CEPT ECC
Electronic Communications Committee

ECC Recommendation (20)03

Frame structures to facilitate cross-border coordination of TDD MFCN in the frequency band 3400-3800 MHz

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INTRODUCTION

The ECC Recommendation (15)01 [3], as amended on 14 February 2020, addresses, among other bands, the cross-border coordination of TDD MFCN in the frequency band 3400-3800 MHz. The synchronisation of TDD networks in border areas in this frequency band is recommended as it ensures a higher degree of efficient spectrum utilisation especially for outdoor network deployments. In addition, cross-border synchronisation requires a common phase clock reference and a compatible frame structure to be used on both side of the border to avoid simultaneous UL/DL transmissions.

When non-compatible frame structures are used but with a common phase clock reference, the DL symbol blanking feature allows to avoid interference from DL symbols into UL symbols of a base station in a neighbouring country with some degree of downlink capacity loss and some loss in coverage. DL symbol blanking is not available yet in existing equipment and further studies are being carried out within CEPT. In this regard, the availability of such feature will be fostered by a limited choice of frame structures. The list of frame structures may need to be updated when more information about existing systems, new services and performance requirements are known. DL symbol blanking could be complemented by one or more of interference avoidance mechanisms such as antenna tilting, restricted beamforming, downlink power reduction, minimum inter-cell interference scheduling. Such mechanisms could reduce the area where DL symbol blanking needs to be applied.

Many CEPT countries have authorised or will authorise soon the frequency band 3400-3800 MHz for MFCN and have engaged in cross-border negotiations with their neighbours in order to enable spectrum efficient deployment at the border.

Therefore, CEPT has identified a need for an ECC Recommendation regarding TDD MFCN frame structures to be used in cross-border coordination in order to facilitate the negotiation of cross-border coordination agreements between administrations and facilitate the conclusion of operator arrangements, as well as the development of DL symbol blanking feature in due time.

ECC RECOMMENDATION 20(03) OF 23 OCTOBER 2020 ON FRAME STRUCTURES TO FACILITATE CROSS-BORDER COORDINATION OF TDD MFCN IN THE FREQUENCY BAND 3400-3800 MHZ

"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 frequency band 3400-3800 MHz;

b) that ECC Report 296 [2] describes national synchronisation framework options in 3400-3800 MHz;

c) that ECC Recommendation (15)01 [3] on cross-border coordination for MFCN defines a coordination trigger value at the geographical border for unsynchronised TDD networks in the frequency band 3400-3800 MHz which may result in large distances from the border where neighbouring administrations will need to coordinate base stations deployment; such large distances may impact negatively coverage and services provisions at both sides of the border;

d) that ECC Recommendation (15)01 recommends the synchronisation of TDD MFCN at the border and provides further guidance on its implementation including examples of frame structure options and mitigation techniques[1];

e) that frame structures in order to facilitate cross-border coordination of TDD MFCN in the frequency band 3400-3800 MHz, as defined in Annex 1, related to the important timing required for synchronisation but does not preclude the use of classical mitigation techniques and further studies in the future;

f) that synchronised operation ensures an efficient spectrum usage especially for outdoor network deployments in case of TDD MFCN in the 3400-3800 MHz frequency band;

g) that in line with ECC Report 216 [4] and ECC Report 296 [2], the synchronised operation of TDD networks requires a common phase clock reference (i.e. a reference clock with consistent time offsets relatively to a common UTC-based time reference to ensure full alignment of transmissions) and a compatible frame structure;

h) that ECC Report 216 states that synchronised operation implies "configuring compatible frame structures, i.e. setting the length of the frame, the TDD uplink/downlink ratio and guard period in order to align UL/DL switching points, so that the last transmitter stops before the first receiver starts, taking into account the propagation delay (e.g. in LOS non co-sited cases). Frame structures do not need to be exactly identical provided this condition is met", which enables different sizes for the guard period;

i) when networks have a common phase clock reference, downlink symbol blanking allows the base stations' schedulers to switch off transmissions ("blanking") for those downlink symbols of each network that correspond to simultaneous uplink transmissions or simultaneous gap symbols. This allows the deployment of non-compatible frame structures across borders with some degree of downlink capacity loss and some loss in coverage. Downlink symbol blanking is a base station scheduler feature in the cross-border coordination area and does not require standardisation by 3GPP;

j) that there are legacy networks in some CEPT countries which may constrain the choice of a frame structure at a national level;

k) that the frame structures given in Annex 1, Frame A and Frame B can be implemented for NR (New Radio) systems;

l) that the Frame B[2] given in Annex 1 is compatible with the LTE-TDD frame structure configuration no. 2 DSUDDDSUDD (10 ms duration), where different special subframe "S" configurations are possible such

[1] A list of mitigation techniques is provided in ECC Recommendation (15) 01 such as antenna tilting, restricted beamforming, downlink power reduction, minimum inter-cell interference scheduling, preferential frequency use

[2] In terms of DL/UL pattern frame B (DDDSUUDDDD) is equivalent to the frame DDDDDDDSUU with -2ms/+3ms time offset, which in turn is compatible with LTE frame structure configuration no. 2

as “S” configuration n°6 (9:3:2) or n°7 (10:2:2), where (x:y:z) represents the number of, Downlink:Guard Period:Uplink, OFDM symbols.

recommends

1. that CEPT administrations should use the frame structures defined in Annex 1 for especially outdoor TDD MFCN in the frequency band 3400-3800 MHz with an agreed common phase clock reference in order to facilitate cross-border coordination;

2. that CEPT administrations should retain the flexibility to adapt to national circumstances, e.g. for taking into account legacy networks (although a national migration roadmap of all legacy systems should be defined), indoor TDD MFCN and new services;

3. that bilateral/multilateral agreements and operator arrangements should address the transition period which may be necessary until the DL symbol blanking feature is available.”

Note:

Please check the Office documentation database https://docdb.cept.org/home for the up to date position on the implementation of this and other ECC Recommendations.

ANNEX 1: RECOMMENDED FRAME STRUCTURES IN ORDER TO FACILITATE CROSS-BORDER COORDINATION OF TDD MFCN IN THE FREQUENCY BAND 3400-3800 MHZ

Table 1 defines the two frame structures (Frame A and Frame B) for TDD MFCN in order to facilitate cross-border coordination in the frequency band 3400-3800 MHz. Frames are of 10 ms duration, divided into two equally-sized half-frames. Each frame consists of twenty slots. The number of consecutive symbols per slot is 14, for example, these might represent OFDM symbols in NR technology.

Table 1: Recommended frame structures for TDD MFCN cross-border coordination in 3400-3800 MHz

<table>
<tr><th></th><th colspan="3">Frame A</th><th colspan="3">Frame B</th></tr>
<tr><td>DL/UL slot pattern</td><td colspan="3">DDDSU DDDSU DDDSU DDDSU
(see note 1)</td><td colspan="3">DDDSUUDDDD DDDSUUDDDD
(see notes 1, 4)</td></tr>
<tr><td>Frame duration</td><td colspan="3">10 ms</td><td colspan="3">10 ms</td></tr>
<tr><td>Slot Duration</td><td colspan="3">0.5 ms</td><td colspan="3">0.5 ms</td></tr>
<tr><td>Slot pattern periodicity</td><td colspan="3">2.5 ms</td><td colspan="3">5 ms</td></tr>
<tr><td rowspan="3">Special slot “S” configuration
(i.e., DL:GP:UL symbols)</td><td>Downlink</td><td>Guard period</td><td>Uplink</td><td>Downlink</td><td>Guard period (note 5)</td><td>Uplink</td></tr>
<tr><td rowspan="2">10</td><td rowspan="2">2</td><td rowspan="2">2</td><td>6</td><td>4</td><td>4</td></tr>
<tr><td>4</td><td>6</td><td>4</td></tr>
<tr><td>Time base (see note 3)</td><td colspan="3">Start of UTC second epoch (see note 2) +/- 1.5 µs</td><td colspan="3">Start of UTC second epoch (see note 2) +/- 1.5 µs</td></tr>
</table>

Note 1: D = Downlink slot; S = Special slot; U = Uplink slot

Note 2: UTC = Coordinated Universal Time in accordance with Recommendation ITU-R TF.460 [5]. The typical measuring signal is 1 pps (pulse-per-second) signal from the clock device with the rising-edge materializing the exact second epoch.

Note 3: The start of frame (defined as the beginning of the first slot in the UL/DL pattern of the Table 1) has to be phase-synchronised with the time base. The start of the radio frame on the output shall be synchronous with the input time reference, i.e., when an UTC traceable reference is required, the start of the radio frame shall be aligned with the start time of the UTC second epoch. A configurable time-offset of start frame shall be supported by all base stations in synchronized TDD-unicast areas in order to achieve interoperability in coexistence scenarios.

Note 4: In terms of DL/UL slot pattern DDDSUUDDDD half-frame B is equivalent to the DDDDDDDSUU half-frame when a -2 ms or +3 ms time offset is applied. This means that, instead of frame B, operators may choose to implement two consecutive DDDDDDDSUU half-frames with proper time offset.

Note 5: As mentioned in considering (h), different guard period sizes can still be implemented while retaining synchronised operation. It should be noted that the size of the guard period defines a corresponding geographical area where synchronised operation is effective. Increasing this guard period also increases the size of the synchronised area at the expense of some capacity loss and may contribute to solve some specific interference issues between far-away sites in line-of-sight with exceptional propagation conditions.

ANNEX 2: 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”, approved December 2011, latest amended October 2018

[2] 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”, approved March 2019

[3] 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 February 2016, latest amended February 2020

[4] ECC Report 216: “Practical guidance for TDD networks synchronisation”, approved August 2014

[5] Recommendation ITU-R TF.460: “Standard-frequency and time-signal emissions”