ECC Recommendation (16)03

Cross-border coordination for Broadband Public Protection and Disaster Relief (BB-PPDR) systems in the frequency band 698 to 791 MHz

Approved 17 October 2016

Edition 17.10.2016

ECC RECOMMENDATION (16)03 OF 17 October 2016 ON CROSS-BORDER COORDINATION FOR BROADBAND PUBLIC PROTECTION AND DISASTER RELIEF (BB-PPDR) SYSTEMS IN THE FREQUENCY BAND 698 to 791 MHz

"The European Conference of Postal and Telecommunications Administrations,

considering

a) that ECC/DEC/(16)02 [1] provides the harmonised technical conditions and frequency bands for the implementation of Broadband Public Protection and Disaster Relief (BB-PPDR) systems;

b) that there is a need for threshold levels which will trigger co-ordination between neighbouring countries;

c) 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);

d) that to ensure the service coverage in border areas, coordination or bilateral agreements are likely to be required, also to facilitate cross-border operations;

e) that ECC/DEC/(15)01 [2] 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);

f) that the amended ECC/REC/(15)01 [3] provides guidance to CEPT administrations on cross-border coordination for mobile / fixed communications networks (MFCN) in amongst others the frequency band 694-790 MHz;

g) that in some CEPT countries the frequency band 694-790 MHz may be used for terrestrial broadcasting services. The implementation of the 700 MHz frequency arrangement by national administrations will require coordination with any other administration whose broadcasting service and/or other primary terrestrial services are considered to be affected. For coexistence with broadcasting, the coordination procedure will take into account the framework of the GE-06 agreement;

h) that guidance on cross-border coordination for BB-PPDR systems in the 450-470 MHz frequency band is provided in Recommendation T/R 25-08 [4];

i) that frequency planning of land mobile systems in border areas will be based on coordination between national administrations in cooperation with their operators;

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

k) that PPDR is a sovereign national matter and that each CEPT administration shall decide on a national basis how much spectrum and which specific frequency ranges should be designated for BB-PPDR radio systems within harmonised tuning ranges;

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

m) that coordination is necessary between countries operating different technologies and different channel bandwidths in the same frequency band;

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

o) that Physical Cell Identifier (PCI) coordination is necessary for LTE systems to avoid unnecessary signalling load and handover failures;

recommends

1. that coordination between BB-PPDR systems and BB-PPDR systems with other land mobile systems operating in the 700 MHz range in border areas should be based on bilateral / multilateral agreements between administrations;

2. that frequency coordination between BB-PPDR systems and other systems in neighbouring countries should be based on bilateral / multilateral agreements between administrations;

3. that bilateral / multilateral agreements should define coordination methods which encompass all land mobile system radio interfaces present on each side of the border;

4. that operation between BB-PPDR systems as well as BB-PPDR and other land mobile systems should be based on the principles and the field strength limits provided in Annex 1;

5. that interference field strength predictions should be made using the appropriate propagation models defined in Annex 2 for BB-PPDR and other land mobile systems;

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

7. that coordination between neighbouring BB-PPDR and other land mobile systems using LTE technology in border areas should use the PCIs provided in Annex 4 when channel centre frequencies are aligned;

8. that other radio parameters for BB-PPDR and other land mobile systems using LTE technology may need to be coordinated on a bilateral /multilateral basis based on the guidance provided in Annex 5;

9. 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;

10. 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."

Note:

Please check the Office documentation database http://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 OPERATION BETWEEN BB-PPDR AND OTHER LAND MOBILE SYSTEMS

A1.1 Field strength levels for the cross-border operations for the 698-791 MHz frequency band

Parts of the 758-788 MHz band (as specified in ECC/DEC/(15)01 [2]), the 753-758 MHz band as well as the 788-791 MHz band may be used for BB-PPDR FDD systems (downlink) without coordination if the mean field strength of each cell produced by the BB-PPDR base station does not exceed the value of 59 dBµV/m/5 MHz at a height of 3 m above ground level at the borderline between concerned countries and a value of 41 dBµV/m/5 MHz at a height of 3 m above ground level at a distance of 6 km inside the neighbouring country.

For field strength predictions the calculations should be made according to Annex 2. In cases of other frequency block sizes 10 x Log10 (frequency block size/5 MHz) should be added to the field strength values.

ANNEX 2: PROPAGATION MODELS

The following methods are proposed for assessment of anticipated interference inside neighbouring country based on established trigger values. Due to complexity of radiowave 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.

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 [4]. For the relevant transmitting terminal, 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 station shall be required to be coordinated.

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

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 [5]. This model is to be employed for 50% locations, 10% time and using a receiver 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[1] .

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.

[1]e.g. as used by members of the HCM-Agreement [6]

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 trigger field strength value 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 trigger field strength value 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 [5] with the terrain clearance angle correction factor TCA, HCM method with the terrain clearance angle correction factor or Recommendation ITU–R P.1812 [7]).

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

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.

As a basis during the exchange of information besides listed characteristics above administrations could use formats created within ITU in accordance with Resolution 906 (WRC-12) [9].

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

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

ETSI TS 136 211 [10] 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 PCIs on an equitable basis when channel centre frequencies are aligned as shown in the Table below. It has to be noted that dividing the PCI groups or PCIs is equivalent. Each country should only use their own preferential PCIs close to the border and can use all PCIs away from the border. This transition distance between “close to the border” and “away from the border” should be agreed between neighbouring countries.

Administrations may wish to define different field strength levels (than those in Annex 1) for non-preferential PCIs.

As shown in the table below, the PCIs should be 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.

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

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

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

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

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

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) All PCIs are available in areas away from the border.

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

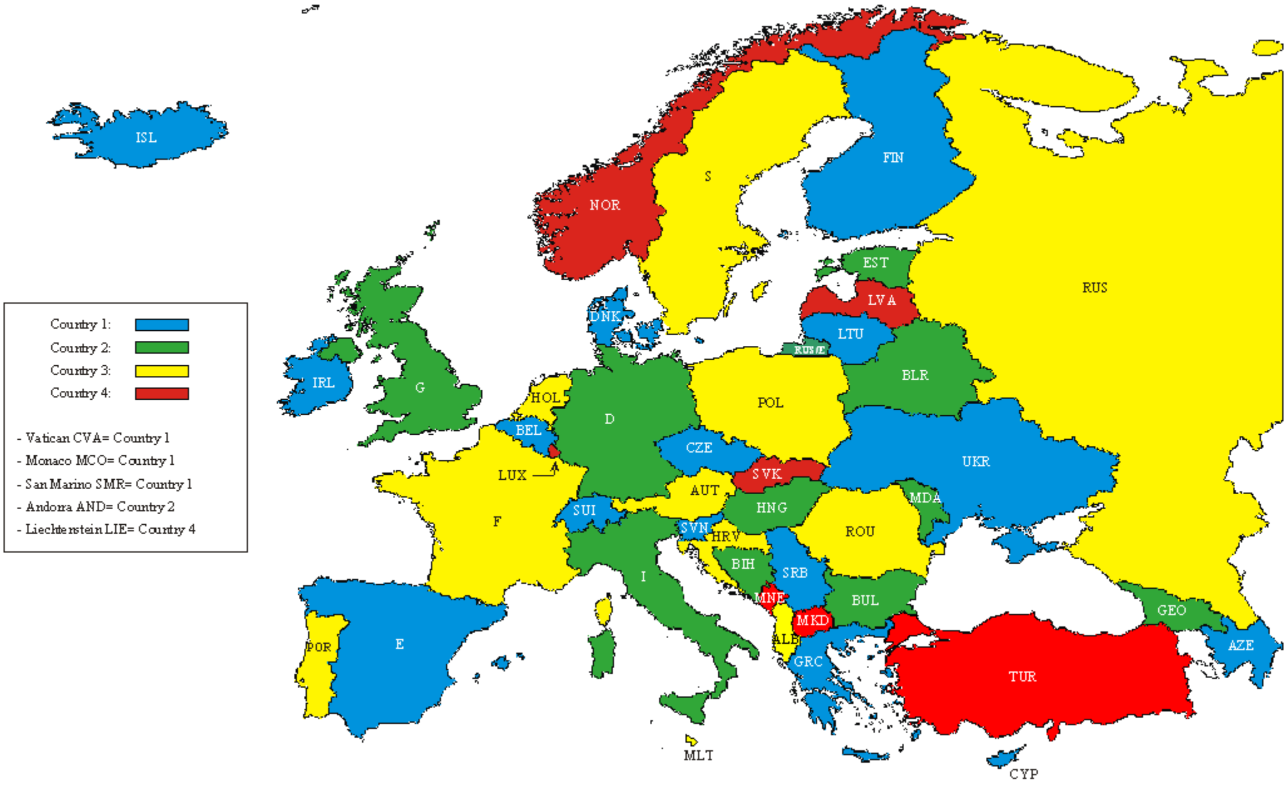

Figure 1: Country type map

ANNEX 5: 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 bi-lateral 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. The following guidance provides the basis for operators to consider in border areas in case of high levels of uplink interference.

A5.1 DEMODULATION REFERENCE SIGNAL (DM RS) 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 [10]. 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 of which of these methods is 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.

A5.2 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-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. 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 that only logical root sequences numbering needs be used for coordination. Unfortunately the process of root sequences planning doesn’t involve direct mapping of root sequences between cells because the number of root sequences needed for one cell is dependent on the cell range. The table showing such interdependency is presented below:

Table 1: PRACH root sequences and cell range

PRACH Configuration	Number of root seq. 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
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 reparation it will be the responsibility of radio network planners to assign the correct number of root sequences in order to not to 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 the text of Recommendation but could be deduced in a similar manner to the PCI repartition shown in the previous Annex.

ANNEX 6: LIST OF REFERENCE

This annex contains the list of relevant reference documents.

[1] ECC Decision (16)02 on the harmonised technical conditions and spectrum bands for the implementation of European Broadband Public Protection and Disaster Relief (BB-PPDR) systems
[2] ECC Decision (15)01 on 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)
[3] ECC Recommendation (15)01 on cross-border coordination for mobile / fixed communications networks (MFCN) in the frequency bands 694-790 MHz, 1452-1492 MHz, 3400-3600 MHz and 3600-3800 MHz
[4] CEPT Recommendation T/R 25-08: Planning criteria and coordination of frequencies for land mobile systems in the range 29.7-470 MHz
[5] 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
[6] Recommendation ITU-R P.1546: Method for point-to-area predictions for terrestrial services in the frequency range 30 MHz to 3 000 MHz
[7] HCM Agreement: http://www.hcm-agreement.eu/
[8] Recommendation ITU-R P.1812: A path-specific propagation prediction method for point-to-area terrestrial services in the VHF and UHF bands
[9] Recommendation ITU-R P.1406: Propagation effects relating to terrestrial land mobile and broadcasting services in the VHF and UHF bands
[10] Resolution 906 (WRC-12): Electronic submission of notice forms for terrestrial services to the Radiocommunication Bureau and exchange of data between administrations
[11] ETSI TS 136 211: LTE; Evolved Universal Terrestrial Radio Access (E-UTRA); Physical channels and modulation