz to 3000 GHz

[4] ECC Report 276 – Thresholds for the coordination of CDMA and LTE broadband systems in the 400 MHz band

[5] ETSI TS 136 211 – LTE; Evolved Universal Terrestrial Radio Access (E-UTRA); Physical channels and modulation (3GPP TS 36.211 version)

[6] ERC Report 68 – Monte-Carlo Radio Simulation Methodology for the use in sharing and compatibility studies between different radio services or systems, February 2000, revised May 2001 and June 2002

[7] HCM Agreement (Harmonised Calculation Method) between the administrations of Austria, Belgium, the Czech Republic, Germany, France, Hungary, the Netherlands, Croatia, Italy, Liechtenstein, Lithuania, Luxembourg, Poland, Romania, the Slovak Republic, Slovenia and Switzerland on the Coordination of frequencies between 29.7 MHz and 43.5 GHz for the Fixed Service and the Land Mobile Service. The latest version of this agreement can be found from http://www.hcm-agreement.eu/http/englisch/verwaltung/index_europakarte.htm

[8] ITU-R Recommendation P.1546: Method for point-to-area predictions for terrestrial services in the frequency range 30 MHz to 3 000 MHz