ECC Recommendation (15)01

Cross-border coordination for Mobile/Fixed Communications Networks (MFCN) in the frequency bands: 694-790 MHz, 1427-1518 MHz and 3400-3800 MHz

Approved 13 February 2015

latest amendment on 14 February 2020

INTRODUCTION

Following the harmonised technical conditions for the frequency bands 694-790 MHz (700 MHz), 1427-1518 MHz and 3400-3800 MHz defined in the relevant ECC Decisions, this Recommendation contains provisions for cross-border coordination between Mobile/Fixed Communications Networks (MFCN) in these frequency bands in order to avoid harmful interference and provide guidance in case of synchronised and unsynchronised MFCN TDD systems operation in the 3400-3800 MHz frequency band.

This Recommendation covers Wideband (WB) vs. Wideband systems cross-border coordination scenarios but does not address cross-border coordination of MFCN vs. other systems in these bands.

In this Recommendation, Wideband systems include LTE and New Radio (NR).

In this Recommendation, the term legacy refers to historical MCFN TDD networks and which is not NR system.

ECC RECOMMENDATION (15)01 OF 13 FEBRUARY 2015 ON CROSS-BORDER COORDINATION FOR MOBILE/FIXED COMMUNICATIONS NETWORKS (MFCN) IN THE FREQUENCY BANDS: 694-790 MHZ, 1427-1518 MHZ AND 3400-3800 MHZ, AMENDED ON 6 FEBRUARY 2016 AND ON 14 FEBRUARY 2020

"The European Conference of Postal and Telecommunications Administrations,

considering

a) that ECC Decision (11)06 [1] provides the harmonised conditions for Mobile/Fixed Communications Networks (MFCN) operating in the band 3400-3800 MHz;

b) that in some CEPT countries, the deployment of networks will need a bilateral agreement concerning the use of stations in the mobile service in one country and stations of other primary services in a neighbouring country (e.g. earth stations of the fixed satellite service) (see RR 5.430A [2] for the band 3400-3600 MHz);

c) that ECC Decision (13)03 [3] provides the harmonised conditions for Mobile/Fixed Communications Networks Supplemental Downlink (MFCN SDL) operating in the band 1452-1492 MHz;

d) that ECC Decision (17)06 [4] provides the harmonised conditions for MFCN SDL operating in the bands 1427-1452 MHz and 1492-1518 MHz;

e) that some administrations may use the frequency band or part of the band 1427-1518 MHz for terrestrial broadcasting, aeronautical telemetry, MFCN other than SDL or other terrestrial systems;

f) that the 1427-1452 MHz and 1492-1518 MHz bands are also used for land and maritime military systems in some CEPT countries according to ERC Report 25 [5] (ECA Table), however this does not exclude the utilisation for civil applications;

g) that in some CEPT countries bilateral agreement will be needed to ensure coexistence between fixed links and MFCN (e.g. in the frequency bands 1427-1452 MHz and 1492-1518 MHz);

h) that the use of aeronautical mobile service in the countries mentioned in RR No 5.342 [2] is subject to coordination and agreement between the administrations concerned;

i) that according to the provisions of No. 5.341A of the ITU Radio Regulations (RR) [2], in some CEPT countries, the use of IMT stations in the frequency bands 1429-1452 MHz and 1492-1518 MHz is subject to agreement obtained under No. 9.21 of RR with respect to the aeronautical mobile service used for aeronautical telemetry in accordance with No. 5.342 of RR;

j) that "Mobile/Fixed Communications Networks" (MFCN) for the purpose of this Recommendation includes IMT and other communications networks in the mobile and fixed services;

k) that ECC Report 295 [6] provides guidance on cross border coordination between MFCN and Aeronautical Telemetry Systems (ATS) in the 1429-1518 MHz band;

l) that ECC Decision (15)01 [7] provides the harmonised technical conditions for Mobile/Fixed Communications Networks (MFCN) in the band 694-790 MHz including a paired frequency arrangement (Frequency Division Duplex 2x30 MHz) and an optional unpaired frequency arrangement (Supplemental Downlink, MFCN SDL);

m) that in some CEPT countries the frequency bands or part of the bands 694-790 MHz and 1452-1479.5 MHz may be used for terrestrial broadcasting services before allowing the use of MFCN in these bands[1]. Nevertheless, there is a need to reorganise these bands before the introduction of MFCN. The implementation of the 700 MHz band frequency arrangements for MFCN 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 coexistence with broadcasting service, the coordination procedure will take into account the framework of the GE06 Agreement [10];

n) that in some CEPT countries the defragmentation of the frequency band 3400-3800 MHz will be achieved mainly after 2020 leaving existing fixed or mobile systems operating for several years in some parts of the band. Due to the CEPT roadmap for the introduction of 5G, different portions of the spectrum will be available and assigned for 5G in specific countries and will introduce the need to establish bilateral/multilateral agreements between neighbouring countries to protect existing services;

[1] See Decision (EU) 2017/899 (UHF including 700 MHz))[8], see ECC Decision (13)02 [9] which withdrew the ECC Decision (03)02 (BSS in 1452-1492 MHz)

o) that unsynchronised operation of MFCN TDD networks in the 3400-3800 MHz frequency band may imply a need for large separation distances to deploy MFCN TDD networks in border areas (ECC Report 296 [11] indicates a separation distance of 60 km between AAS BS without mitigation techniques), which may have a considerable impact on MFCN global coverage;

p) that synchronised operation of MFCN TDD networks in the 3400-3800 MHz frequency band ensures a higher degree of efficient spectrum utilisation especially for outdoor network deployments in adjacent geographic areas (see ECC Report 296 [11]);

q) that in the frequency band 3400-3800 MHz, the time reference (t0) is defined according to Coordinated Universal Time (UTC)

r) that a MFCN supplemental downlink (SDL) is a mobile broadband system, which by means of base station transmitters in the network, uses unpaired spectrum in the downlink to provide a supplemental downlink capacity to carry comprehensive text, audio, images, data, sound and video content in general, in a unicasting, multicasting or broadcasting mode;

s) that a MFCN SDL could aggregate the usual downlink channel of a MFCN paired (FDD) band with a supplemental downlink channel(s) in the unpaired spectrum to increase the downlink capacity;

t) that in many CEPT member countries there may be multiple operators for MFCN systems;

u) that frequency planning of MFCN in border areas should be based on coordination between national administrations in cooperation with their operators;

v) that different administrations may wish to adopt different approaches to cross border coordination;

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

x) that cross-border coordination is necessary between countries operating different technologies and different channel bandwidths in the same frequency band;

y) that in the case of operator arrangements approved by national administrations it is possible to deviate from this Recommendation;

z) that Physical-layer Cell Identity (PCI) coordination is necessary for LTE/NR systems to avoid unnecessary signalling load and handover failures;

recommends

1. that cross-border coordination between MFCN systems in border areas should be based on bilateral / multilateral agreements between administrations;

2. that in case of MFCN TDD systems in the 3400-3800 MHz frequency band, administrations should preferably facilitate implementation of frame structure options given as examples in Annex 5, where possible, in order to facilitate synchronisation in border areas

3. that in case of MFCN TDD systems in the 3400-3800 MHz frequency band, administrations should preferably facilitate synchronised networks, where possible, for an efficient usage of the spectrum in border areas

4. that in case of MFCN TDD systems in the 3400-3800 MHz frequency band, agreements/arrangements between administrations/operators should consider synchronise MFCN TDD networks based on the guidance given in Annex 5;

5. that cross-border coordination between MFCN systems and other systems in neighbouring countries should be based on bilateral / multilateral agreements between administrations;

6. that bilateral / multilateral agreements should define coordination methods which encompass LTE and NR radio interfaces present on each side of the border;

7. that cross-border coordination between MFCN systems should be based on the principles and the field strength limits provided in Annex 1;

8. that interference field strength predictions should be made using the appropriate propagation models defined in Annex 2 for MFCN systems;

9. that if the levels in Annex 1 are exceeded, the coordination is required and the procedure detailed in Annex 3 should be used;

10. that coordination between neighbouring MFCN systems using LTE/NR technology in border areas should use preferential PCIs provided in Annex 4 when channel centre frequencies are aligned;

11. that administrations should encourage and facilitate the establishment of arrangements between operators in different countries with the aim to enhance the efficient use of the spectrum and to optimise the coverage/throughput in their respective border areas;

12. that coordination in coastal areas is based on prediction of field strength levels at the coastline of the neighbouring country while other principles for coordination in coastal areas may be agreed between the administrations concerned;

13. that this Recommendation may be revised in order to include new frequency bands harmonised for MFCN;

14. that this Recommendation may be revised in the light of future technical developments, to ease cross-border coordination;

15. that this Recommendation should be reviewed within 5 years of its adoption in the light of practical experience of its application and of the operation of MFCN systems."

Note:

Please check the Office documentation database https://www.ecodocdb.dk for the up to date position on the implementation of this and other ECC Recommendations.

ANNEX 1: FIELD STRENGTH LEVELS FOR THE CROSS-BORDER COORDINATION BETWEEN MFCN SYSTEMS

In this Annex, trigger values of field strength are given for cross-border scenarios of wideband vs wideband MFCN systems.

Preferential and non-preferential PCIs for LTE and NR are given in Annex 4. Administrations/operators may agree on other trigger values of field strength and preferential frequency usage based on bilateral or multilateral agreements/arrangements.

A1.1 FIELD STRENGTH LEVELS IN THE 700 MHZ FREQUENCY BAND

A1.1.1 FDD case

A) **Non-AAS base stations of WB systems on both sides of the borderline in the frequency band 758-788 MHz with centre frequencies not aligned for all PCIs or with centre frequencies aligned and for preferential PCIs may be used without coordination with a neighbouring country if the mean field strength of each cell produced by base station does not exceed the values of:**

   59 dBμV/m/5 MHz at a height of 3 m above ground at the borderline between countries and

   41 dBμV/m/5 MHz at a height of 3 m above ground at a distance of 6 km inside the neighbouring country.

b) **Non-AAS base stations of WB systems on both sides of the borderline in the frequency band 758-788 MHz with centre frequencies aligned and for non-preferential PCIs may be used without coordination with a neighbouring country if the mean field strength of each cell produced by base station does not exceed the value of:**

   41 dBμV/m/5 MHz at a height of 3 m above ground at the borderline between neighbouring countries.

A1.1.2 SDL case

The 738-758 MHz band may be used for MFCN SDL systems, as a national option, and in the case of MFCN SDL vs. MFCN SDL scenario the same field strength levels should be used as for FDD case (see points A) and B) in paragraph A1.1.1).

The following table gives an overview of the trigger values of the field strength and the relevant sections of this Annex.

Table 1: Field strength levels at a height of 3 m above ground between wideband systems

Case	Wideband system vs. Wideband system		
	Centre frequencies aligned		Centre frequencies not aligned
	Preferential PCIs	Non-preferential PCIs	All PCIs
FDD case	59 dBµV/m/5 MHz @ 0 km and 41 dBµV/m/5 MHz @ 6 km (paragraph A1.1.1 A)	41 dBµV/m/5 MHz @ 0 km (paragraph A1.1.1 B)	59 dBµV/m/5 MHz @ 0 km and 41 dBµV/m/5 MHz @ 6 km (paragraph A1.1.1 A)
SDL case	Similar to FDD case (paragraph A1.1.2)		
@ stands for “at a distance inside the neighbouring country”			

A1.2 FIELD STRENGTH LEVELS IN THE 1427-1517 MHZ FREQUENCY BAND

A) Non-AAS SDL base stations of WB systems on both sides of the borderline in the frequency band 1427-1517 MHz with centre frequencies not aligned for all PCIs or with centre frequencies aligned and for preferential PCIs may be used without coordination with a neighbouring country if the mean field strength of each cell produced by base station does not exceed the values of:

65 dBµV/m/5 MHz at a height of 3 m above ground at the borderline between countries and

47 dBµV/m/5 MHz at a height of 3 m above ground at a distance of 6 km inside the neighbouring country.

B) Non-AAS SDL base stations of WB systems on both sides of the borderline in the frequency band 1427-1517 MHz with centre frequencies aligned and for non-preferential PCIs may be used without coordination with a neighbouring country if the mean field strength of each cell produced by base station does not exceed the value of:

47 dBµV/m/5 MHz at a height of 3 m above ground at the borderline between neighbouring countries.

The following table gives an overview of the trigger values of the field strength and the relevant sections of this Annex.

Table 2: Field strength levels at a height of 3 m above ground between wideband systems

<table>
<tr><th rowspan="3">Case</th><th colspan="3">Wideband system vs. Wideband system</th></tr>
<tr><th colspan="2">Centre frequencies aligned</th><th>Centre frequencies not aligned</th></tr>
<tr><th>Preferential PCIs</th><th>Non-preferential PCIs</th><th>All PCIs</th></tr>
<tr><td>SDL case</td><td>65 dBµV/m/5 MHz @ 0 km
and
47 dBµV/m/5 MHz @ 6 km
(paragraph A1.2 A)</td><td>47 dBµV/m/5 MHz @ 0 km
(paragraph A1.2 B)</td><td>65 dBµV/m/5 MHz @ 0 km
and
47 dBµV/m/5 MHz @ 6 km
(paragraph A1.2 A)</td></tr>
<tr><td colspan="4">@ stands for “at a distance inside the neighbouring country”</td></tr>
</table>

A1.3 FIELD STRENGTH LEVELS IN THE 3400-3800 MHZ FREQUENCY BAND

The following sections A and B provide the field strength trigger values in case of synchronised and unsynchronised operations between MFCN TDD systems across the border.

A) Synchronised case

1. AAS and non-AAS base stations of synchronised TDD systems on both sides of the borderline in the frequency band 3400-3800 MHz with centre frequencies not aligned for all PCIs or with centre frequencies aligned and for preferential PCIs may be used without coordination with a neighbouring country if the mean field strength of each cell produced by the base station does not exceed the values of:

   67 dBµV/m/5 MHz at a height of 3 m above ground at the borderline between countries and

   49 dBµV/m/5 MHz at a height of 3 m above ground at a distance of 6 km inside the neighbouring country.

2. AAS and non-AAS base stations of synchronised TDD systems on both sides of the borderline in the frequency band 3400-3800 MHz with centre frequencies aligned and for non-preferential PCIs may be used without coordination with a neighbouring country if the mean field strength of each cell produced by the base station does not exceed the value of:

   49 dBµV/m/5 MHz at a height of 3 m above ground at the borderline between countries

The following table gives an overview of the trigger values of the field strength and the relevant sections of this Annex.

Table 3: Trigger values at a height of 3 m above ground between synchronised MFCN TDD systems with AAS and non-AAS

SYNCHRONISED CASE		
Centre frequencies aligned		Centre frequencies not aligned
Preferential PCIs	Non-preferential PCI	All PCIs
67 dBµV/m/5 MHz @ 0 km and 49 dBµV/m/5 MHz @ 6 km	49 dBµV/m/5 MHz @ 0 km	67 dBµV/m/5 MHz @ 0 km and 49 dBµV/m/5 MHz @ 6 km
@ stands for "at a distance inside the neighbouring country". Note (1): It should be noted that for NR BS, in case of same PCIs use when centre frequencies are not aligned, the field strength levels for synchronised operation should be further studied. In fact, in NR, if the centre frequencies are not aligned it doesn't imply automatically that SSB blocks are not aligned. In case of LTE centre frequencies alignment is equivalent to synchronisation signals alignment. Note (2): However, in case of AAS systems, these thresholds are not sufficient to deploy networks in border areas without further measures to be studied.		

B) Unsynchronised case

1. AAS and non-AAS base stations of unsynchronised TDD systems on both sides of the borderline in the frequency band 3400-3800 MHz for all PCIs may be used without coordination with a neighbouring country if the mean field strength of each cell produced by the base station does not exceed a value of

   0 dBµV/m/5 MHz at a height of 3 m above ground level at the borderline between countries.

If preferential and non-preferential frequency blocks are defined in the 3400-3800 MHz band and are distributed between neighbouring countries, the following provisions apply:

2. AAS and non-AAS base stations of unsynchronised TDD systems on both sides of the borderline in the frequency band 3400-3800 MHz with preferential frequency blocks and for preferential PCIs may be used without coordination with a neighbouring country if the mean field strength of each cell produced by the base station does not exceed the trigger values of:

   45 dBµV/m/5 MHz at a height of 3 m above ground at the borderline between countries and

   27 dBµV/m/5 M Hz at a height of 3 m above ground at a distance of 6 km inside the neighbouring country.

3. AAS and non-AAS base stations of unsynchronised TDD systems on both sides of the borderline in the frequency band 3400-3800 MHz with preferential frequency blocks and for non-preferential PCIs may be used without coordination with a neighbouring country if the mean field strength of each cell produced by the base station does not exceed the trigger values of:

   27 dBµV/m/5 MHz at a height of 3 m above ground at the borderline between countries .

4. AAS and non-AAS base stations of unsynchronised TDD systems on both sides of the borderline in the frequency band 3400-3800 MHz with non-preferential frequency blocks and for all PCIs may be used without coordination with a neighbouring country if the mean field strength of each cell produced by the base station does not exceed the trigger values of:

   0 dBµV/m/5 MHz at a height of 3 m above ground level at the borderline between countries

The following table gives an overview of the trigger values of the field strength and the relevant sections of this Annex.

Table 4: Trigger values at a height of 3 m above ground for preferential frequency blocks of unsynchronised MFCN TDD systems with AAS and non-AAS

UNSYNCHRONISED CASE		
PREFERENTIAL FREQUENCY BLOCKS		NON-PREFERENTIAL FREQUENCY BLOCKS
Preferential PCIs	Non-preferential PCI	All PCIs
45 dBµV/m/5 MHz @ 0 km and 27 dBµV/m/5 MHz @ 6 km	27 dBµV/m/5 MHz @ 0 km	0 dBµV/m/5 MHz @ 0 km
@ stands for "at a distance inside the neighbouring country"		

A1.4 CALCULATION EXPLANATION

For field strength predictions, the calculations should be made according to Annex 2. In the case of channel bandwidth other than 5 MHz, a factor of 10 x $\log_{10}$ (channel bandwidth[2]/5 MHz), should be added to the field strength levels.

For the 3400-3800 MHz band, due to the low field strength level in the unsynchronised case, in order to enable the field strength measurement, a conversion factor of 23 dB from 3 m to 10 m could be applied for suburban environment.

A1.5 GUIDANCE FOR OPERATORS FOR DEPLOYMENT IN BORDER AREAS

This section lists different techniques as a guidance for operators that can be used to reduce the interference across the border in case of both TDD and FDD systems. In the context of TDD systems, while these techniques decrease the interference, they may not be sufficient to enable unsynchronised operation of TDD networks across the border.

1. Antenna tilting and restricted beamforming

Tilt optimisation of the base station is applicable for both non-AAS and AAS radios, where the downtilt of the base station antennas is adjusted such that there is suppression of all signals towards the horizon, thereby reducing the horizon component of interference to the base stations. In the case of AAS antennas at the base stations, configured elevation-domain codeword subset restriction may also be used to decrease the interference to the base stations across the border.

2. Downlink power reduction

Another possible solution could be to reduce the downlink power on the base station sectors which are facing the border or located at sites near the border. One of the main advantages of this technique is that there is less interference radiated across the border. Moreover, since the difference between the uplink and downlink transmit powers is smaller, there is reduced UL/DL imbalance in a cell. The direct consequence of this technique is that the downlink to uplink interference becomes less problematic as there is a smaller area with vulnerable UEs. Also, smaller cells can be deployed closer to the border, providing stronger uplink. Additionally, the performance degradation due to downlink power reduction can be compensated by link adaptation.

[2] not occupied bandwidth

3. Minimum inter-cell interference scheduling

The selection of start Physical Resource Blocks (PRB) or Resource Block Group (RBG) in the scheduler can be enhanced to reduce the inter-cell interference. This can be accomplished through restricted or randomised distributed PRB scheduling in uplink or RBG scheduling in downlink.]

ANNEX 2: PROPAGATION MODELS

The following methods are proposed for assessment of anticipated interference inside neighbouring country based on established field strength levels. Due to complexity of radio wave propagation nature different methods are proposed to be considered by administrations and are included here for guidance purposes only.

It should be noted that following methods provide theoretical predictions based on available terrain knowledge. It is practically impossible to recreate these methods with measurement procedures in the field. Therefore only some approximation of measurements could be used to check compliance with those methods based on practical measurement procedures. The details of such approximation are not included in this recommendation and should be negotiated between countries based on their radio monitoring practices.

A2.1 PATH SPECIFIC MODEL

Where appropriate detailed terrain data is available, the propagation model for interference field strength prediction is the latest version of Recommendation ITU-R P.452 [12]. For the relevant transmitting base station, predictions of path loss would be made at x km steps along radials of y km at z degree intervals. The values for those receiver locations within the neighbouring country would be used to construct a histogram of path loss – and if 10% of predicted values exceed the threshold, the base station shall be required to be coordinated.

Values for x, y and z are to be agreed between the administrations concerned.

A2.2 SITE GENERAL MODEL

If it is not desirable to utilise detailed terrain height data for the propagation modelling in the border area, the basic model to be used to trigger coordination between administrations and to decide, if coordination is necessary, is Recommendation ITU-R P.1546-6 [13]. This model is to be employed for 50% locations, 10% time and using a receiver antenna height of 3 m.

For specific reception areas where terrain roughness adjustments for improved accuracy of field strength prediction are needed, administrations may use correction factors according to terrain irregularity and/or an averaged value of the terrain clearance angle (TCA) parameter in order to describe the roughness of the area on and around the coordination line.

Administrations and/or operators concerned may agree to deviate from the aforementioned model by mutual consent[3].

A2.3 AREA CALCULATIONS

In the case where greater accuracy is required, administrations and operators may use the area calculation below.

For calculations, all the pixels of a given geographical area to be agreed between the Administrations concerned in a neighbouring country are taken into consideration.

For the relevant base station, predictions of path loss should be made for all the pixels of a given geographical area from a base station and at a receiver antenna height of 3 m above ground.

[3] e.g. as used by members of the HCM-Agreement [14]

For evaluation:

- only 10 percent of the number of geographical area between the borderline (including also the borderline) and the 6 km line itself inside the neighbouring country may be interfered by higher field strength than the values given for the borderline in Annex 1 at a height of 3 m above ground;
- only 10 percent of the number of geographical area between the 6 km (including also 6 km line) and 12 km line inside the neighbouring country may be interfered by higher field strength than the values given for the 6 km line in Annex 1 at a height of 3 m above ground.

It is recommended that during area calculations not only detailed terrain data but also clutter data be taken into account. Use of correction factors for clutter is crucial in particular where the border area is ‘open’ or ‘quasi-open’ from the point of view of clutter or where the interfering base station is just a few kilometres from a borderline.

If the distance between a base station and a terrain point of a borderline is closer than or equal to 1 km, free space propagation model needs to be applied. Furthermore, if there is no terrain obstacle within the 1st Fresnel zone,” also the free space propagation model should be applied.

If clutter data is not available, it is proposed to extend the usage of free space propagation model to a few kilometres, depending on the clutter situation in border areas.

For area type interference calculations, propagation models with path specific terrain correction factors are recommended (e.g. Recommendation ITU–R P.1546 [13] with the terrain clearance angle correction factor TCA, HCM method with the terrain clearance angle correction factor or Recommendation ITU–R P.1812 [15]).

As to correction factors for clutters ‘open area’ and ‘quasi-open area’, 20 dB and 15 dB should be used respectively. Recommendation ITU–R P.1406 [16] should be used if a finer selection of clutter is required. It must be noted that terrain irregularity factor Δh is not recommended to be used in area calculations. Administrations and/or operators concerned may agree to deviate from the aforementioned models by mutual consent.

ANNEX 3: EXCHANGE OF INFORMATION

When requesting coordination, the relevant characteristics of the base station, the code group number and the PCI (physical-layer cell-identity) numbers (in case of a network, e.g. LTE, uses PCI), should be forwarded to the Administration affected. All of the following characteristics should be included:

1. channel centre frequency (MHz);
2. channel bandwidth (MHz);
3. Name of transmitter station;
4. country of location of transmitter station;
5. geographical coordinates (W/E, N; WGS84);
6. (effective) antenna height (m);
7. antenna polarisation;
8. antenna azimuth (deg);
9. directivity in antenna systems or antenna gain (dBi);
10. effective radiated power (dBW);
11. expected coverage zone;
12. date of entry into service (month, year);
13. PCI numbers used (only for LTE and NR);
14. antenna electrical and mechanical tilt (deg);
15. antenna pattern or envelope.

For synchronised LTE and NR TDD networks in the 3400-3800 MHz band, the following characteristics should be included:

1. Frame structure including the special slot “S” configuration (the format at symbol level for slots between downlink and uplink slots);
2. Clock phase, frequency and time synchronisation;
3. Global Synchronisation Channel Number (GSCN) in case of NR.

The Administration affected shall evaluate the request for coordination and shall within 30 days notify the result of the evaluation to the Administration requesting coordination.

If in the course of the coordination procedure an Administration may request additional information.

If no reply is received by the Administration requesting coordination within 30 days it may send a reminder to the Administration affected. An Administration not having responded within 30 days following communication of the reminder shall be deemed to have given its consent and the code coordination may be put into use with the characteristics given in the request for coordination.

The periods mentioned above may be extended by common consent.

ANNEX 4: PHYSICAL-LAYER CELL IDENTITIES (PCI) FOR LTE & NR

ETSI TS 136 211 [17] defines 168 “unique physical-layer cell-identity groups” in §6.11, numbered 0..167, hereafter called “PCI groups” for LTE. Within each PCI group there are three separate PCIs giving 504 PCIs in total.

ETSI TS 138 211 [18] defines NR Physical channels and modulation, in NR 2-step identification using PSS/SSS detection of the Physical Cell ID (same as LTE), the number of different cell IDs has been increased from 504 in LTE to 1008 for NR.

Administrations should apply sharing of PCIs in border areas, an equitable distribution of 504/1008 PCIs, for preferential and non-preferential PCIs as proposed in the Table 5 below.

Each country should only use their own preferential PCIs as a result of sharing of PCIs, depending on cross-border co-ordination scenario and interference field strength.

Sharing of PCIs between operators of neighbouring countries should only be applied where channel centre frequencies used in the neighbouring countries are aligned independent of the channel bandwidth or where it is not known whether or not the channel centre frequencies used in the neighbouring countries are aligned, or where there is no network in operation in the neighbouring country unless otherwise stated in Annex 1 or administration agreements / operator arrangements. In addition, the trigger values of field strength given in Annex 1 for non-preferential PCIs should also be examined.

The preferential PCIs of a two country PCI sharing should be applied for a base station if the trigger value of field strength relating to non-preferential PCIs (in Annex 1) could be exceeded at the borderline of only one neighbouring country. The preferential PCIs of a three country PCI sharing should be applied for a base station if the trigger value of field strength relating to non-preferential PCIs (Annex 1) could be exceeded at the borderline of only two neighbouring countries.

As shown in the Table 5 below, the PCIs for LTE and NR are divided into 6 sub-sets containing each one sixth of the available PCIs. Each country is allocated three sets (half of the PCIs) in a bilateral case and two sets (one third of the PCIs) in a trilateral case, therefore dividing the PCI groups or PCIs is equivalent. For the deployment of LTE systems only the PCIs between 0 to 503 should be used and for NR systems PCIs between 0 to 1007 may be used. Four types of countries are defined in such a way 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, 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: ALB, AUT, F, HOL, HRV, MLT, POL, POR, ROU, RUS and S.

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

(Note: Country type map can be found in the figure below).

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

	Preferential PCI
	non-preferential PCI

Table 5: PCI sub-sets for LTE and NR for use in border areas

PCI	Set A	Set B	Set C	Set D	Set E	Set F
Country 1 LTE	0..83	84..167	168..251	252..335	336..419	420..503
Country 1 NR	0..83 504-587	84..167 588..671	168..251 672..755	252..335 756..839	336..419 840..923	420..503 924..1007
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 LTE	0..83	84..167	168..251	252..335	336..419	420..503
Country 2 NR	0..83 504-587	84..167 588..671	168..251 672..755	252..335 756..839	336..419 840..923	420..503 924..1007
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 LTE	0..83	84..167	168..251	252..335	336..419	420..503
Country 3 NR	0..83 504-587	84..167 588..671	168..251 672..755	252..335 756..839	336..419 840..923	420..503 924..1007
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 LTE	0..83	84..167	168..251	252..335	336..419	420..503
Country 4 NR	0..83 504-587	84..167 588..671	168..251 672..755	252..335 756..839	336..419 840..923	420..503 924..1007
Border 4-1						
Zone 4-1-2						
Border 4-2						
Zone 4-2-3						
Border 4-3						
Zone 4-3-1						

Note

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) and at the same time harmful interference for that distance could occur, it may be necessary to address the situation in bilateral /multilateral coordination agreements as necessary, and further subdivision of the allocated PCIs may be included in certain areas.

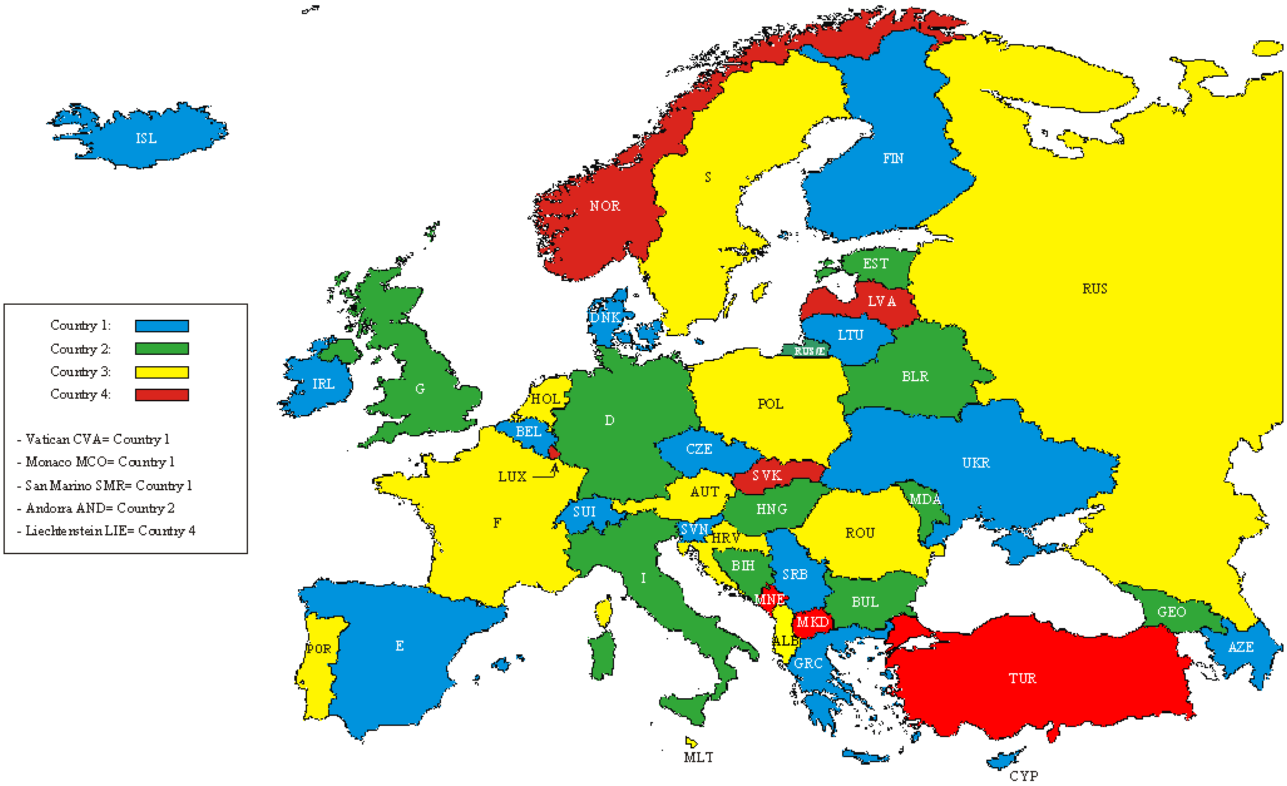

Figure 1: Country type map

ANNEX 5: GUIDANCE FOR CROSS-BORDER COORDINATION OF SYNCHRONISED AND UNSYNCHRONISED MFCN TDD SYSTEMS IN THE 3400-3800 MHZ BAND

With ECC Report 296 [11], CEPT studies have already provided a toolbox for coexistence of MFCN TDD networks in 3400-3800 MHz to help administrations setting up the synchronisation frameworks at national level. This annex is aimed to provide a toolbox to help administrations in cross-border situations for synchronised and unsynchronised operation.

A5.1 CROSS-BORDER COORDINATION BASED ON SYNCHRONISATION

A5.1.1 Synchronised operation

Synchronised operation avoids all separation distances at the border (both for AAS and non-AAS BS) and enables an efficient use of the spectrum but requires all operators to agree on the same reference clock and on a compatible frame structure.

A5.1.1.1 Reference clock

All macro base stations should incorporate a mechanism to retrieve a Primary Reference Time Clock (PRTC) traceable to UTC or TAI with an accuracy of +/- 1.5µs[4]. Several mechanisms make it possible to meet this requirement (see ECC Report 216 [19]: GNSS is the main technique on macrocells). It is expected that operators synchronise all their equipment (except in the case of a single isolated base station) and ensure the proper functioning of the PRTC to avoid co-channel interference within their own network. There is therefore no significant additional cost to assume that TDD base stations at the border already implement a proper PRTC compliant with "UTC +/- 1.5µs".

A5.1.1.2 Frame structure

Synchronised operation requires all relevant operators/administrations to agree on compatible frame structures to be adopted across all TDD networks.

In neighbouring countries where there is no need to ensure coexistence with LTE, the example of NR frames given in Table 6 may be used.

Table 6: Examples of NR frame structures

Frame structure		Subframe number																			
		0		1		2		3		4		5		6		7		8		9	
NR Frame (SCS 30 kHz)	DDSU	D	D	S	U	D	D	S	U	D	D	S	U	D	D	S	U	D	D	S	U
NR Frame (SCS 30 kHz)	DDDSU	D	D	D	S	U	D	D	D	S	U	D	D	D	S	U	D	D	D	S	U

In case there is a need to ensure compatibility with LTE systems and considering the state of frame structure implementations at the time of writing and cross-technology compatible configurations within the country while allowing deployments close to the border, the LTE frame structure configuration n°2 should be used by LTE operators, with the following corresponding NR frame structures.

[4] This value is the most stringent, based on LTE-TDD and 5G-NR requirements. Some more relaxed values may be acceptable in some cases e.g. as described in 3GPP TS 36.133 §7.4 ("Cell phase synchronisation accuracy (TDD)").

Table 7: NR frame structures compatible with the LTE frame structure configuration n°2

Frame structure (note 1)		Subframe number (10 ms frame)																			
LTE frame		0		1		2		3		4		5		6		7		8		9	
SCS 15 kHz	DSUDD	D		S		U		D		D		D		S		U		D		D	
NR frame - Variant 1f		0		1		2		3		4		5		6		7		8		9	
SCS 30 kHz	DDDSUUDDDD	D	D	D	S	U	U	D	D	D	D	D	D	D	S	U	U	D	D	D	D
NR frame - Variant 2		4		5		6		7		8		9		0		1		2		3	
SCS 30 kHz	DDDDDDDSUU (note 2) + 3 ms	D	D	D	S	U	U	D	D	D	D	D	D	D	S	U	U	D	D	D	D

Note (1): The time reference (t0) is defined according to Coordinated Universal Time (UTC).

Note (2): NR frame ”DDDDDDDSUU” (Variant 2) is equivalent to NR frame ”DDDSUUDDDD” (Variant 1) when a -2 ms or +3 ms time offset is applied. This means that if operators choose to implement Variant 2 they need to apply the above mentioned time offset in order to be compatible with the LTE frame (DSUDD). These NR frames have been developed by standardisation.

Among the frame structures that are defined for the NR by the 3GPP, only a subset are being implemented by base station vendors by 2020. As a consequence and based on feedback from vendors there are two frame structures (NR frame - Variant 1 and Variant 2) compatible with the LTE frame structure configuration n°2.

A5.1.1.3 LTE "special subframes” and NR slots “S”

The LTE "special subframes” and NR “special slots” (“S”) are placed at the boundary between DL and UL transmissions and should be defined taking into account, the maximum expected base station to base station distance under Line of Sight conditions which is limited by the “Guard Period” (GP). If the separation distance between base stations is greater than the maximum allowed LoS distance associated with the selected GP, the base stations will experience cross link interference due to the simultaneous DL and UL transmissions[5].

For example, the special subframe format n°7 “10:2:2” (i.e. DDDDDDDDDDGGUU) should be used for the LTE frame structure and the equivalent for NR[6] is the slot “S”, “6:4:4” (DDDDDDFFFFUUUU), configuration coming from format n° 44 “6:6:2” (i.e. DDDDDDFFFFFFUU where two flexible slots “F” are fixed in UL. For the deployment of NR frame non compatible with LTE, the slot format which offer the best capacity is the format n°32, “10:2:2” (DDDDDDDDDDFFUU), other format could be used taking into consideration the maximum separation distance between two base stations.

[5] It should be noted that the special subframe S has a “Guard Period” (GP) field which size should depend on the maximum cell size (e.g. 21 km in case of LTE subframe “S” config 7, considering the signal propagation time). It also leads to a maximum distance of the “synchronised operation area” (which is double of the previous one i.e. 42 km in the case of LTE S config 7) : if base stations farther than this distance have a low coupling loss, then synchronised operation does no longer completely prevent interferences since the guard period is not long enough to compensate for the propagation time and prevent the end of the downlink collide with the beginning of the uplink slots. If that situation occurs, a larger GP should be configured (for example in the case of LTE, special subframe S configurations 0, 1, 2, 5 and 6 could be considered). Setting a larger GP has of course an impact on spectrum efficiency (which is even greater if the UL/DL switching periodicity is high).

[6] In 5G, there is no special subframe define such as in LTE, all the format may be used. In the example, the format 44 is compatible with the S format n° 7 for LTE

Table 8: Example of Special Subframe "S" for LTE and slot "S" for NR

System	Format	Cyclic Prefix	LTE Symbols		
			DwPTS	GP	UpPTS
LTE	7	**Normal CP**	10	2	2
			NR Symbols		
			DL	**GP**	**UL**
NR	44	**Normal CP**	6	6	2
NR with 2 additional UL symbols	44 modified	**Normal CP**	6	4	4
NR	32	**Normal CP**	10	2	2

A5.1.1.4 Field strength

In case of synchronised operation for AAS and/or non-AAS Base station, the field strength trigger values from Annex 1 Table 3 apply.

A5.1.1.5 Remarks

In terms of terminology, to avoid confusion about frame structures regarding ”D” and ”U” slots (including special slots “S”), different technologies use different SCS (resulting in different slot durations): for example the LTE ”DSUDD” frame with an SCS of 15 kHz is equivalent to the NR ”DDDSUUDDDD” frame when 30 kHz SCS is adopted for NR (not equivalent to the NR ”DSUDD” frame in case of 30 kHz SCS). It should also be noted that compared to LTE-TDD, 5G-NR allows significantly more flexibility in the frame structure with the ability to configure uplink / downlink / mixed transmission at the symbol level.

A5.1.1.6 Frame structures alignment over the air

Synchronised operation of different TDD frames (5G NR, LTE-TDD) should be based on the selection of consistent time offsets relatively to a common UTC-based time reference to ensure full alignment of transmissions over the air.

As illustrated in Figure 2:, the first slot of the LTE-TDD frame (DSUDD) begins at time t_0 which refers to a UTC-based time reference. In order to align the frames over the air, the LTE-compatible NR frame DDDSUUDDDD (Variant 1) will have an offset t_{offset}=0 ms; in case of LTE-compatible NR frame DDDDDDDSUU (Variant 2), the first slot of the NR frame is shifted byt_{offset}=+3ms such that the frame begins as $t_0 + t_{offset}$.

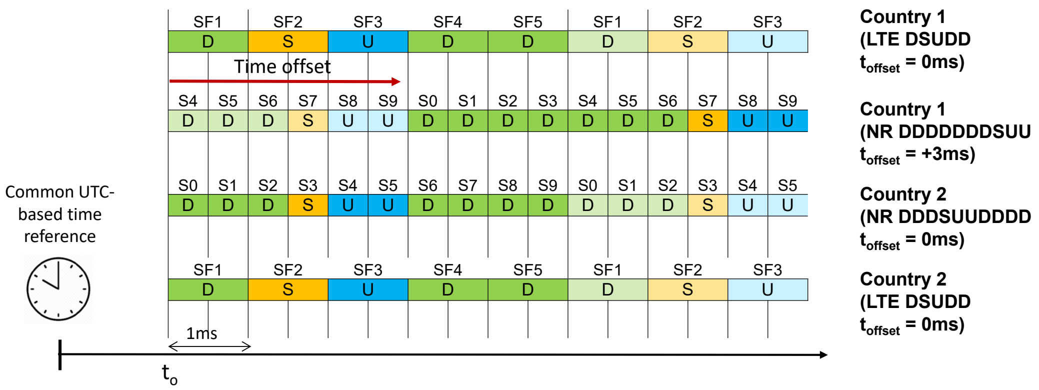

Figure 1: Aligned of LTE and LTE-compatible frame structures over the air

Furthermore, the neighbouring countries deploying frame structures not compatible to LTE-TDD will also need to choose consistent time offsets relatively to a common UTC-based time reference.

A5.1.2 DL symbol blanking WITH clock synchronisation

When available and provided that networks adopt the same clock and switch off transmissions ("blanking") in some specific DL symbols as described, this approach, in an environment of NR vs NR, would allow the deployment of different NR frame structures across borders with some degree of downlink capacity loss.

However, this approach also lead to some loss in coverage.

By the time of writing the Recommendation, this feature is not already available and will need further studies in order to be correctly implemented by manufacturers.

The availability of this feature will be subject to market demand and will be fostered by a limited choice of frame structure (e.g. DDDSU and NR compatible frames structure with LTE).

Therefore, administrations/operators will have to find a short term solution for cross border coordination.

Nevertheless, the impact of DL symbol blanking on some signalling functions and network functionalities needs to be evaluated.

The DL symbol blanking require operators/administrations to agree on:

- A common clock across their networks;
- Frame time shift allowing to maximise the frame alignment over the air;
- Sharing information of the frame structure used and agree to perform blanking of downlink symbols of each network that correspond to simultaneous uplink transmissions or simultaneous gap symbols for the other network (either symbols in uplink slots or uplink and gap symbols in the LTE "S" subframes or NR "S" slots at the transition from a downlink slot to an uplink slot) in order to have a fair treatment between neighbouring networks;
- The identification of the coordination area for application of DL symbol blanking on each side of the border. Base station deployed within this coordination area from the border will apply DL symbol blanking and may suffer from downlink throughput performance degradation (see Table 9).

Table 9: Examples of downlink symbol loss due to DL blanking

	Country 1				Country 2				Country 3			
	Frame structure	# of DL Symbols (10 ms)			Frame structure	# of DL Symbols (10 ms)			Frame structure	# of DL Symbols (10 ms)		
		Before DL blanking	With DL blanking	DL symbol Loss		Before DL blanking	With DL blanking	DL symbol Loss		Before DL blanking	With DL blanking	DL symbol Loss
Example 1 (2 countries)	**DDDSU (S: 10:2:2)**	208	172	**17.3%**	**DDDDDDDSUU w. -3ms shift (LTE compatible) (S: 6:4:4)**	208	172	**17.3%**	NA	NA	NA	NA
Example 2 (2 countries)	**DDSU (S: 10:2:2)**	190	144	**24.2%**	**DDDSUUDDDD (LTE compatible) (S: 6:4:4)**	208	144	**30.8%**	NA	NA	NA	NA
Example 3 (2 countries)	**DDDSU (S: 10:2:2)**	208	144	**30.8%**	**DDSU (S: 10:2:2)**	190	144	**24.2%**	NA	NA	NA	NA
Example 4 (3 countries)	**DDDSU (S: 10:2:2)**	208	126	**39.4%**	**DDSU (S: 10:2:2)**	190	126	**33.7%**	**DDDSUUDDDD or DDDDDDDSUU w. -3ms shift (S: 6:4:4) (LTE compatible)**	208	126	**39.4%**
Example 5 (2 countries)	**DDDSUUDDDD (LTE compatible) (S: 6:4:4)**	136	72	**34.6%**	**DDDSUUDDDD +2ms (LTE compatible) (S: 6:4:4)**	136	72	**34.6%**	NA	NA	NA	NA

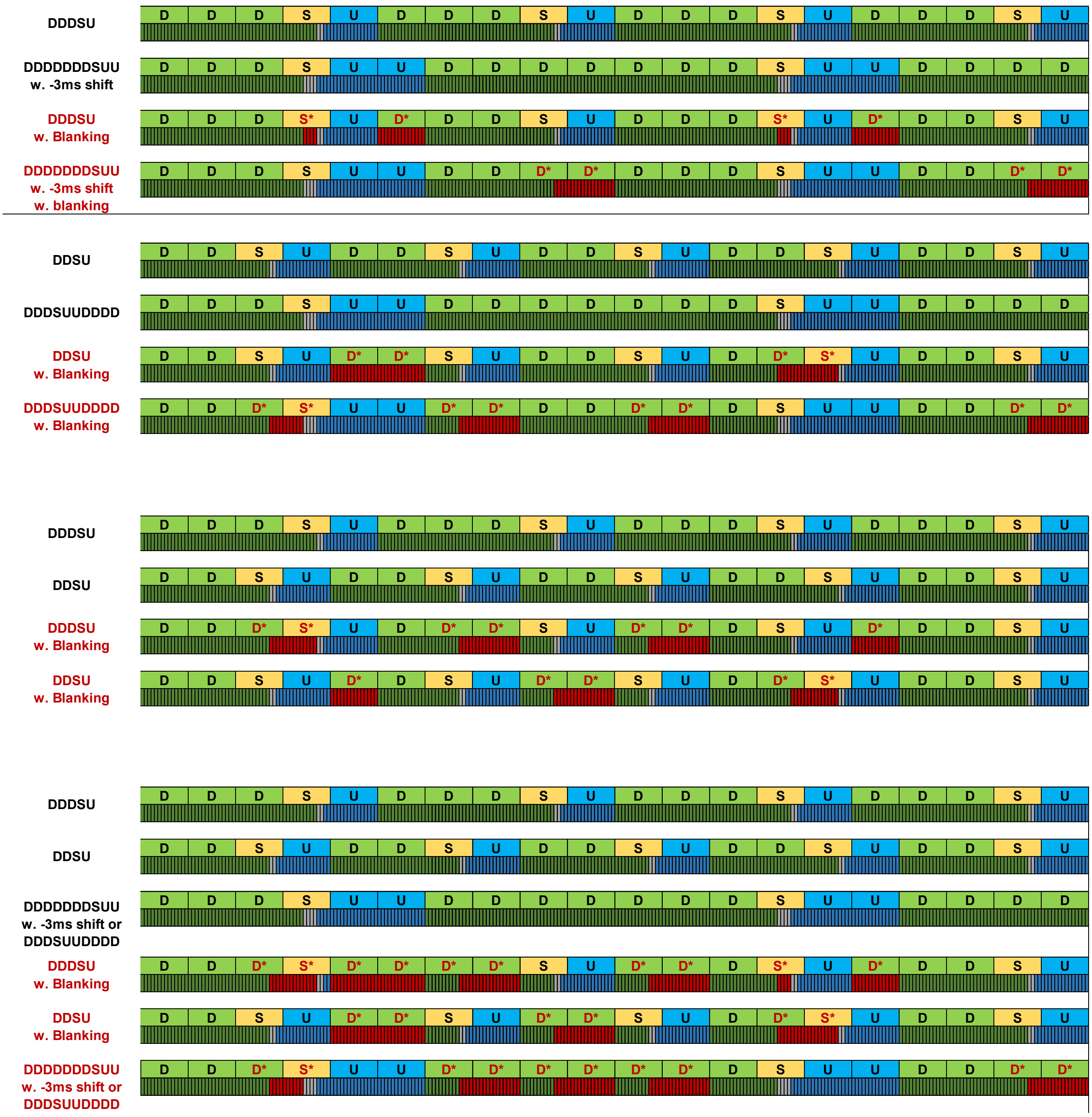

Figure 2: Examples of downlink symbol loss due to DL blanking

The table and the figure above show initial estimations of downlink symbol loss experienced in case of DL symbol blanking.

This approach would provide a solution for cross-border coordination where the networks are not using the same frame structure across the border:

- The scheduler of the operators' base stations that are located within the coordination area will be configured to implement the required DL symbol blanking. Transmission in all DL symbols will be scheduled for all BS beyond the coordination area .
- DL symbol blanking avoids the need for geographic isolation between two networks due to the fact that DL symbols will not collide with UL symbols from the other network.

The proposed approach leads to the following impacts:

- No more than two NR frame structures should be used in order to reduce the capacity loss at the border (see Table 9). Inside the coordination area, base station applying DL symbol blanking will suffer from downlink throughput performance degradation. The extent of degradation depends on the selected frame structures;

- Some coverage loss will be experienced where DL symbol blanking is applied due to the possible blanking of Synchronisation and Broadcast Beams. The expected impact depends on the specific frame structures and need further studies. While, specific features (e.g. power bosting) could be considered to mitigate this;
- The operators will be able to use their preferred frame structure (without the need to apply blanking) beyond the area of coordination for unsynchronised operation of TDD networks operating in the co-channel case;
- The adoption of this technique requires agreement between all stakeholders involved in bilateral / multi-lateral cross border discussions;.
- The DL symbol blanking is not currently available in case of LTE and WiMAX would require further study.

Based on the above, Administrations and stakeholders that are considering to apply DL symbols blanking could focus on the following two frame structures: the NR frame structure DDDSU and the LTE-compatible NR frame structure DDDSUUDDDD. Such choice would make the implementation of DL symbol blanking more efficient and will facilitate the timely availability of this feature in the market.

A5.1.1.7 Field strength

In case of synchronised operation with DL symbol blanking, for AAS and/or non-AAS Base station within the coordination area, the field strength trigger values from Annex 1 in Table 3 (for synchronised case) apply. For AAS and/or non-AAS Base station beyond the area of coordination area, the field strength trigger values for unsynchronised case in Annex 1 apply.

A5.1.1.8 Remarks

Another possible solution is to blank only non-essential signalling from the base stations, i.e., not blanking synchronisation and broadcast beams (SSB), TRS and CSI-RS. Further studies are required to analyse the impact on interference and the corresponding field strength trigger values.

A5.1.3 Cross-border coordination in the context of unsynchronised operations

The “unsynchronised operation” terminology refers to the general case where neither time synchronisation between operators’ MFCNs nor inter-operator frame alignment is implemented. ECC Report 281 [21] provides the following definition “the unsynchronised operation in the context of this Report means operation of TDD in several different networks, where at any given moment in time at least one network transmits in DL while at least one network transmits in UL. This might happen if the TDD networks either do not align all UL and DL transmissions or do not synchronise at the beginning of the frame".

A5.1.3.1 Cross-border coordination based on preferential/non-preferential frequency blocks

Administrations/operators may conclude bi/multilateral agreements/arrangements on sharing frequency (to define preferential frequency blocks). The radio spectrum will be divided between countries/operators in order to avoid co-channel operations between different operators at the border. This makes separation distances smaller (though still needed to protect adjacent channels,).

When possible, contiguous preferential frequency blocks in border areas for operators are preferable.

Nevertheless, it is not efficient use of the spectrum and reduce the opportunity of rapid deployment of TDD MFCN networks at the borders.

A5.1.3.2 Field strength

In case of unsynchronised operation, for AAS and/or non-AAS Base station, the field strength trigger values from Table 4 in Annex 1 apply.

ANNEX 6: LIST OF ABBREVIATIONS

Abbreviation	Explanation
AAS	Active Antenna Systems
ATS	Aeronautical Telemetry Systems
CEPT	European Conference of Postal and Telecommunications Administrations
DL	Downlink
ECA	European Common Allocation
ECC	Electronic Communications Committee
ERP	Effective Radiated Power
EIRP	Equivalent Isotropically Radiated Power
GSCN	Global Synchronisation Channel Number
HCM	Harmonised Calculation Method
LTE	Long Term Evolution
MFCN	Mobile/Fixed Communication Networks
NR	New Radio
PCI	Physical Cell ID
PRB	Physical Resource Blocks
RBG	Resource Block Group
RR	Radio Regulations
SCS	Subcarrier Spacing
SDL	Supplemental Downlink
TCA	Terrain Clearance Angle
TDD	Time Division Duplex
TRP	Total Radiated Power
UL	Uplink
UTC	Coordinated Universal Time
WB	Wideband

ANNEX 7: LIST OF REFERENCES

This annex contains the list of relevant reference documents.

[1] ECC Decision (11)06: "Harmonised technical and regulatory conditions for the use of the bands 3400-3600 MHz and 3600-3800 MHz for MFCN", amended October 2018

[2] ITU Radio Regulations Edition of 2016

[3] ECC Decision (13)03: "Harmonised technical and regulatory conditions for the use of the band 1452-1492 MHz for MFCN Supplemental Downlink", amended March 2018

[4] ECC Decision (17)06: "The harmonised use of the frequency bands 1427-1452 MHz and 1492-1518 MHz for Mobile/Fixed Communications Networks Supplemental Downlink (MFCN SDL)", corrected March 2018

[5] ERC Report 25: "The European table of frequency allocations and applications in the frequency range 8.3 kHz to 3000 GHz", updated March 2019

[6] ECC Report 295: "Guidance on Cross-border coordination between MFCN and Aeronautical Telemetry Systems in the 1429-1518 MHz band MFCN-ATS", March 2019

[7] ECC Decision (15)01 "Harmonised technical conditions for mobile/fixed communications networks (MFCN) in the band 694-790 MHz including a paired frequency arrangement (Frequency Division Duplex 2x30 MHz) and an optional unpaired frequency arrangement (Supplemental Downlink)", approved March 2015

[8] Decision (EU) 2017/899 of the European Parliament and of the Council of 17 May 2017 on the use of the 470-790 MHz frequency band in the Union

[9] ECC Decision (13)02: "ECC Decision on the withdrawal of ECC Decision (03)02", approved June 2013

[10] Final Acts of the Regional Radiocommunication Conference for planning of the digital terrestrial broadcasting service in parts of Regions 1 and 3, in the frequency bands 174-230 MHz and 470-862 MHz (RRC-06), June 2006

[11] ECC Report 296: "National synchronisation regulatory framework options in 3400-3800 MHz: a toolbox for coexistence of MFCNs in synchronised, unsynchronised and semi-synchronised operation in 3400-3800 MHz", March 2019

[12] Recommendation ITU-R P.452: Prediction procedure for the evaluation of interference between stations on the surface of the Earth at frequencies above about 0.1 GHz

[13] Recommendation ITU-R P.1546-6: Method for point-to-area predictions for terrestrial services in the frequency range 30 MHz to 4 000 MHz

[14] HCM Agreement: http://www.hcm-agreement.eu/

[15] Recommendation ITU-R P.1812: A path-specific propagation prediction method for point-to-area terrestrial services in the VHF and UHF bands

[16] Recommendation ITU-R P.1406: Propagation effects relating to terrestrial land mobile and broadcasting services in the VHF and UHF bands

[17] ETSI TS 136 211 V15.7.0: "LTE; Evolved Universal Terrestrial Radio Access (E-UTRA); Physical channels and modulation"

[18] ETSI TS 138 211 V15.8.0: 5G;NR;Physical channels and modulation

[19] ECC Report 216: "Practical guidance for TDD networks synchronisation", August 2014

[20] 3GPP TS 36.133 v 16.4.0: "Evolved Universal Terrestrial Radio Access (E-UTRA); Requirements for support of radio resource management"

[21] EEC Report 281: "Analysis of the suitability of the regulatory technical conditions for 5G MFCN operation in the 3400-3800 MHz band", July 2018

[22] ECC Report 287: "Guidance on defragmentation of the frequency band 3400-3800 MHz", October 2018