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

CROSS-BORDER COORDINATION OF MULTIPOINT FIXED WIRELESS SYSTEMS IN FREQUENCY BANDS FROM 3.4 GHz TO 33.4 GHz

Vilamoura, February 2006

EXECUTIVE SUMMARY

This ECC Report addresses the issue of finding a most suitable method and criteria for cross-border coordination between point to point (P-P) system and multipoint fixed wireless access (FWA MP) system located on different sides of a national border. The guidance in this report is directed to Administrations wishing to develop FWA MP systems in their countries.

Several recommendations and reports have addressed the issue of coexistence between multipoint (MP) systems:

- ECC Report 32, ERC Recommendations (00)05 and (01)03 and ECC Recommendation (04)06 for the 24.5-26.5 GHz, 27.5-29.5 GHz and 31.8-33.4 GHz bands
- ECC Recommendation (01)04 for the 40.5-42.5 GHz band
- Report 33 for the 3.4-3.8 GHz band and associated ECC Recommendation (04)05.

These coexistence studies addressed both the issue of interference in adjacent channel and in adjacent area. Only this second element is of interest for this report.

It was assumed that the existing methods used for cross-border coordination between the same types of system will also in the future remain suitable. These methods are based on definition of threshold degradation for co-ordination of P-P links, and pfd limits for MP systems.

There are existing multilateral agreements between several European countries for cross-border coordination of FWA MP systems in the 3.5 GHz and 26 GHz bands. These agreements are based on the principles of use of preferential frequencies and certain pfd limits at the national border or close to the border. In accordance with these agreements, P-P links are to be co-ordinated following the same principles as for MP FWA systems, because according to the Recommendations ITU-R F.1399 and F.1401, point to multipoint and point to point systems are to be considered as FWA systems.

During deliberations of this report it became apparent that most administrations believed that the necessity of specific PP to MP FWA coordination method was doubtful as such cases would occur relatively seldom. Therefore it is a general finding of this report that administrations in neighbouring countries wishing to address co-existence of P-P vs FWA MP systems may consider establishing bi- or multilateral coordination agreements, based on the concept of preferential frequencies and PFD limits.

A sample of some such multilateral agreements for different frequencies bands is provided in section 3 of this report for reference purposes.

In cases where no bi- or multilateral coordination agreement exist between concerned countries, the concerned countries may wish to consider coordinating PP vs FWA MP links on a case-by-case basis, using the guidance given in section 2 of this report.

INDEX TABLE

1 INTRODUCTION

This ECC Report addresses the issue of finding a most suitable method and criteria for cross-border coordination between point to point (P-P) system and multipoint fixed wireless access (FWA MP) system located on different sides of a national border. The guidance in this report is directed to Administrations wishing to develop FWA MP systems in their countries.

Several recommendations and reports have addressed the issue of coexistence between multipoint (MP) systems:

- ECC Report 32, ERC Recommendations (00)05 and (01)03 and ECC Recommendation (04)06 for the 24.5-26.5 GHz, 27.5-29.5 GHz and 31.8-33.4 GHz bands
- ECC Recommendation (01)04 for the 40.5-42.5 GHz band
- Report 33 for the 3.4-3.8 GHz band and associated ECC Recommendation (04)05.

These coexistence studies addressed both the issue of interference in adjacent channel and in adjacent area. Only this second element is of interest for this report.

It was assumed that the existing methods used for cross-border coordination between the same types of system will also in the future remain suitable. These methods are based on definition of threshold degradation for co-ordination of P-P links, and pfd limits for MP systems.

There are existing multilateral agreements between several European countries for cross-border coordination of FWA MP systems in the 3.5 GHz, 26 GHz and 28 GHz bands. These agreements are based on the principles of use of preferential frequencies and certain pfd limits at the national border or close to the border. In accordance with these agreements, P-P links are to be co-ordinated following the same principles as for MP FWA systems, because according to the Recommendations ITU-R F.1399 and F.1401, point to multipoint and point to point systems are to be considered as FWA systems.

2 CASE-BY-CASE COORDINATION

2.1 General Approach and Check List

The guidance provided below considers example of coordination between a P-P system in country A, and a FWA MP system in its neighbouring country B. The sequence of check points proposed here may be used when no multilateral agreement exists between country A and country B.

The decision tree to be followed in this coordination process is illustrated by the flow-chart in Fig. 1.

1. Consider the bands and countries concerned. Is it an existing problem, i.e. both systems already exist (go to 2), or a rather a theoretical one, i.e. one of the systems or both systems is in planned (go to 3)?
2. Is it expected further development of the P-P systems in the considered band?
    a. Yes, go to 4.
    b. No: the FWA systems should take due account of existing coordinated P-P links (see 3-a).
3. Two cases must be considered:
    a. Considering that the P-P link already exists, but not the FWA system:
        i. Choose the worst Terminal Station (TS) position, considering the axis of the P-P link and the axis of the TS link towards Central Station (CS), i.e. TS-CS link. Use the same method as for the coordination between P-P links (threshold degradation). The difficulty of this method is to determine the worst TS position. If it is not possible, go to ii).
        ii. The position of the CS is known, but not the positions of the TS. Since it is not possible to coordinate every TS, a possible solution would be to have N (e.g. N=6) TS located appropriately in the service area (see example in section 2.2). These N TS-CS links are then coordinated as P-P links (threshold degradation). It is assumed that every existing TS stations will receive the appropriate protection under the umbrella of those N coordinated links.

    b. Considering that the FWA system already exists, but not the P-P link: in this case, the method generally used for coordination of mobile systems can be applied, i.e. pfd limit at the border and statistical simulations. **An example of statistical simulations is given in annex to this report.**
4. Consider a balanced situation where both systems can develop in a fair manner alleviating the coordination constraints, several directions may be investigated, one after the other:
    a. Applicability of the Rec. ITU-R F.1671
    b. Protection of P-P systems using threshold degradation and of FWA using pfd, like in point 3b (values can be taken from section 3: Examples of existing FWA MP coordination agreements from document FS(05)15_FS Frequency ranges_D.doc, presented in HCM-FS in Biel, 21-22 April 2005, supposing that parameters from the Agreements for the 28 GHz band could be as well used for the 32 GHz one).
    c. Protection of P-P systems and FWA using threshold degradation like in point 3a.

Note: For those administrations who may consider that the pfd limits may not be sufficient to prevent harmful interference to P-P links, they may consider introducing a specific sub-band for exclusively P-P systems for use on both sides of the border where conventional coordination is assumed, as illustrated below.

P-P	Guard Band	P-MP	P-MP
Both countries		Country A	Country B

This would mean that the whole available frequency band needs to be split up in three parts. One for preferential frequencies for P-MP in one country, one for preferential frequencies for P-MP in the other country and one part a sub-band for P-P systems. The sub-band for P-P should be wide enough to accommodate sufficient wide band P-P systems. A guard band between the parts for P-MP and P-P may be taken into account. Such a guard band should be balanced to the bandwidth of the systems used in the band.

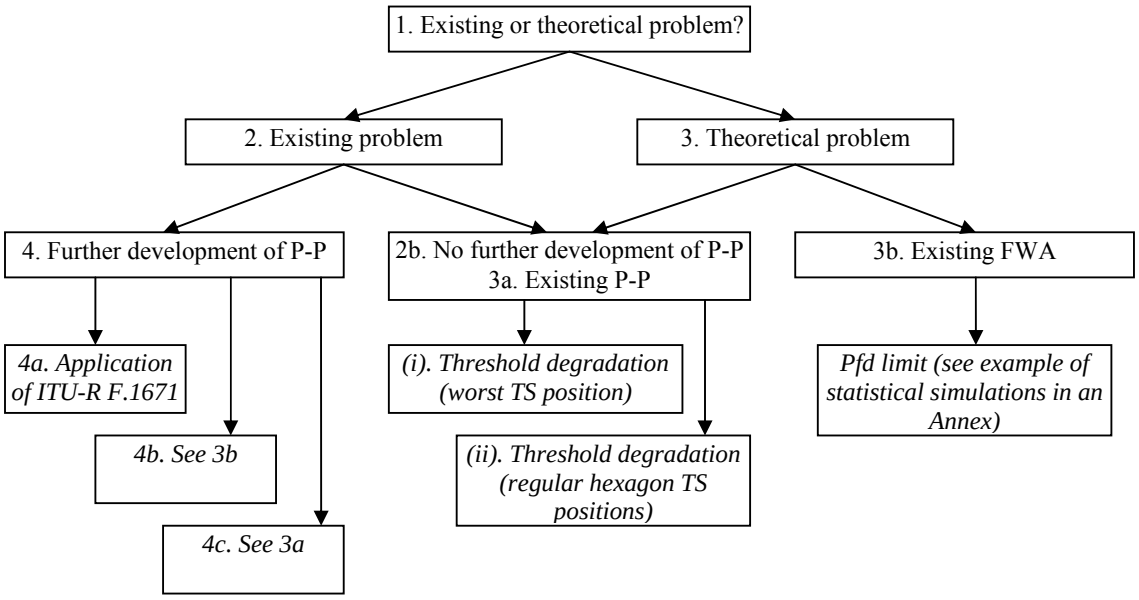


Figure 1: Flow-chart illustration of the co-ordination decision tree

2.2 Example of Describing Deployment of Terminal Stations in a FWA MP System

It is a general problem in coordinating a FWA MP system that the precise position of its TS is not known (in advance). Such TSs could be notified with the ITU in accordance with the provisions of No. 11.17 of the Radio Regulations as typical stations, but not in all frequency bands shared between Terrestrial and Space Services with equal rights.

In these bands the only solution is to present the FWA system as P-MP system with the central station and some typical terminals on the edge of operational area, and use these for co-ordination or for notification to the ITU in accordance with the provisions of No. 11.2 of the Radio Regulations.

And example is provided below, which represents one FWA system cell with known location of the central station CS and unknown locations of the terminals TS, as a P-MP system with a central station CS and 6 TS locations on the radius of the service area of the CS. In flat surfaced terrains the terminals could be located at vertices of a regular hexagon. In a particular example given below, the terrain is hilly therefore the hexagon is adapted to the terrain. Illustration of how this was done is shown in Fig. 2 and 3.

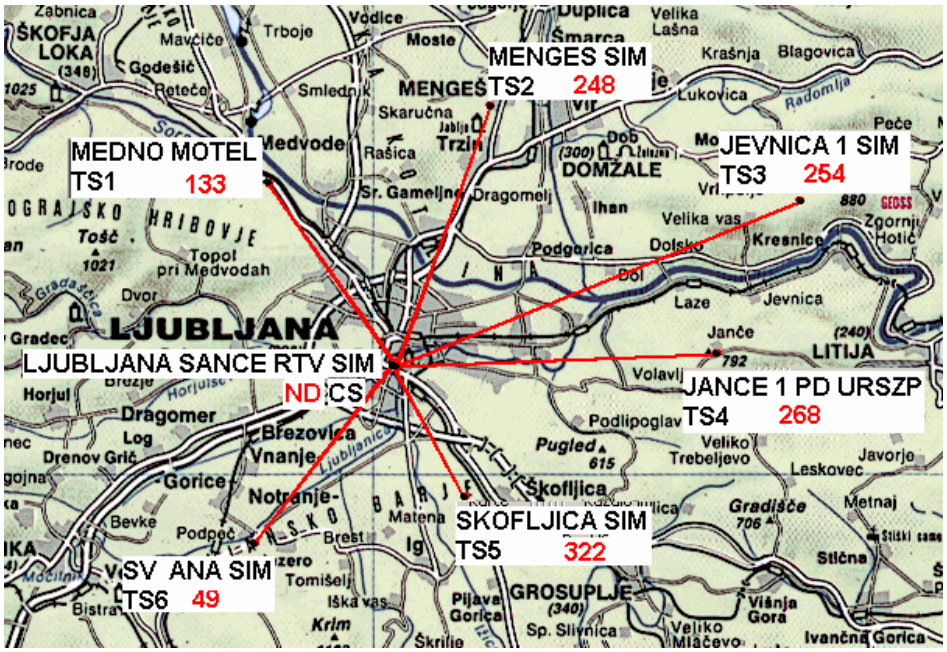


Figure 2: An example of 6 TSs positioned as almost regular hexagon (on the west side of the CS is a small hill)

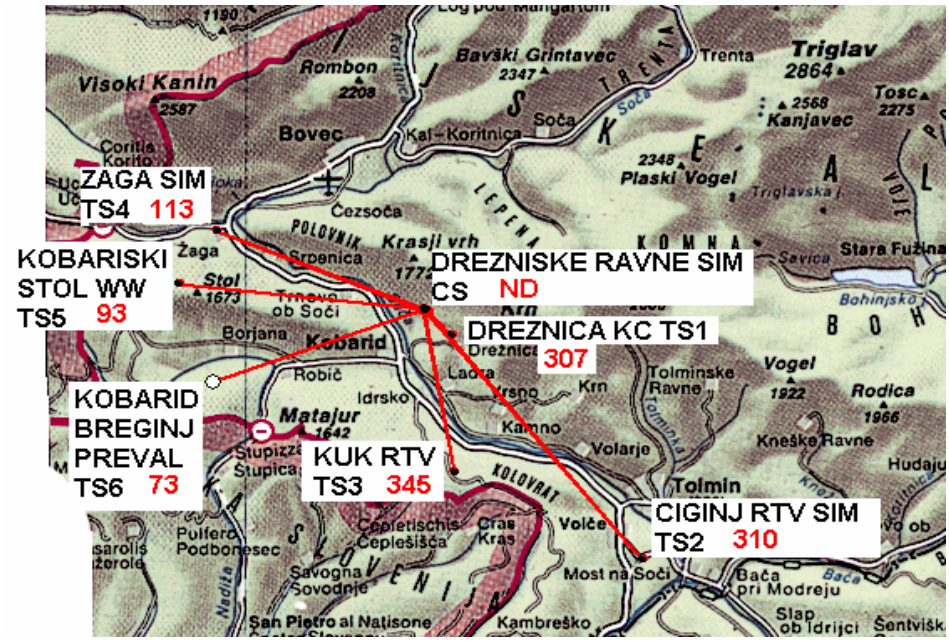


Figure 3: An example of 6 TSs positioned irregularly around CS (mountain ridge is to the North-East of the CS)

The interference can then be assessed in accordance with the ERC/REC (01)05 and in accordance with the Agreement 2003 (former Vienna agreement).

3 EXAMPLES OF SOME EXISTING FWA MP COORDINATION AGREEMENTS

For reference purposes, provisions of some of the existing multilateral agreements for cross-border coordination of FWA MP systems are introduced below as an example. In this list, only the principles of calculation methods and criteria are reported. Nothing is said regarding the coordination process itself. In most of the examples reported below, this process goes along the line of the Agreement 2003. Further details could be found on the web server of the Managing Administration of the Agreement 2003 (see https://ba.bmwa.bund.de/).

a) Agreement between Belgium, France, Germany , Luxembourg and the Netherlands on the frequency coordination for systems for the fixed wireless access (FWA) in the bands 3410-3500 MHz and 3500-3600 MHz

Signed: 14 December 2001

Principle : use of preferential frequencies based on the recommendation CEPT/ERC/REC 14-03 and according to some geographical boundaries

Limit : spectrum flux density (PFD) not exceeding -122 dBW/(MHzxm²) at a distance of 15 km inside the neighbouring country for the use of a preferential frequency or at the border for the use of a non preferential frequency.

Calculation : based on the ITU-R P.452 based on the free space propagation taking an additional statistical loss of 15 dB to consider the influence of for example topography, morphology until an HCM program will be available and accepted by the countries concerned.

Parameters to be exchanged : according to annex 3 of the Agreement(transmitter frequency, receiver frequency, date of bringing into use, name of station, country, geographical coordinates, height of the site, designation of emission, power delivered to the antenna ; maximum radiated power ; directivity of antenna, azimuth of maximum radiation ; elevation angle of maximum radiation, angular with of the radiation main lobe, polarisation ; maximum antenna gain, height of the antenna above ground and remarks) . Formats according to ITU-R form T11.

Technical provisions: Relevant ETSI standards apply. According to the Recommendations ITU-R F 1399 and F 1401, P-MP and P-P are to be considered as FWA systems.

b) Agreement between Austria, France, Germany , Liechtenstein and Switzerland on the frequency coordination for systems for the fixed wireless access (FWA) in the bands 3410-3600 MHz

Signed: 15 August 2000 (Only in French and German languages)

Principle : use of preferential frequencies based on the recommendation CEPT/ERC/REC 14-03 and according to some geographical boundaries

Limit : spectrum flux density (PFD) not exceeding -122 dBW/(MHzxm²) at a distance of 15 km inside the neighbouring country for the use of a preferential frequency or at the border for the use of a non preferential frequency.

Calculation : based on the ITU-R P.452-8 based on the free space propagation

Parameters to be exchanged : according to annex 3 of the Agreement(transmitter frequency, receiver frequency, date of bringing into use, name of station, country, geographical coordinates, height of the site, designation of emission, power delivered to the antenna ; maximum radiated power ; directivity of antenna, azimuth of maximum radiation ; elevation angle of maximum radiation, angular with of the radiation main lobe, polarisation ; maximum antenna gain, height of the antenna above ground and remarks) . Formats according to ITU-R form T11.

Technical provisions : Relevant ETSI standards apply. According to the Recommendations ITU-R F 1399 and F 1401, P-MP and P-P are to be considered as FWA systems. However, Only F will have both.

c) Agreement between the Administrations of Belgium, France, Germany , Luxembourg and the Netherlands on the frequency coordination for systems for the fixed wireless access (FWA) in the bands 24 .549-25.221 GHz and 25.557-26.229 GHz

Signed : 3 April 2000

Principle : use of preferential frequencies based on the recommendation CEPT/T/R 13-02 and according to some geographical boundaries

Limit : spectrum flux density (PFD) not exceeding -105 dBW/(MHzxm²) at a distance of 15 km inside the neighbouring country for the use of a preferential frequency or at the border for the use of a non preferential frequency.

Calculation : based on the ITU-R P.452-8 based on the free space propagation and an atmospheric attenuation of 0.21 dB/km.
Parameters to be exchanged : according to annex 3 of the Agreement(transmitter frequency, receiver frequency, date of bringing into use, name of station, country, geographical coordinates, height of the site, designation of emission, power delivered to the antenna ; maximum radiated power ; directivity of antenna, azimuth of maximum radiation ; elevation angle of maximum radiation, angular with of the radiation main lobe, polarisation ; maximum antenna gain, height of the antenna above ground and remarks) . Formats according to ITU-R form T11.
Technical provisions : Relevant SE 19 reports apply. According to the Recommendations ITU-R F 1399 and F 1401, P-MP and P-P are to be considered as FWA systems.

d) Agreement between Austria, France, Germany , Liechtenstein and Switzerland on the frequency coordination for systems for the fixed wireless access (FWA) in the bands 24.4-25.053 GHz and 25.5-26 .061 GHz

Signed : 15 August 2000 (Only in French and German languages)
Principle : use of preferential frequencies based on the recommendation CEPT/T/R13-02 Annex B and according to some geographical boundaries
Limit : spectrum flux density (PFD) not exceeding -105 dBW/(MHzxm²) at a distance of 15 km inside the neighbouring country for the use of a preferential frequency or at the border for the use of a non preferential frequency.
Calculation : based on the ITU-R P.452-8 based on the free space propagation
Parameters to be exchanged : according to annex 3 of the Agreement(transmitter frequency, receiver frequency, date of bringing into use, name of station, country, geographical coordinates, height of the site, designation of emission, power delivered to the antenna ; maximum radiated power ; directivity of antenna, azimuth of maximum radiation ; elevation angle of maximum radiation, angular with of the radiation main lobe, polarisation ; maximum antenna gain, height of the antenna above ground and remarks) . Formats according to ITU-R form T11.
Technical provisions : According to the Recommendations ITU-R F 1399 and F 1401, P-MP and P-P are to be considered as FWA systems. However, Only F will have both.

e) Agreement between Austria, the Czech Republic, Hungary, Poland, the Slovak Republic, Slovenia and Ukraine on the frequency coordination for systems for the fixed wireless access (FWA) in the bands 3410-3500 MHz and 3500-3600 MHz

Signed : 5 September 2002

Same provisions as agreement described under 3(a) above, with an addition about the position of uplink (3410-3500 MHz) and downlink (3500-3600 MHz) bands

f) Agreement between the administrations of Austria, the Czech Republic, Hungary, Poland, the Slovak Republic, Slovenia and Ukraine on the frequency coordination in the bands 28052.5-28444.5 MHz and 29060.5-29452.5 MHz

Signed : 5 September 2002
Principle : use of preferential frequencies based on the recommendation CEPT T/R 13-02 Annex C and according to some geographical boundaries
Limit : spectrum flux density (PFD) not exceeding -105 dBW/(MHzxm²) at a distance of 15 km inside the neighbouring country for the use of a preferential frequency or at the border for the use of a non preferential frequency fro P-MP links. spectrum flux density (PFD) not exceeding -115 dBW/(MHzxm²) at a distance of 25 km inside the neighbouring country for the use of a preferential frequency or at the border for the use of a non preferential frequency for P-P links
Calculation : based on the ITU-R P.452-8 based on the free space propagation. The calculation method shall be reconsidered after the availability of the harmonized calculation program developed by TWG-HCM.
Parameters to be exchanged : according to annex 3 of the Agreement(transmitter frequency, receiver frequency, date of bringing into use, name of station, country, geographical coordinates, height of the site, designation of emission, power delivered to the antenna ; maximum radiated power ; directivity of antenna, azimuth of maximum radiation ; elevation angle of maximum radiation, angular with of the radiation main lobe, polarisation ; maximum antenna gain, height of the antenna above ground and remarks) . Formats according to ITU-R form T11.
Technical provisions : Recommendation ERC/REC/(01)03 for FDD systems shall apply.

g) Agreement between the Administrations of Austria, the Czech Republic, Germany, Hungary, the Slovak Republic and Slovenia on the frequency coordination for systems for the fixed wireless access (FWA) in the bands 24.549 – 25.053 GHz and 25.557 – 26.061 GHz

Signed : 28 November 2000

Principle : use of preferential frequencies based on the recommendation CEPT T/R 13-02 annex B and according to some geographical boundaries

Limit : spectrum flux density (PFD) not exceeding -105 dBW/(MHzxm²) at a distance of 15 km inside the neighbouring country for the use of a preferential frequency or at the border for the use of a non preferential frequency.

Calculation : based on the ITU-R P.452-8 based on the free space propagation. The calculation method shall be reconsidered after the availability of the harmonized calculation program developed by TWG-HCM.

Parameters to be exchanged : according to annex 3 of the Agreement(transmitter frequency, receiver frequency, date of bringing into use, name of station, country, geographical coordinates, height of the site, designation of emission, power delivered to the antenna ; maximum radiated power ; directivity of antenna, azimuth of maximum radiation ; elevation angle of maximum radiation, angular with of the radiation main lobe, polarisation ; maximum antenna gain, height of the antenna above ground and remarks) . Formats according to ITU-R form T11.

Technical provisions : Recommendation ERC/REC/(00)05 for FDD systems shall apply.

h) Agreement between the administrations of Croatia, Hungary, Romania, Slovenia and Ukraine on the frequency coordination for Fixed Wireless Access (FWA) systems in the bands 3410-3500 MHz and 3500-3600 MHz

Signed: 21 October 2005

Principle : use of preferential frequencies based on the recommendation CEPT/ERC/REC 14-03 and according to some geographical boundaries

Limit : spectrum flux density (PFD) not exceeding -122 dBW/(MHzxm²) at a distance of 15 km inside the neighbouring country for the use of a preferential frequency or at the border for the use of a non preferential frequency.

Calculation : based on the ITU-R P.452 based on the free space propagation taking an additional statistical loss of 15 dB to consider the influence of for example topography, morphology.

Parameters to be exchanged : not necessary in case the preferential conditions are fulfilled. Otherwise according to the general bi- or multilateral agreements is force.

i) Agreement between the Administrations of the Czech Republic, Germany, Hungary, Poland, the Slovak Republic and Ukraine on the frequency coordination for systems for the fixed wireless access (FWA) in the bands 24.549 – 25.053 GHz and 25.557 – 26.061 GHz

Signed : 5 September 2002

Principle : use of preferential frequencies based on the recommendation CEPT/T/R 13-02 annex B and according to some geographical boundaries

Limit : spectrum flux density (PFD) not exceeding -105 dBW/(MHzxm²) at a distance of 15 km inside the neighbouring country for the use of a preferential frequency or at the border for the use of a non preferential frequency.

Calculation : based on the ITU-R P.452-8 based on the free space propagation. The calculation method shall be reconsidered after the availability of the harmonized calculation program developed by TWG-HCM.

Parameters to be exchanged : according to annex 2 of the Agreement(transmitter frequency, receiver frequency, date of bringing into use, name of station, country, geographical coordinates, height of the site, designation of emission, power delivered to the antenna ; maximum radiated power ; directivity of antenna, azimuth of maximum radiation ; elevation angle of maximum radiation, angular with of the radiation main lobe, polarisation ; maximum antenna gain, height of the antenna above ground and remarks) . Formats according to ITU-R form T11.

Technical provisions : Recommendation ERC/REC/(00)05 for FDD systems shall apply.

j) Agreement between the Administrations of Croatia, Hungary, Romania, Slovenia and Ukraine on the frequency coordination for fixed wireless systems in the bands 24.549 – 25.053 GHz and 25.557 – 26.061 GHz

Signed : 21 October 2005

Principle : use of preferential frequencies based on the recommendation CEPT/T/R 13-02 annex B and according to some geographical boundaries

Limit : spectrum flux density (PFD) not exceeding -105 dBW/(MHzxm²) at a distance of 15 km inside the neighbouring country for the use of a preferential frequency or at the border for the use of a non preferential frequency for P-MP links. spectrum flux density (PFD) not exceeding -115 dBW/(MHzxm²) at a distance of 25 km inside the neighbouring country for the use of a preferential frequency or at the border for the use of a non preferential frequency for P-P links.

Calculation : based on the ITU-R P.452-12 based on the free space propagation and an atmospheric attenuation of 0.21 dB/km.

The above mentioned pfd values and the calculation of interference are provisional, and should be revised in accordance with relevant ECC documents to be developed or on the basis of practical experiences of the signatory administrations.

Parameters to be exchanged : not necessary in case the preferential conditions are fulfilled. Otherwise according to the general bi- or multilateral agreements is force.

Technical provisions : Recommendation ERC/REC/(00)05 for FDD systems shall apply.

k) Agreement between the administrations of Croatia, Hungary, Romania, Slovenia and Ukraine on the frequency coordination for fixed wireless systems in the bands 27940.5-28444.5 MHz and 28948.5-29452.5 MHz

Signed : 21 October 2005

Principle : use of preferential frequencies based on the recommendation CEPT/T/R 13-02 Annex C and according to some geographical boundaries

Limit : spectrum flux density (PFD) not exceeding -105 dBW/(MHzxm²) at a distance of 15 km inside the neighbouring country for the use of a preferential frequency or at the border for the use of a non preferential frequency for P-MP links. spectrum flux density (PFD) not exceeding -115 dBW/(MHzxm²) at a distance of 25 km inside the neighbouring country for the use of a preferential frequency or at the border for the use of a non preferential frequency for P-P links

Calculation : based on the ITU-R P.452-12 based on the free space propagation and an atmospheric attenuation of 0.21 dB/km.

The above mentioned pfd values and the calculation of interference are provisional, and should be revised in accordance with relevant ECC documents to be developed or on the basis of practical experiences of the signatory administrations.

Parameters to be exchanged : not necessary in case the preferential conditions are fulfilled. Otherwise according to the general bi- or multilateral agreements is force.

Technical provisions : Recommendation ERC/REC/(01)03 for FDD systems shall apply.

4 CONCLUSIONS

During deliberations of this report it became apparent that most administrations believed that the necessity of specific PP to MP FWA coordination method was doubtful as such cases would occur relatively seldom. Therefore it is a general finding of this report that administrations in neighbouring countries wishing to address co-existence of P-P vs FWA MP systems may consider establishing bi- or multilateral coordination agreements, based on the concept of preferential frequencies and PFD limits.

A sample of some such multilateral agreements for different frequencies bands is provided in section 3 of this report for reference purposes.

In cases where no bi- or multilateral coordination agreement exist between concerned countries, the concerned countries may wish to consider coordinating PP vs FWA MP links on a case-by-case basis, using the guidance given in section 2 of this report.

ANNEX

Introduction

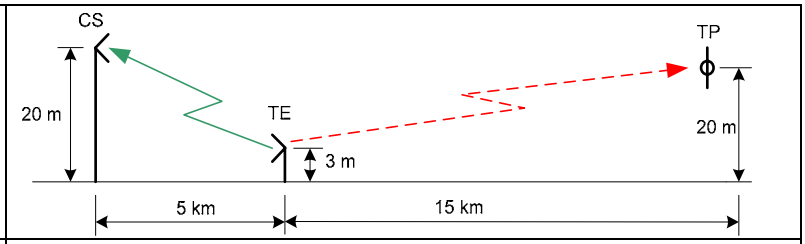
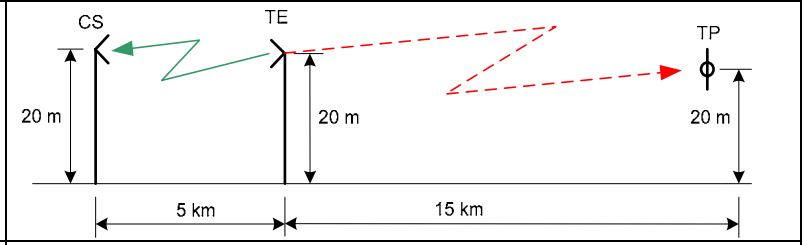
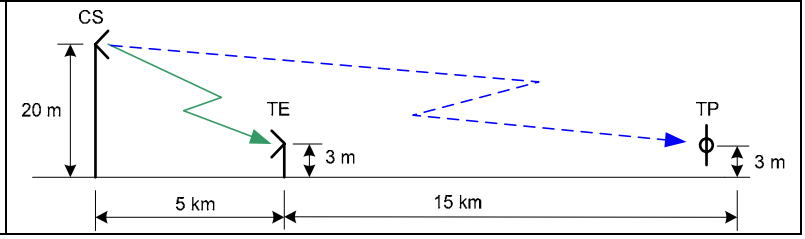
This annex contains an example for calculation of power flux density at a distance of 15 km across the border of a cell, using the CEPT's SEAMCAT-3 Monte-Carlo simulations tool. The results with a Central Station (CS) and a number of Terminal Stations, referred in this study as Terminal Equipment (TE), are shown in the following tables.
Two propagation scenarios are used: the extended Hata model and the Free Space Loss model. The test point is at a height of 3 m (e.g. for nomadic applications) and at 20 m (e.g. for fixed applications).

Parameters:

	Central station	**Terminal stations/TE**
Bandwidth	3.5 MHz	3.5 MHz
Max. output power; with power control	35 dBm	27 dBm
Antenna RPE characteristic (according EN 302 326-3)	9 dBi omnidirectional 17 dBi; α = 60° sector	4 dBi omnidirectional 20 dBi directional
Antenna height (above ground level)	20 m	3 m / 20 m
RX-sensitivity RSL 16QAM (according EN 302 326-2)	-74 dBm	-74 dBm
Number of snapshots (fully loaded channel)	1000	

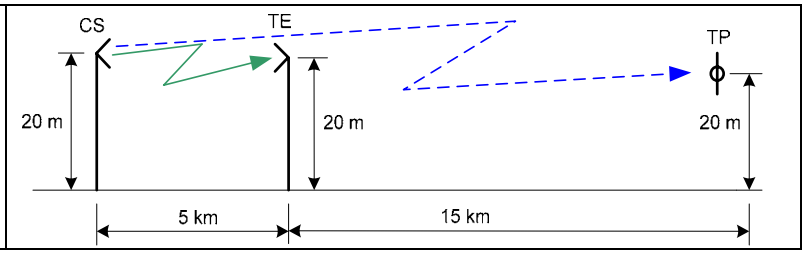
No other additional losses and margins (e.g. wall penetration, implementation margin, etc) were considered. It is calculated direct to receiver threshold sensitivity level (RSL). The results are absolute minimum values; if necessary, additional margins have to be added. On the other hand the RSL, taken from ETSI standards (-74 dBm), is well below the state of the art equipment (approx. -81 dBm).

The following 4 main scenarios were considered in simulations:

Nomadic scenario: Wanted: TE → CS Unwanted: TE → Test Point (TP) CS at 20 m TE at 3 m e.g. nomadic TP at 20 m e.g. victim central station receiver	
Fixed BWA scenario: Wanted: TE → CS Unwanted: TE → TP CS at 20 m TE at 20 m e.g. fixed TP at 20 m e.g. victim central station receiver	
Nomadic scenario: Wanted: CS → TE Unwanted: CS → TP CS at 20 m TE at 3 m e.g. nomadic TP at 3 m e.g. victim nomadic terminal receiver	

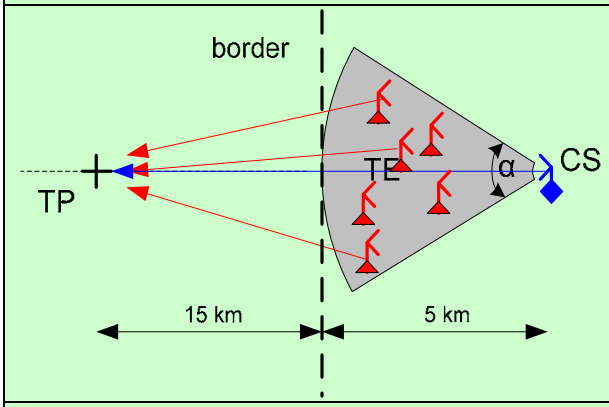
Fixed BWA scenario:

Wanted: CS → TE
Unwanted: CS → TP
CS at 20 m
TE at 20 m e.g. fixed
TP at 20 m e.g. victim terminal equipment receiver

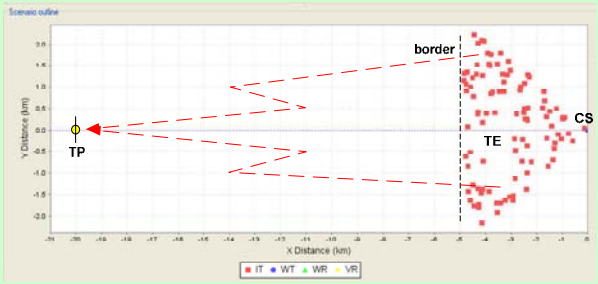


Principle:

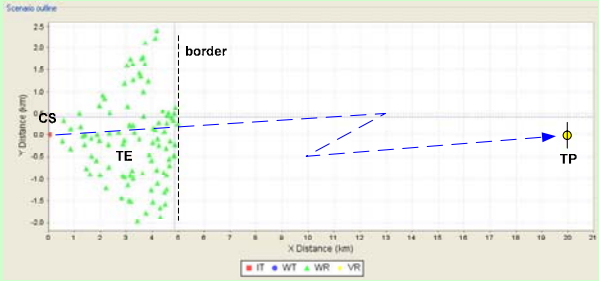
Case a)
Central station is situated 5 km from the border; antenna points to the border.
Terminal station antennas point to CS, away from the border.



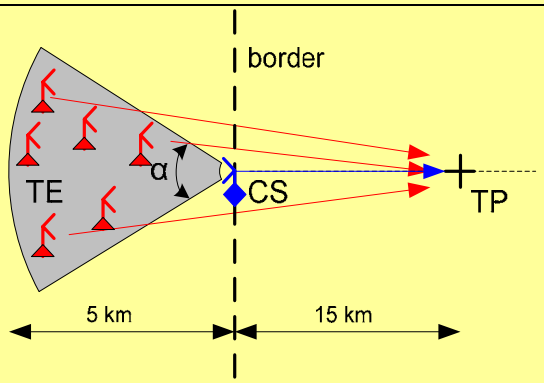
SEAMCAT example:
wanted: uplink TE → CS
unwanted: TE → TP



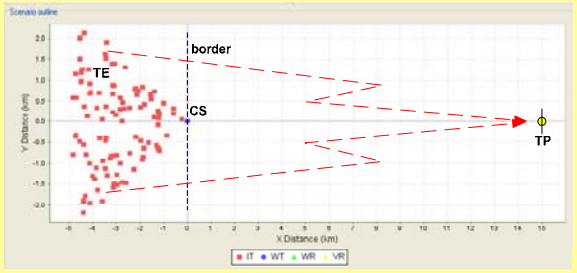
SEAMCAT example:
wanted: downlink CS → TE
unwanted: CS → TP



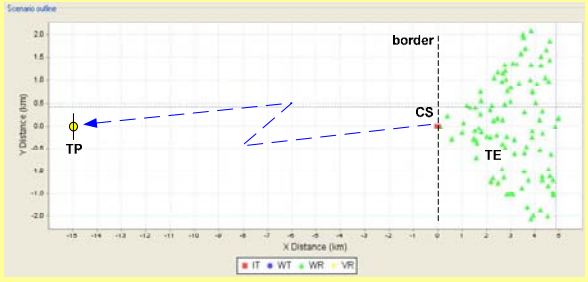
Case b)
Central station is situated at the border, antenna point away from the border.
Terminal station antennas point to CS and to the border.



SEAMCAT example:
wanted: uplink TE → CS
unwanted: TE → TP



SEAMCAT example:
wanted: downlink CS → TE
unwanted: CS → TP



				Results at test point TP													
					Interferer Uplink TE → CS						**Interferer Downlink CS → TE**					
Antenna CS	**case**	**Antenna TE**	**TE height**	**TP height**	**extended Hata** (3 GHz)			**FSL** (3.5 GHz)			**extended Hata** (3 GHz)			**FSL** (3.5 GHz)		
(h= 20 m)			m	m	dBm	$\frac{dBW}{MHz*m^2}$	σ (dBm)	dBm	$\frac{dBW}{MHz*m^2}$	σ (dBm)	dBm	$\frac{dBW}{MHz*m^2}$	σ (dBm)	dBm	$\frac{dBW}{MHz*m^2}$	σ (dBm)
17 dBi; α= 60°	**a)**	**20 dBi directional**	3	3	-148,6	**-151,7**	13,2	-120,1	**-123,2**	4,9	-116,5	**-119,6**	14,3	-104,5	**-107,6**	4,7
				20	-132,4	**-135,5**	13,2				-93,7	**-96,8**	14,5			
			20	3	-140,1	**-143,2**	13,7				-128,0	**-131,1**	13,0			
				20	-120,4	**-123,5**	13,9				-105,2	**-108,3**	12,8			
		4 dBi omni	3	3	-133,0	**-136,1**	11,5	-100,0	**-103,1**	5,4	-102,0	**-105,1**	13,1	-89,2	**-92,3**	4,3
				20	-117,1	**-120,2**	12,0				-78,8	**-81,9**	13,3			
			20	3	-123,0	**-126,1**	12,7				-112,2	**-115,3**	12,9			
				20	-101,0	**-104,1**	12,5				-88,0	**-91,1**	13,3			
	b)	**20 dBi directional**	3	3	-131,7	**-134,8**	13,6	-102,5	**-105,6**	5	-134,0	**-137,1**	15,3	-123,5	**-126,6**	4,9
				20	-114,7	**-117,8**	13,6				-112,2	**-115,3**	14,6			
			20	3	-125,8	**-128,9**	13,9				-144,9	**-148,0**	13,4			
				20	-101,5	**-104,6**	13,1				-123,2	**-126,3**	13,9			
		4 dBi omni	3	3	-134,2	**-137,3**	11,1	-100,7	**-103,8**	4,2	-120,6	**-123,7**	13,1	-108,2	**-111,3**	4,4
				20	-117,8	**-120,9**	11,1				-98,1	**-101,2**	13,3			
			20	3	-124,2	**-127,3**	12,3				-130,3	**-133,4**	13,3			
				20	-101,3	**-104,4**	12,9				-107,5	**-110,6**	13,9			
9 dBi ; omni α= 360°	**a)**	**20 dBi directional**	3	3	-137,7	**-140,8**	13,7	-106,5	**-109,6**	7,2	-117,3	**-120,4**	14,3	-104,6	**-107,7**	4,6
				20	-121,4	**-124,5**	13,7				-93,7	**-96,8**	14,2			
			20	3	-131,3	**-134,4**	13,8				-128,1	**-131,2**	13,4			
				20	-106,9	**-110,0**	14,2				-104,7	**-107,8**	13,2			
		4 dBi omni	3	3	-133,5	**-136,6**	10,3	-94,8	**-97,9**	4,0	-106,3	**-109,4**	11,5	-88,5	**-91,6**	4,6
				20	-117,3	**-120,4**	10,5				-82,6	**-85,7**	11,5			
			20	3	-120,6	**-123,7**	11,4				-113,0	**-117,1**	12,5			
				20	-96,8	**-99,9**	11,0				-89,3	**-92,4**	12,7			
9 dBi ; omni α= 180°	**b)**	**20 dBi directional**	3	3	-130,3	**-133,4**	13,5	-100,5	**-103,6**	6,4	-112,5	**-115,6**	13,8	-102,0	**-105,1**	4,6
				20	-113,6	**-116,7**	13,6				-91,4	**-94,5**	14,4			
			20	3	-123,2	**-126,3**	13,9				-123,3	**-126,4**	13,2			
				20	-104,3	**-107,4**	14,0				-102,5	**-105,6**	13,4			
		4 dBi omni	3	3	-131,3	**-134,4**	10,2	-93,5	**-96,6**	3,5	-101,9	**-105,0**	10,7	-86,0	**-89,1**	4,5
				20	-114,4	**-117,5**	9,9				-79,5	**-82,6**	11,2			
			20	3	-117,6	**-120,7**	11,1				-108,1	**-111,2**	12,7			
				20	-95,1	**-98,2**	11,5				-86,9	**-90,0**	12,2			

σ = standard deviation

Table A.1: Receive level and power flux density at test point (TP) for height of 3 m and 20 m; <u>CS and TE use Tx power control</u>

				Results at test point TP												
					Uplink TE → CS						Downlink CS → TE					
Antenna CS (h= 20 m)	**case**	**Antenna TE**	**TE height**	**TP height**	**extended Hata** (3 GHz)			**FSL** (3.5 GHz)			**extended Hata** (3 GHz)			**FSL** (3.5 GHz)		
			m	m	dBm	$\frac{dBW}{MHz*m^2}$	σ (dBm)	dBm	$\frac{dBW}{MHz*m^2}$	σ (dBm)	dBm	$\frac{dBW}{MHz*m^2}$	σ (dBm)	dBm	$\frac{dBW}{MHz*m^2}$	σ (dBm)
17 dBi; α= 60°	**a)**	**20 dBi directional**	3	3	-132,7	**-135,8**	8,9	-95,3	**-98,4**	1,2	-94,4	**-97,5**	9,0	-71,9	**-75,0**	1
				20	-116,5	**-119,6**	9,1				-70,8	**-73,9**	8,9			
			20	3	-116,5	**-119,6**	8,9				94,3	**-97,4**	9,0			
				20	-94,3	**-97,4**	8,7				-70,5	**-73,6**	9,2			
		4 dBi omni	3	3	-128,8	**-131,9**	8,7	-91,4	**-94,5**	1,2	-94,8	**-97,9**	9,0	-71,9	**-75,0**	1
				20	-113,1	**-116,2**	8,9				-70,8	**-73,9**	9,1			
			20	3	-112,3	**-115,4**	9,0				94,0	**-97,1**	9,0			
				20	-90,4	**-93,5**	8,8				-70,3	**-73,4**	9,0			
	b)	**20 dBi directional**	3	3	-116.0	**-119,1**	9,2	-77,8	**-80,9**	1.1	-112,1	**-115,2**	9,1	-91,0	**-94,1**	2,5
				20	-99,2	**-102,3**	9,3				-89,8	**-92,9**	9,5			
			20	3	-99,4	**-102,5**	9,3				-111,1	**-114,2**	8,9			
				20	-76,9	**-80,0**	9,2				-90,5	**-93,6**	9,4			
		4 dBi omni	3	3	-130,3	**-133,4**	9,0	-92,1	**-95,2**	1,1	-112,0	**-115,1**	9,5	91,1	**-94,2**	2,6
				20	-113,5	**-116,6**	8,7				-89,1	**-92,2**	9,1			
			20	3	-114,0	**-117,1**	9,2				-111,9	**-115,0**	9,4			
				20	-91,0	**-94,1**	9,0				-89,3	**-92,4**	9,3			

σ = standard deviation

Table A.2: Receive level and power flux density at test point TP for height of 3 m and 20 m; <u>without TX power control at CS and TE</u>

Conclusions of studies reported in this Annex:

In most of the preferential frequency agreements the PFD value at a distance of 15 km across the border is -122 dBW/(MHz*m^2). The free space propagation according ITU-R P.452-8 is used for calculation.

The calculation with FSL shows that this value can be met only under certain circumstances and TX power control is necessary in both the central station (CS) and in the terminal stations/equipment (TE). Normally the level at test point TP at a distance of 15 km is, even with TX power control, approx. 10…30 dB too high. According to table A.1 it is recommended to use directional antennas, especially if the antenna is installed outdoor at a certain height; e.g. of more than 3 m.

If omni-directional antennas are used then it can be assumed that these applications are indoor nomadic. In this case the wall attenuation has to be added in the uplink TE→ CS case. Unfortunately in this case the CS Tx power has to be increased and therefore the downlink case CS→ TE will be worse.