F 1/09

Anlage A

Verzeichnis der Bezirke und Gemeinden der Regionen

Region A

Teilpaket	Gemeinde ID	Gemeinde	Bezirk
A1			Krems an der Donau (Stadt)
A1			Sankt Pölten (Stadt)
A1			Waidhofen an der Ybbs (Stadt)
A1			Wiener Neustadt (Stadt)
A1			Baden
A1			Bruck an der Leitha
A1			Gänserndorf
A1			Gmünd
A1			Hollabrunn
A1			Horn
A1			Korneuburg
A1			Krems (Land)
A1			Lilienfeld
A1			Melk
A1			Mistelbach
A1			Mödling
A1			Neunkirchen
A1			Sankt Pölten (Land)
A1			Scheibbs
A1			Tulln
A1			Waidhofen an der Thaya
A1			Wiener Neustadt (Land)
A1			Wien-Umgebung
A1			Zwettl
A1			Wien 1.,Innere Stadt
A1			Wien 2.,Leopoldstadt
A1			Wien 3.,Landstraße
A1			Wien 4.,Wieden
A1			Wien 5.,Margareten
A1			Wien 6.,Mariahilf
A1			Wien 7.,Neubau
A1			Wien 8.,Josefstadt
A1			Wien 9.,Alsergrund
A1			Wien 10.,Favoriten
A1			Wien 11.,Simmering
A1			Wien 12.,Meidling
A1			Wien 13.,Hietzing
A1			Wien 14.,Penzing
A1			Wien 15.,Rudolfsheim-Fünfhaus
A1			Wien 16.,Ottakring
A1			Wien 17.,Hernals
A1			Wien 18.,Währing
A1			Wien 19.,Döbling
A1			Wien 20.,Brigittenau
A1			Wien 21.,Floridsdorf
A1			Wien 22.,Donaustadt
A1			Wien 23.,Liesing
A1	30501	Allhartsberg	Amstetten
A1	30502	Amstetten	Amstetten
A1	30503	Ardagger	Amstetten
A1	30504	Aschbach-Markt	Amstetten
A1	30507	Biberbach	Amstetten
A1	30510	Ertl	Amstetten
A1	30511	Euratsfeld	Amstetten
A1	30512	Ferschnitz	Amstetten
A1	30516	Hollenstein an der Ybbs	Amstetten
A1	30517	Kematen an der Ybbs	Amstetten
A1	30520	Neuhofen an der Ybbs	Amstetten
A1	30521	Neustadtl an der Donau	Amstetten
A1	30522	Oed-Oehling	Amstetten

A1	30524	Opponitz	Amstetten
A1	30526	Sankt Georgen am Reith	Amstetten
A1	30527	Sankt Georgen am Ybbsfelde	Amstetten
A1	30532	Seitenstetten	Amstetten
A1	30533	Sonntagberg	Amstetten
A1	30536	Viehdorf	Amstetten
A1	30538	Wallsee-Sindelburg	Amstetten
A1	30541	Winklarn	Amstetten
A1	30542	Wolfsbach	Amstetten
A1	30543	Ybbsitz	Amstetten
A1	30544	Zeillern	Amstetten
A3	30506	Behamberg	Amstetten
A3	30508	Ennsdorf	Amstetten
A3	30509	Ernsthofen	Amstetten
A3	30514	Haag	Amstetten
A3	30515	Haidershofen	Amstetten
A3	30529	Sankt Pantaleon-Erla	Amstetten
A3	30530	Sankt Peter in der Au	Amstetten
A3	30531	Sankt Valentin	Amstetten
A3	30534	Strengberg	Amstetten
A3	30539	Weistrach	Amstetten

Region B

Teilpaket	Bezirk
B1	Eisenstadt (Stadt)
B1	Rust (Stadt)
B1	Eisenstadt-Umgebung
B1	Mattersburg
B1	Neusiedl am See
B1	Oberpullendorf
B2	Güssing
B2	Jennersdorf
B2	Oberwart

Region C

Teilpaket	Gemeinde ID	Gemeinde	Bezirk
C1	61205	Altenmarkt bei Sankt Gallen	Liezen
C1	61210	Gaishorn am See	Liezen
C1	61211	Gams bei Hieflau	Liezen
C1	61219	Johnsbach	Liezen
C1	61221	Landl	Liezen
C1	61230	Palfau	Liezen
C1	61239	Sankt Gallen	Liezen
C1	61246	Treglwang	Liezen
C1	61248	Weißenbach an der Enns	Liezen
C1	61250	Weng bei Admont	Liezen
C1	61251	Wildalpen	Liezen
C2			Graz (Stadt)
C2			Bruck an der Mur
C2			Deutschlandsberg
C2			Feldbach
C2			Fürstenfeld
C2			Graz-Umgebung
C2			Hartberg
C2			Judenburg
C2			Knittelfeld
C2			Leibnitz
C2			Leoben

C2			Mürzzuschlag
C2			Murau
C2			Radkersburg
C2			Voitsberg
C2			Weiz
C3	61201	Admont	Liezen
C3	61202	Aich	Liezen
C3	61203	Aigen im Ennstal	Liezen
C3	61204	Altaussee	Liezen
C3	61206	Ardning	Liezen
C3	61207	Bad Aussee	Liezen
C3	61208	Donnersbach	Liezen
C3	61209	Donnersbachwald	Liezen
C3	61212	Gössenberg	Liezen
C3	61213	Gröbming	Liezen
C3	61214	Großsölk	Liezen
C3	61215	Grundlsee	Liezen
C3	61216	Hall	Liezen
C3	61217	Haus	Liezen
C3	61218	Irdning	Liezen
C3	61220	Kleinsölk	Liezen
C3	61222	Lassing	Liezen
C3	61223	Liezen	Liezen
C3	61224	Michaelerberg	Liezen
C3	61225	Mitterberg	Liezen
C3	61226	Bad Mitterndorf	Liezen
C3	61227	Niederöblarn	Liezen
C3	61228	Öblarn	Liezen
C3	61229	Oppenberg	Liezen
C3	61232	Pichl-Preunegg	Liezen
C3	61233	Pichl-Kainisch	Liezen
C3	61234	Pruggern	Liezen
C3	61235	Pürgg-Trautenfels	Liezen
C3	61236	Ramsau am Dachstein	Liezen
C3	61237	Rohrmoos-Untertal	Liezen
C3	61238	Rottenmann	Liezen
C3	61240	Sankt Martin am Grimming	Liezen
C3	61241	Sankt Nikolai im Sölktal	Liezen
C3	61242	Schladming	Liezen
C3	61243	Selzthal	Liezen
C3	61244	Stainach	Liezen
C3	61245	Tauplitz	Liezen
C3	61247	Trieben	Liezen
C3	61249	Weißenbach bei Liezen	Liezen
C3	61252	Wörschach	Liezen

Region D

Teilpaket	Bezirk
D2	Klagenfurt (Stadt)
D2	Villach (Stadt)
D2	Hermagor
D2	Klagenfurt Land
D2	Sankt Veit an der Glan
D2	Spittal an der Drau
D2	Villach Land
D2	Völkermarkt
D2	Wolfsberg
D2	Feldkirchen

Region E

Teilpaket	Bezirk
E2	Lienz

Region F

Teilpaket	Bezirk
F2	Innsbruck-Stadt
F2	Imst
F2	Innsbruck-Land
F2	Kitzbühel
F2	Kufstein
F2	Landeck
F2	Reutte
F2	Schwaz

Region G

Teilpaket	Bezirk
G2A	Zell am See
G2B	Tamsweg
G3	Salzburg (Stadt)
G3	Hallein
G3	Salzburg-Umgebung
G3	Sankt Johann im Pongau

Region H

Teilpaket	Gemeinde ID	Gemeinde	Bezirk
H1A	41102	Arbing	Perg
H1A	41103	Baumgartenberg	Perg
H1A	41104	Dimbach	Perg
H1A	41105	Grein	Perg
H1A	41107	Klam	Perg
H1A	41108	Bad Kreuzen	Perg
H1A	41112	Mitterkirchen im Machland	Perg
H1A	41113	Münzbach	Perg
H1A	41115	Pabneukirchen	Perg
H1A	41119	Sankt Georgen am Walde	Perg
H1A	41121	Sankt Nikola an der Donau	Perg
H1A	41122	Sankt Thomas am Blasenstein	Perg
H1A	41123	Saxen	Perg
H1A	41125	Waldhausen im Strudengau	Perg
H1B	41505	Gaflenz	Steyr-Land
H1B	41519	Weyer Land	Steyr-Land
H1B	41520	Weyer Markt	Steyr-Land
H3			Linz (Stadt)
H3			Wels (Stadt)
H3			Braunau am Inn
H3			Eferding
H3			Freistadt
H3			Gmunden
H3			Grieskirchen
H3			Kirchdorf an der Krems
H3			Linz-Land
H3			Ried im Innkreis
H3			Rohrbach

H3			Schärding
H3			Urfahr-Umgebung
H3			Vöcklabruck
H3			Wels-Land
H3			Steyr (Stadt)
H3	41101	Allerheiligen im Mühlkreis	Perg
H3	41106	Katsdorf	Perg
H3	41109	Langenstein	Perg
H3	41110	Luftenberg an der Donau	Perg
H3	41111	Mauthausen	Perg
H3	41114	Naarn im Machlande	Perg
H3	41116	Perg	Perg
H3	41117	Rechberg	Perg
H3	41118	Ried in der Riedmark	Perg
H3	41120	Sankt Georgen an der Gusen	Perg
H3	41124	Schwertberg	Perg
H3	41126	Windhaag bei Perg	Perg
H3	41501	Adlwang	Steyr-Land
H3	41502	Aschach an der Steyr	Steyr-Land
H3	41503	Bad Hall	Steyr-Land
H3	41504	Dietach	Steyr-Land
H3	41506	Garsten	Steyr-Land
H3	41507	Großraming	Steyr-Land
H3	41508	Laussa	Steyr-Land
H3	41509	Losenstein	Steyr-Land
H3	41510	Maria Neustift	Steyr-Land
H3	41511	Pfarrkirchen bei Bad Hall	Steyr-Land
H3	41512	Reichraming	Steyr-Land
H3	41513	Rohr im Kremstal	Steyr-Land
H3	41514	Sankt Ulrich bei Steyr	Steyr-Land
H3	41515	Schiedlberg	Steyr-Land
H3	41516	Sierning	Steyr-Land
H3	41517	Ternberg	Steyr-Land
H3	41518	Waldneukirchen	Steyr-Land
H3	41521	Wolfern	Steyr-Land

F 1/09

Anlage B

Vollständigkeitserklärung

Vollständigkeitserklärung

An

Telekom-Control-Kommission
Mariahilferstrasse 77-79
A-1060 Wien
Österreich

Name und Anschrift des Antragstellers

Betr.: **Antrag zu F 1/09**

Der Antragsteller erklärt Folgendes:

Die Informationen und Unterlagen, die gemäß Ausschreibungsunterlage, F 1/09, verlangt werden und die sonst für die Beurteilung des Antrags im Frequenzzuteilungsverfahren gemäß den anzuwendenden Bestimmungen des europäischen Gemeinschaftsrechts und den anzuwendenden österreichischen Rechtsvorschriften, insbesondere des Telekommunikationsgesetzes, erforderlich sind, sind im Antrag vollständig und wahrheitsgemäß enthalten, auch wenn diese in der Ausschreibungsunterlage nicht ausdrücklich verlangt werden.

Insbesondere bestehen hinsichtlich

- der Eigentumsverhältnisse des Antragstellers
- der geplanten Finanzierung
- des Geschäftsplanes

außer den im Antrag offen gelegten keine Vereinbarungen, Nebenabreden oder andere relevante Sachverhalte, welche Einfluss auf die Beurteilung des Antrags haben können.

Datum:

(firmenmäßige Zeichnung)

F 1/09

Telekom-Control-Kommission

TKK

Anlage C

Antragsformular

Antragsformular im Verfahren betreffend Frequenzzuteilungen im Frequenzbereich 3,5 GHz

1. Name und Anschrift des Antragstellers

Regionen

In folgenden Regionen ist eine Teilnahme an der Auktion vorgesehen:

- ❑ Region A
- ❑ Region B
- ❑ Region C
- ❑ Region D
- ❑ Region E
- ❑ Region F
- ❑ Region G
- ❑ Region H

Bietberechtigung

Es wird eine Bietberechtigung im Umfang von ______________________________ (in Worten ____) Punkten beantragt.

Besicherung

Die Besicherung in der Höhe von Euro ____________________________ (in Worten ____) liegt dem Antrag bei.

Datum:

____________________ ____________________

(firmenmäßige Zeichnung)

F 1/09

Anlage D

Schutz von Peilempfangsanlagen

Zum Schutz der im Folgenden angeführten stationären Peilempfangsanlagen der Fernmeldebehörden darf an den angegebenen Standorten der durch Sendeanlagen verursachte Spitzenwert der Feldstärke, gemessen mit der systemkonformen Bandbreite, den Wert von 105 dBµV/m nicht überschreiten.

Wien

16E22 39	**48N14 24**	**1200**	**WIEN, Höchstädtplatz 3**
16E20 08	48N15 45	1190	WIEN, Krapfenwaldgasse 17
16E15 43	48N13 04	1140	WIEN, Ulmenstraße 160
16E23 32	48N11 14	1030	WIEN, Ghegastraße 1

Niederösterreich

16E28 43	48N19 40	2201	GERASDORF, Peilstelle Seyring (EZ 146/2)
14E48 24	48N00 12	3332	ROTTE, Nöchling Nr. 5

Oberösterreich

14E16 02	**48N17 52**	**4020**	**LINZ, Freinbergstraße 22**
14E01 31	48N14 54	4611	SCHARTEN, Hochscharten 3

Salzburg

13E02 44	**47N49 14**	**5020**	**SALZBURG, Mittelstraße 17**
13E02 20	47N48 05	5020	SALZBURG, Mönchsberg 35
13E26 02	47N46 35	5360	ST.GILGEN, Schafberg/Berghotel

Tirol

11E26 23	**47N15 56**	**6020**	**INNSBRUCK, Valiergasse 60**
11E22 51	47N18 43	6020	INNSBRUCK, Hafelekar/Berghütte
11E33 19	47N15 12	6060	HALL, Tulferberg, Tulfes 59
12E19 36	47N30 06	6370	REITH bei Kitzbühel, Astberg

Vorarlberg

09E42 23	**47N29 29**	**6971**	**HARD, Rheinstraße 4**
09E39 38	47N26 49	6890	LUSTENAU, Hagen-Silo
09E38 36	47N29 06	6972	FUSSACH, Peilstelle

Steiermark

15E25 49	47N02 07	8055	GRAZ, Triester Straße 280
15E29 14	47N05 01	8010	GRAZ-RIES, Ledermoarweg 19
15E54 51	47N31 49	8253	WALDBACH, Hochwechsel-Aspangberg (107m westlich Wetterkoglerhaus)

Kärnten

14E18 19	**46N37 22**	**9010**	**KLAGENFURT, Dr. Herrmann-Gasse 4**
14E18 05	46N36 21	9020	KLAGENFURT, Südring 240
13E51 33	46N36 44	9500	VILLACH, Dr. Semmelweißstraße 18
14E29 48	46N38 19	9131	GRAFENSTEIN, Thon 21 (Gebäude der Messstelle und Peilantennenstandort)

(alle Koordinatenangaben nach WGS84)

Stand vom 2.Juni 2008

F 1/09

Anlage E

Funkschnittstellenbeschreibung FSB-RR039

Schnittstelle Nr.: FSB-RR039 (Ausgabe 20. 6. 2006)

	Parameter	Beschreibung
Normativer Teil		
[01]	Frequenzband	**3410 – 3494 MHz (Unterband)** **3510 – 3594 MHz (Oberband)**
[02]	Funkdienst laut Vollzugsordnung	**Fester Funkdienst**
[03]	Verwendungszweck	**Punkt-zu-Multipunkt Richtfunksysteme (Richtfunkverteilsysteme)**
[04]	Bewilligungsart	**Individuelle Bewilligung**
[05]	Kanalabstand / Art der Aussendung oder Art der Modulation	**Kanalabstand: mindestens 1,75 MHz, maximal 14 MHz (in Inkrementen von 0,250 MHz)** **digitale Modulationsverfahren**
[06]	max. Sendeleistung / max. Senderausgangsleistung / max. Strahlungsleistung	**max. Senderausgangsleistung: + 35 dBm** **max. Strahlungsleistungsdichte: + 23 dBW/MHz e.i.r.p.** **Die im Einzelfall zulässige Strahlungsleistungsdichte wird in der Betriebsbewilligung festgelegt.**
[07]	Antennencharakteristik / Polarisation	**wird in der Betriebsbewilligung festgelegt**
[08]	Sendezeitverhältnis / Kanalzugriffsverfahren	**nicht festgelegt**
[09]	Duplexabstand / Duplexverfahren	**Duplexabstand: 100 MHz (bei FDD)** **Duplexverfahren: FDD, TDD**
[10]	Erfordernis für Funkerzeugnis	**nein**
[11]	Andere Einschränkungen hinsichtlich der Benützung des Frequenzbandes	**Nutzung ausschließlich entsprechend den Bestimmungen des von der Regulierungsbehörde erteilten Frequenzzuteilungsbescheides.**
[12]	Vorgesehene Änderungen	**keine**
[13]	Anmerkungen	**zu [05]:** **Ermittlung der Kanaleckfrequenzen:** • **Generell: entsprechend CEPT-Empfehlung ERC/REC 14-03 *recommends* 1** • **Bei FDD: entsprechend CEPT-Empfehlung ERC/REC 14-03 Annex B1.** **zu [06]:** **Die festgelegte max. Senderausgangsleistung bzw. max. Strahlungsleistungsdichte gilt sowohl für zentrale Funkstellen als auch für Teilnehmerfunkstellen.** **Bei der Festlegung der max. Strahlungsleistungsdichte im Bereich von Staats- bzw. Regionsgrenzen werden insbesondere auch die Bestimmungen der §§ 11 - 13 der Frequenzzuteilungsurkunde (Anlage zum Frequenzzuteilungsbescheid der Regulierungsbehörde) berücksichtigt.** **zu [09]:** **Bei Verwendung des Duplexverfahrens TDD sind die diesbezüglichen Bestimmungen des § 10 der Frequenzzuteilungsurkunde (Anlage zum Frequenzzuteilungsbescheid der Regulierungsbehörde) einzuhalten.**
Informativer Teil		
[14]	Referenzspezifikationen	**EN 302 326-1, EN 302 326-2, EN 302 326-3,** **ERC/REC 14-03, ECC/REC/(04)05**
[15]	Empfohlene (harmonisierte) Normen	**EN 302 326**

F 1/09

Anlage F

CEPT-Rec. 14-03 E (Harmonised Radio Frequency Channel Arrangments and Block Allocations for low and medium Capacity Systems in the Band 3.400 MHz to 3.600 MHz)

CEPT/ERC/RECOMMENDATION 14-03 E (Turku 1996, Podebrady 1997)

HARMONISED RADIO FREQUENCY CHANNEL ARRANGEMENTS AND BLOCK ALLOCATIONS FOR LOW AND MEDIUM CAPACITY SYSTEMS IN THE BAND 3400 MHz TO 3600 MHz

Recommendation adopted by the Working Group "Spectrum Engineering" (WGSE)

"The European Conference of Postal and Telecommunications Administrations,

considering

1. that CEPT has a long term objective to harmonise the use of frequencies throughout Europe,

2. that CEPT should develop radio frequency channel arrangements and block allocation rules in order to make the most effective use of the spectrum for point to point (P-P), point to multipoint (P-MP) and ENG/OB applications,

3. that CEPT/ERC Recommendation 25-10 designates this band as a tuning range for ENG/OB,

4. that the band 3400 MHz to 3410 MHz is used by land, airborne and naval military radars,

5. that the achievement of harmonisation requires the adoption of a limited number of channel arrangements and block allocation rules,

noting

a) that the table of frequency allocations in the Radio Regulations allocates the band 3400 MHz to 3600 MHz on a primary basis to the Fixed and Fixed - Satellite services and on a secondary basis to the Radiolocation and Mobile services,

b) that countries desire to deploy different combinations of P-P, P-MP and ENG/OB systems on a primary basis in this band,

c) that there is an ITU-R Recommendation (F-635) for P-P wide band applications incorporating this band for some administrations,

d) that frequency separation may be required for uncoordinated deployment of current and future systems,

e) that cellular deployment of P-MP systems preferably requires the allocation of continuous spectrum to the operator, *recommends*

1) that frequency assignments should in all cases be based on 0.25 MHz slots within the 3410 MHz to 3600 MHz band,

the frequency of the lower edge of any slot shall be defined by the general equation:

$f_s = 3410 + 0.25\,N$ MHz

where

$0 \leq N \leq 759$

2) that administrations should assign all or part of the band to any system or combination of the three systems in accordance with Annex A and/or B."

ANNEX A

50 MHz ARRANGEMENTS

A1 Point to multipoint systems

P-MP systems may be operated in the ranges 3410-3500 MHz and 3500-3600 MHz.

Where a frequency duplex allocation is required, the spacing between the lower edges of the paired sub-bands shall be 50 MHz. The edges of each sub-band are defined as follows:

3410 MHz - 3500 MHz

Lower sub-band:	0.25 N + 3410 to 0.25 (N + k) + 3410	MHz
Upper sub-band:	0.25 (N + 200) + 3410 to 0.25 (N + k + 200) + 3410	MHz MHz
$1 \leq k \leq 160$, $0 \leq N \leq 159$, $k + N \leq 160$		

3500 MHz - 3600 MHz

Lower sub-band	0.25 N + 3410 to 0.25 (N + k) + 3410	MHz
Upper sub-band	0.25 (N + 200) + 3410 to 0.25 (N + k + 200) + 3410	MHz
$1 \leq k \leq 200$, $360 \leq N \leq 559$, $k + N - 360 \leq 200$		

In the tables above, k defines the width of each sub-band and N defines the lower edge of each sub-band.

P-MP equipment may be used having a duplex spacing other than exactly 50 MHz. However, such equipment must conform to the limits of the block allocation as defined above.

A2 Point to point systems with a duplex spacing of 50 MHz

Channel centre frequencies are defined at the edges of 0.25 MHz slots as follows:

A2.1 Systems with 1.75 MHz channel spacing

3410 MHz - 3500 MHz

Lower sub-band	$f_{c,n}$ = 3410 + 1.75 n MHz	n = 1, 2, …, 22
Upper sub-band	$f_{c,n}$ = 3410 + 1.75 n MHz	

3500 MHz - 3600 MHz

Lower sub-band	$f_{c,n}$ = 3500 + 1.75 n MHz	n = 1, 2, …, 28
Upper sub-band	$f_{c,n}$ = 3550 + 1.75 n MHz	

A2.2 Systems with 3.5 MHz channel spacing

3410 MHz - 3500 MHz

Lower sub-band	$f_{c,n}$ = 3408.25 + 3.5 n MHz	n = 1, 2, …, 10
Upper sub-band	$f_{c,n}$ = 3458.25 + 3.5 n MHz	

3500 MHz - 3600 MHz

Lower sub-band	$f_{c,n}$ = 3498.25 + 3.5 n MHz	n = 1, 2, …, 14
Upper sub-band	$f_{c,n}$ = 3548.25 + 3.5 n MHz	

A2.3 Systems with 7 MHz channel spacing

3410 MHz - 3500 MHz

Lower sub-band	$f_{c,n}$ = 3406.5 + 7 n MHz	n = 1, 2, …, 5
Upper sub-band	$f_{c,n}$ = 3456.5 + 7 n MHz	

3500 MHz - 3600 MHz

Lower sub-band	$f_{c,n}$ = 3496.5 + 7 n MHz	n = 1, 2, …, 7
Upper sub-band	$f_{c,n}$ = 3546.5 + 7 n MHz	

A2.4 Systems with 14 MHz channel spacing

3410 MHz - 3500 MHz

Lower sub-band	$f_{c,n}$ = 3403 + 14 n MHz	n = 1, 2
Upper sub-band	$f_{c,n}$ = 3453 + 14 n MHz	

3500 MHz - 3600 MHz

Lower sub-band	$f_{c,n}$ = 3493 + 14 n MHz	n = 1, 2
Upper sub-band	$f_{c,n}$ = 3543 + 14 n MHz	

A3 ENG/OB systems

ENG/OB systems shall be assigned contiguous 0.25 MHz slots, as appropriate for the channel spacings and amount of spectrum required. Exact channel centre frequencies will be allocated within the slots depending on the equipment used.

Where the band 3410-3600 MHz is shared between ENG/OB and P-P or P-MP services by an administration, ENG/OB services will operate within either the range 3410-3500 or 3500-3600 MHz, with P-P and P-MP services in the other part of the band, to minimise co-ordination problems between the services.

ANNEX B

100 MHz ARRANGEMENTS

B1 Point to multipoint systems

P-MP systems may be operated in the range 3410-3500 MHz paired with 3500-3600 MHz.

Where a frequency duplex allocation is required, the spacing between the lower edges of each paired sub-band shall be 100 MHz. The edges of each sub-band are defined as follows:

Lower sub-band	$0.25\,N + 3410$ to $0.25\,(N + k) + 3410$	MHz
Upper sub-band	$0.25\,(N + 400) + 3410$ to $0.25\,(N + k + 400) + 3410$	MHz MHz
$1 \le k \le 360$, $0 \le N \le 359$, $k + N \le 360$		

In the table above, k defines the width of each sub-band and N defines the lower edge of each sub-band.

P-MP equipment may be used having a duplex spacing other than exactly 100 MHz. However, such equipment must conform to the limits of the block allocation as defined above.

B2 Point to point systems with a duplex spacing of 100 MHz

Channel centre frequencies are defined at the edges of 0.25 MHz slots as follows:

B2.1 Systems with 1.75 MHz channel spacing

Lower sub-band	$f_{c,n} = 3410 + 1.75\,n$ MHz	$n = 1, 2, \ldots, 50$
Upper sub-band	$f_{c,n} = 3510 + 1.75\,n$ MHz	

B2.2 Systems with 3.5 MHz channel spacing

Lower sub-band	$f_{c,n} = 3408.25 + 3.5\,n$ MHz	$n = 1, 2, \ldots, 25$
Upper sub-band	$f_{c,n} = 3508.25 + 3.5\,n$ MHz	

B2.3 Systems with 7 MHz channel spacing

Lower sub-band	$f_{c,n} = 3406.5 + 7\,n$ MHz	$n = 1, 2, \ldots, 12$
Upper sub-band	$f_{c,n} = 3506.5 + 7\,n$ MHz	

B2.4 Systems with 14 MHz channel spacing

Lower sub-band	$f_{c,n} = 3403 + 14\,n$ MHz	$n = 1, 2, \ldots, 6$
Upper sub-band	$f_{c,n} = 3503 + 14\,n$ MHz	

B3 ENG/OB systems

ENG/OB systems shall be assigned contiguous blocks of 0.25 MHz slots, as appropriate for the channel spacings and amount of spectrum required. Exact channel centre frequencies will be assigned within the slots depending on the equipment used.

F 1/09

Telekom-Control-Kommission

TKK

Anlage G

ECC-Report 33 (The Analysis of the Coexistence of FWA Cells in the 3.4 – 3.8 GHz Band)

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

THE ANALYSIS OF THE COEXISTENCE OF FWA CELLS IN THE 3.4 - 3.8 GHz BAND

Cavtat, May 2003

EXECUTIVE SUMMARY AND CONCLUSIONS

Summary

The scope of this ECC Report is to provide up-to-date guidelines for efficient, technology independent deployment of 3.5 GHz (or 3.7 GHz) FWA systems.

The Report recognises that the current technology for FWA in bands around 3.5 GHz is in continuous extensive evolution since first ECC Recommendations 14-03 and 12-08 were developed. A detailed study on the coexistence of various technologies was needed in order to provide guidance to Administrations that wish to adopt an efficient and technology neutral approach to the deployment rules in these bands.

It is also noted that ETSI ENs in these bands are not presently designed for a technology neutral deployment (this is done only in the 40 GHz MWS EN 301 997) therefore do not contain system controlling parameters, in terms of EIRP, useful for the desired “technology neutral” and “uncoordinated” deployment. Not having any ECC harmonised guidance for such deployment, the ENS are still bound to a cell-by-cell “co-ordinated deployment” concept actually not used in most of the licensing regimes. This report might generate future feedback actions in revising also ETSI ENs accordingly.

Aspects that relate to sharing issues with FSS, radiolocation (in adjacent band) and ENG/OB are not considered in this Report. However they should be taken into account when applying any method of deployment suggested in this document.

The applicability limits of the current Report are as follows:

- Application is mostly devoted to “block assignment” licensing methods, rather than “channel assignment” method.
- The guidelines presented have been maintained, as far as possible, independent from the access methods described in the ETSI ENs (e.g. EN 301 021, EN 301 124, EN 301 744, EN 301 080 and EN 301 253).
- MP-MP (MESH) architectures are not yet considered. In order to include MESH architectures, a number of assumptions on “typical” application (e.g. on the omni-directional/directional antenna use) need to be defined in order to devise the typical intra-operators, mixed MP-MP/PMP interference scenarios for which simulations would have to be carried.
- Channel sizes and modulation schemes are also not specifically considered unless for defining “typical” system parameters. It should be noted that high state modulations (e.g. 64/128 QAM) have not been specifically addressed in the typical system parameters; nevertheless they would not change the general framework of this report. This may be considered during future update.
- FDD/TDD, symmetric/asymmetric deployments are considered.
- Additionally, system independent, EIRP density limits and/or guard-bands at the edge of deployed region (pfd boundary conditions) as well as at the edge of assigned spectrum (block edge boundary conditions) are considered as licensing conditions for neighbouring operators’ coexistence (similarly to the latest principles in ECC Recommendation 01-04 in the 40 GHz band).

Presently, the spectrum blocks assigned to an operator vary widely from country to country - from 10 MHz up to 28MHz (single or duplex) blocks have been typically assigned. The block allocation size and the frequency re-use plan employed by the operator to achieve a multi-cell and multi-sector deployment drives the channel bandwidth of the systems presently on the market to be typically no greater than 7MHz. Conversely, the requirement for higher data throughputs is driving the need for wider channel widths (e.g. up to ~28 MHz) and therefore correspondingly wider spectrum blocks assignment in the future.

Therefore, system channel bandwidths and block sizes are not fixed, even if typical data for current technologies are used for feasibility analysis of the “block-edge” constraints.

The report considers two different aspects of deployment scenarios for two operators:

1. Operating in the same or partly overlapping area with adjacent bands assignment
2. Operating in adjacent or nearby areas and re-using the same band assignment.

A number of different methods have been used to assess the severity of interference. These are:

- Worst Case (WC) (generally used for CS to CS interference) and for PFD limits at geographical boundary for frequency (block) reuse
- Interference Scenario Occurrence Probability (ISOP) (for CS to TS interference between adjacent blocks)
- Monte Carlo simulations for CDF (cumulative distribution function) vs. C/I (e.g. for TS to CS interference between adjacent blocks).

For the above methods it has been possible to estimate the probability of interference between FWA systems. From these results, estimates have been made of the frequency and/or geographical spacing needed between these systems in order to reduce the level of interference to an acceptably low level. Absolute recommendations cannot be made because some system parameters are not defined by the available standards and because the effects of buildings and terrain are very difficult to model. The report therefore gives guidelines that will lead to acceptably low levels or low probability of interference in most cases.

For the above methods that might be described as:

- The **Worst Case (WC)** method derives system deployment parameters to ensure that interference is always below a set threshold for all cases.
- The **Interference Scenario Occurrence Probability (ISOP)** is defined as the probability that an operator places at least one terminal in the IA. ISOP is related to the number of terminals deployed by the operator, and possibly to the cell planning methodology. The ISOP method evaluates the NFD or the out-of-block rejection required in order to meet an interference probability lower than a certain value.
- The **Cumulative Distribution Function (CDF),** derived from Monte Carlo simulation of large number of “trial” TSs with a certain equipment/antenna/propagation model, is defined as the probability that a certain percentage of those trials would result in a C/I of the victim CS exceeding a predefined target limit.

The Report derives the following alternative parameters, useful for defining an “uncoordinated technology independent” deployment:

- The **Interference protection factor (IPF) and associated guard-band** method used to define the amount of isolation required from the interfering station to victim receivers in adjacent frequency block in terms of Net Filter Discrimination (NFD), obtained also by frequency separation (guard bands) and EIRP limitation.
- The **Block Edge EIRP Density Mask** (BEM) method is used for directly limiting the EIRP density in the adjacent block, and for assessing the CS to CS worst case interference, the CS to TS interference through acceptable ISOP value and the TS to CS through acceptable probability of exceeding a limit C/I to the victim CS.

An important finding of this Report is that stringent protection requirement (e.g. in terms of BEM or NFD) is required only for CS emissions; the protection factor for TS is far less stringent and reduces as the antenna directivity is improved.

Another important conclusion is a significant impact of CS antenna height on co-ordination distance for the frequency block reuse; due to the low LoS attenuation with distance, sensible size of co-ordination distance and associated PFD value are obtained only considering spherical diffraction attenuation. If the CS antenna height is not limited (or a down-tilt angle is required) as a licensing parameter, it is nearly impossible to tell how far away the block may be reused.

The example presented, made with typical system values, led to examples of BEM coherent with a “technology neutral” deployment of different systems in adjacent blocks. Receiver filters are assumed to be stringent enough to maintain the potential NFD implicit in the BEM (i.e. have sufficient out-of-block selectivity for avoiding non linear distortion in the RX front-end chain).

In some specific annexes technical background and studies for related issues are also reported. They include urban obstructed propagation (near-NLoS) models and examples of practical application of RF filtering for easing the CS absolute EIRP BEM fulfilment when using equipment-generic relative spectrum masks defined by ETSI.

Conclusions

This Report has considered a number of facts as initial considerations for deriving the coexistence study:

1. Presently ECC Recommendations 14-03 and 12-08 for the bands 3.6 GHz and 3.8 GHz do not give harmonised and detailed suggestion to administration for implementing FWA (such as those produced for 26, 28 and 40 GHz). Those ECC Recommendations offer only channel arrangements.
2. The band is limited and wasted guard-bands might drastically reduce the number of licensed operators, limiting the potential competition for new services.
3. Legacy systems (P-P and already licensed FWA) are present in these bands. "Block assignment" methods of different sizes (for different applications) are generally used for licensing FWA.
4. Sharing issues with FSS, radiolocation (in adjacent band), ENG/OB exist and should be taken into account.
5. At least for CSs, ETSI ENs in these bands are not presently designed for a technology neutral deployment (this is done only in the 40 GHz MWS EN 301 997) therefore do not contain system controlling parameters, in terms of EIRP, which would be useful for the desired "technology neutral" and "uncoordinated" deployment
6. The suggested guard-bands/mitigation(s) would depend on system bandwidth/characteristics. Presently, in this band, it is not possible to identify a "typical" system bandwidth on which base the definition of a guard-band. Symmetric/asymmetric, narrow/wide/broad band services[1], TDD/FDD, P-MP/Mesh architectures are already available on the market, each one with its own benefits and drawbacks, fitting to specific segments of the whole FWA market. It should be noted that e-Europe initiatives call for faster Internet applications (i.e. requiring relatively wide-band FWA) to be available on the whole European territory.
7. Typical block size ~ 7 to 14 MHz (e.g. from a block of channels based on 3.5 MHz raster) or ~10 to 15 MHz (e.g. when a basic 0.5 MHz raster is used) is considered practical for new wide/broad band services demand. Nevertheless the conclusions should be valid for wider block sizes (e.g. up to ~ 28/30 MHz) depending on the band availability in each country.
8. Also for "conventional" symmetric FDD the central-gap between go and return sub-bands do not exist in ECC Recommendations 14-03 and 12-08; therefore situation with TX/RX happening on adjacent channels exist (unless specifically addressed by single administrations in licensing rules).
9. It is also shown that, for PMP TSs, the antenna RPE plays a fundamental role in the coexistence; the more directive is the antenna of TSs, the less demanding might be their NFD (or the EIRP density BEM) required (offering a flexible trade-off to the market).
10. MP-MP (MESH) architectures have not been considered in this Report. In particular it is recognised that, for MESH architectures, a number of assumptions (e.g. on the omni-directional/directional antenna use) need to be defined in order to devise the typical intra-operator, mixed MP-MP/PMP interference scenarios for which simulations would habe to be carried.

Based on the above observations this Report recommended Interference Protection Factor/ isolation values ensuring acceptable coexistence levels between systems.

It has been shown that the required IPF levels can be achieved, depending on situations, by a combination of basic equipment NFD and appropriate additional isolation factor (e.g. suitable guard bands and/or mitigation(s) techniques)

In the case of a block assignment and where a guard band approach is not retained, these IPF levels can be ensured with additional EIRP BEM. This is deemed convenient for "technology independent" deployment and eventually feasible from a cost-effective equipment point-of-view. Especially when considering that the additional EIRP constraint (with respect to ETSI EN) might burden only CS design.

In addition, basic rules has been set for the co-ordination distance and PFD boundary levels between operators re-using the same block in adjacent geographical areas. In this field, the importance of limiting CS antenna height (or down-tilt angle) as possible licensing parameter is highlighted in order to have sensible co-ordination distances (i.e. limited by spherical diffraction attenuation).

1 Narrow band services are considered here as < 64 kbit/s, wide-band from 64 to 1.5 Mbit/s and broadband above 1.5 Mbit/s

INDEX TABLE

THE ANALYSIS OF THE COEXISTENCE OF FWA CELLS IN THE 3.4 - 3.8 GHz BAND

1 INTRODUCTION

1.1 Scope

The scope of this report is to investigate the co-existence of Point to Multi-point systems. These systems are developed in accordance with the ETSI EN 301 021, EN 301 080, EN 301 124, EN 301 253 and EN 301 744. In conjunction with the CEPT channel plan defined by the ERC Recommendations 14-03 (sections A1 and B1) and 12-08 (sections B2.1.1 and B2.2.1).

Systems, owned by different operators, should be able to be deployed without mutual interference when operating in:

a) adjacent frequency blocks in the same area or,
b) the same frequency block(s) in adjacent areas.

This report aims to assist the administrations in the assignment of frequency blocks to the operators who operate FWA systems in the available bands between 3.4 GHz to 3.8 GHz.

These bands were subject to the previous ERC Recommendation 14-03, on harmonised radio frequency arrangements for Multipoint systems. Nowadays more experience has been gained from recent studies for the 26 and 28 GHz bands, finalised by ERC Report 99 and Recommendations 00-05 and 01-03, and most of all for the 42 GHz MWS band, finalised by ERC Recommendation 01-04.

ERC Report 97 qualitatively summarised requirements for modern licensing process and has also been taken into account in developing this report.

This report incorporates and enriches the information in earlier reports and recommendations.

Following the approach in this report, the goal might be the decoupling as much as possibles, of the ETSI equipment standards from the ECC licensing rules. For this purpose, the introduction of:

- “additional” EIRP density limits and/or guard-bands for regulating the mutual acceptable interference between adjacent frequency blocks, licensed to operators in the same area,
- borderline rules between operators re-using the same block,

would generally fulfil the requirements.

In order to cater for the mix of technologies and services to be delivered it is most appropriate that a block (or blocks) of spectrum is made available to a potential operator in a manner consistent with the technology and market that the operator may wish to address.

Medium size frequency blocks are considered and will depend to an extent on the applications foreseen. Presently, blocks would be tailored to systems on the market typically of small/medium bandwidth (e.g. < ~10 MHz), however the possibility that wider bandwidth (e.g. up to ~28 MHz) might become possible in future should be taken into account.

A key principle of the assignment guidelines is that even though a technology specific channelisation scheme is expected to operate within an assigned block this channelisation is not the basis for the assignment process. Operators are free to subdivide the assigned frequency block in the most efficient way for deploying or re-deploying the selected technology.

Due to the flexibility required in newly deployed services, it is important that the block assignment process supports systems for both symmetric and asymmetric traffic as well as systems that employ FDD and TDD techniques.

In principle no assumption has been made regarding the architecture of any FWA network; however MP-MP (MESH) architectures have not been considered in detail in this Report. Other ECC work has reported and concluded on MESH systems in higher frequency millimetric bands. It is recognised that whilst some of the results in this report might also be applicable to mixed PMP and MESH architectures, others may clearly need additional work. In particular, regarding the impact of MESH TS antenna patterns (e.g. some MESH systems use omni-directional/directional antennas). These studies might be carried on in due time if needed and when manufacturers will be in a position to offer the necessary information.

Measures are suggested for dealing with the issue of inter-operator coexistence both between adjacent frequency blocks and between neighbouring geographic areas. The basis for these measures is to allow deployment with the minimum of co-ordination although more detailed co-ordination is encouraged as an inter-operator issue.

In order to cope with the often-conflicting requirements of a number of technologies in terms of efficient and appropriate block assignments, some compromise is suggested in order to develop reasonable assignment guidelines, which balance constraints as far as possible on any specific technology.

Reasons in favour of seeking flexible assignment methods, either by introducing block edge mask or assuming specific Interference Protection Factors (IPF), are related to the fact that equipment is likely to exceed ETSI TM4 masks (e.g. through RF filters that might be adopted in these relatively low frequency bands). This is also supported by the experience in the 26/28 GHz CEPT approach for guard-bands, which were based on the fact that spectral emissions of practical equipment might generally be better than ETSI ENs masks.

1.2 The frequency licensing policy and the possible approaches

When considering the adjacent frequency blocks, same area scenario, the possible process of frequency licensing should guarantee, as far as possible, a “controlled interference” deployment. Emissions from one operator’s frequency block into a neighbour block will need to be controlled. This can be done by different methodologies.

A first one, already recommended in other frequency bands, imposes, between the assignments, fixed guard bands evaluated around the most likely equipment to be deployed.

Alternatively, as recommended in the 42 GHz MWS band, a frequency block edge EIRP density emission mask is used. The block edge mask limits the emissions into a neighbouring operator's frequency block and it enables operators to place the outermost radio channels with suitable guard-bands, inside their assigned block, in order to avoid co-ordination with the neighbour's frequency blocks.

For further enhancing the spectrum efficiency, administrations might wish, after the block assignment procedure has been done, not to enforce the guard band or the block-edge mask to neighbour operators who will apply mutual co-ordination at the blocks edge in view to optimise the guard bands. In that case, the enforcing rules will apply only in a “mutually agreed” way or it would be flexibly changed according the actual interference scenario shared by both operators with theirs planning tools.

1.2.1 The Worst Case deployment scenario (derived from ERC Report 99)

In principle, the most efficient way of evaluating the guard bands would be through a “case by case” evaluation. This would imply that the administrations should, in the application phase, analyse the actual behaviour, the planned coverage range, the hubs location, the cellular structure and the cell planning aspects of the system operated by the operators in any particular area.

The administrations should therefore analyse all the possible interference combinations that the MP ETSI standards (EN 301 021, EN 301 080, EN 301 124, EN 301 253 and EN 301 744) make possible (i.e. different access schemes, modulation schemes, duplex schemes and capacity from few to ~ a hundred Mbit/s). Beside, they need to consider that operators could have different deployment requirements. They could have different BER threshold and availability requirements (typically, from 99.9 to 99.999%, sometime including and sometime excluding hardware reliability into their availability evaluation) and they could deploy systems with different system gains (up to several dB). This strongly impacts the coverage range, the cell planning and the frequency reuse allowed by the systems operated by different operators and it dramatically increases the number of interference scenario combinations.

Hence, the “case by case” evaluation is not likely to be a viable, or at least the most preferred, solution, due to the following reasons:

- The number of possible different deployment scenarios is so huge that it is unrealistic to think that administrations could look after all of them
- Operators could change their system or deployment after a period of time without warning the administration and the previous guard band evaluation could become wrong.

For the above reasons, a more realistic approach is necessary, and hereby only the two examples described in next sections 1.2.2 and 1.2.3 are explored in this report.

1.2.2 The “predefined guard band deployment”

In the first approach, here called “*predefined guard band deployment*”, the administration would aime to provide, to both operators and end users, a reasonably interference free environment. By limiting the Interference Scenario Occurrence Probability (ISOP) or Interference Area (IA) to a low level and by stating the guard band required between the assigned spectrum blocks.

Worstcases (typically co-sited or nearby by hub to hub) might happen, in few cases, and should be solved on a case by case basis by the operators concerned.

An administration could set a probability criterion, for the ISOP or IA, which is deemed to be acceptable and derive the corresponding guard bands (by estimation based on required NFD with the methods explained in following sections). In this case, the guard bands are explicitly outside the spectrum block assigned to the operator and would remain unused.

In addition, for maintaining good spectrum efficiency, this method asks for a quite good knowledge of the typical FWA system technologies used. The guard-bands are likely to be determined by the wider band systems therefore the method is most suited in case the differences among deployed technologies (e.g. channel spacing, NFD and modulation formats) are expected to be small or in bands already deployed where fixed channel arrangements are recommended. This approach tends to prevent spectrum efficiency improvement with the technology evolution and thus is not recommended as a preferred method.

1.2.3 The "guided unplanned deployment"

The second approach, here called *”guided unplanned deployment”*, implies that additional EIRP density limits are set in order to allow an “average” interference free scenario to the operators. In this case, the guard band is to be included in the blocks assigned to the operators; the blocks are to be made consequentially larger. In this case the “interference free environment” is ensured by the EIRP density limits set by the administration, evaluated for “average worst-case” interference scenarios.

With this approach, the operator is permitted to use the assigned block as much as the equipment filtering and actual EIRP allow operation close to the block-edge, leaving to him and the manufacturers the possibility to improve the spectral efficiency as far as possible.

This method is most suited when very different technologies are used. The EIRP density mask is designed on the basis of acceptable noise floor increase due to interference from adjacent block; therefore only the knowledge of typical victim receiver noise figure and antenna gain are necessary. The method is therefore quite independent from ETSI standards, and is effective for bands that do not have fixed channel arrangements as a deployment constraint.

For a sensible and cost-effective regulation, a block edge mask is generally designed on the basis of a small degradation in an assumed scenario with a low occurrence probability of a worst case (e.g. two directional antennas pointing exactly each other at close distance).

As for the first method described in section 1.2.2 above, it is not therefore excluded that in a limited number of cases specific mitigation techniques might be necessary; operators would still be asked to solve, with conventional site engineering methods, the "worst cases" that may happen in few cases. In particular when CSs are co-located on the same building or very close to each other, the statistical approach is not applicable and it is assumed that common practice of site engineering (e.g. vertical decoupling) is implemented for improving antenna decoupling as much as possible.

Moreover, for further enhancing the efficiency, administrations are not expected, after the block assignment procedure, to enforce the block-edge requirements to neighbour operators who will apply mutual co-ordination at the block edge in view to optimise the guard bands. In that case, only the maximum "in-block" EIRP/power density applies while the "out-of-block" noise floor will apply only from a "mutually agreed" starting point within the adjacent block.

It is up to operators to possibly further co-ordinate with other operators using adjacent blocks.

Also adjacent block receiver rejection concurs to a reduced interference scenario, however this is not in the scope of this Report to set limits for it; nevertheless it is expected that ETSI standards will adequately cover the issue.

2 “SAME AREA - ADJACENT FREQUENCY BLOCKS” INTERFERENCE SCENARIO

2.1 Analysis of the coexistence of two FWA cells in the 3.4 - 3.6 (3.6 – 3.8) GHz band

2.1.1 Typical System Parameters

Considering the scenario of a wide sub-urban area with relatively high traffic demand and a small amount of obstructing buildings, a medium bandwidth system (7 MHz) is analysed in LoS conditions.

The examples shown refer to the ETSI EN 301 021, only for defining a typical receiver BER thresholds. However, the considerations made are not too sensitive to the multiple access method, provided that all have similar spectral and link-budget characteristics. These data are then “technology independent”, nevertheless for defining typical cell coverage sizes also real modulation formats should be used; in Table 1 data for two systems types only are referred. Different modulation are obviously possible (e.g. 64 states) but, they would not, in principle, lead to different conclusions on the regulatory framework objective of this report.

	System Type (according typical ETSI definitions)	
	Type A (typical 4 state)	Type B (typical 16 state)
Channel bandwidth MHz	7[2]	7 [2]
Actual signal bandwidth BW_{TX} =BW_{RX} (MHz)	6	6
Transmitted Power at section D' (dBm)[3]	30	30
Receiver Noise Figure at section D (dB)	8 [4]	8 [4]
Receiver Threshold for BER= 10^{-6} (dBm)[5]	-84	-76
System Gain D' - D (dB)	114	106
Critical C/I for BER= 10^{-6} (dB)	~14	~22
Hub (CS) antenna - 90° sector bore-sight gain (dB)	16	16
CS antenna azimuth and elevation radiation patterns	ETSI EN 302 085	ETSI EN 302 085
Terminal (TS) antenna bore-sight gain (dBi) and RPE [6]	16 ETSI EN 302 085 ITU-R F.1336	16 ETSI EN 302 085 ITU-R F.1336
CS and TS EIRP density (dBW/MHz)	8	8

Table 1: Typical system data for typical cell size evaluation

The same system parameters will be initially used for both victim and interferer. The 3.5 GHz will be used as radio frequency throughout the calculations.

Due to the importance of Terminal Station (TS) antennas RPEs (and in particular of their main lobe) on the results shown in this Report, suggest that the use of ETSI RPE for TS antennas might give worst-case results that are not experienced in practice. ETSI RPEs are generally defined only for "type approval" purpose (i.e. 100% of RPE values shall be within the mask). Annex2 of ITU-R F.1336 gives typical "average" RPE that are more representative of the field situation; F.1336 recommends RPE for the bands below 3 GHz that here are considered appropriate also in the 3.5 and 3.7 GHz bands; Figure 1 show the difference between those RPE.

The antenna gain is the parameter used in the formulas of Annex 2 of ITU-R F.1336 for identifying different RPEs, therefore it has been used in Figure 1 to reference the different antenna RPEs; the gain range 16 to 20 dB is considered representative, from the ITU-R recommendation F.1336 point of view, of classes of antennas similar to ETSI TS 2 and TS 3. However the objective of this report would be mainly to consider the impact of different ETSI antenna RPEs for coexistence studies, not necessarily for studying the increase of cell size. Therefore, while the typical ITU-R F.1336 RPEs with gain 16 and 20 dBi will be generally used in all numerical evaluations, the Report will maintain a fixed gain of 16 dBi, reported in Table 1 as representative of the average value on the market.

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[2] This channel spacing is considered the most representative for being carried over in the calculation. It is considered that the larger channel systems would lead the coexistence rules. Nevertheless lover spacing channels (e.g. from 1.5 MHz up), also widely popular, should more easily fit in that possible framework

[3] CS and TS power are assumed equal for symmetric traffic. This value includes feeder losses for full indoor applications. The 35 dBm Maximum Power presently allowed in ETSI ENs (e.g. EN 301 021 and 301 080) is considered not realistic from the co-existence point of view.

[4] The Noise Figure estimated from EN 301 021 BER values and typical modulation formats would result in ~12 dB; however this seems too pessimistic and a value of 8 dB has been assumed, it should already give enough margin for the possible necessity of a selective RF channel filter of reduced size for TS

[5] This value includes feeder losses for full indoor applications.

[6] An antenna with relatively low gain is frequently used for transmitting and receiving signals at the out-stations or in sectors of central stations of P-MP radio-relay systems. These antennas may exhibit a gain of the order of 20 dBi or less. It has been found that using the reference radiation pattern given in Recommendation ITU-R F.699 for these relatively low-gain antennas will result in an overestimate of the gain for relatively large off-axis angles. As a consequence, the amount of interference caused to other systems and the amount of interference received from other systems at relatively large off-axis angles will likely be substantially overestimated if the pattern of Recommendation ITU-R F.699 is used. On the other hand ITU-R F.1336 gives low gain TS antenna patterns only for bands below 3 GHz, nevertheless it is considered more appropriate and will be used in this study."

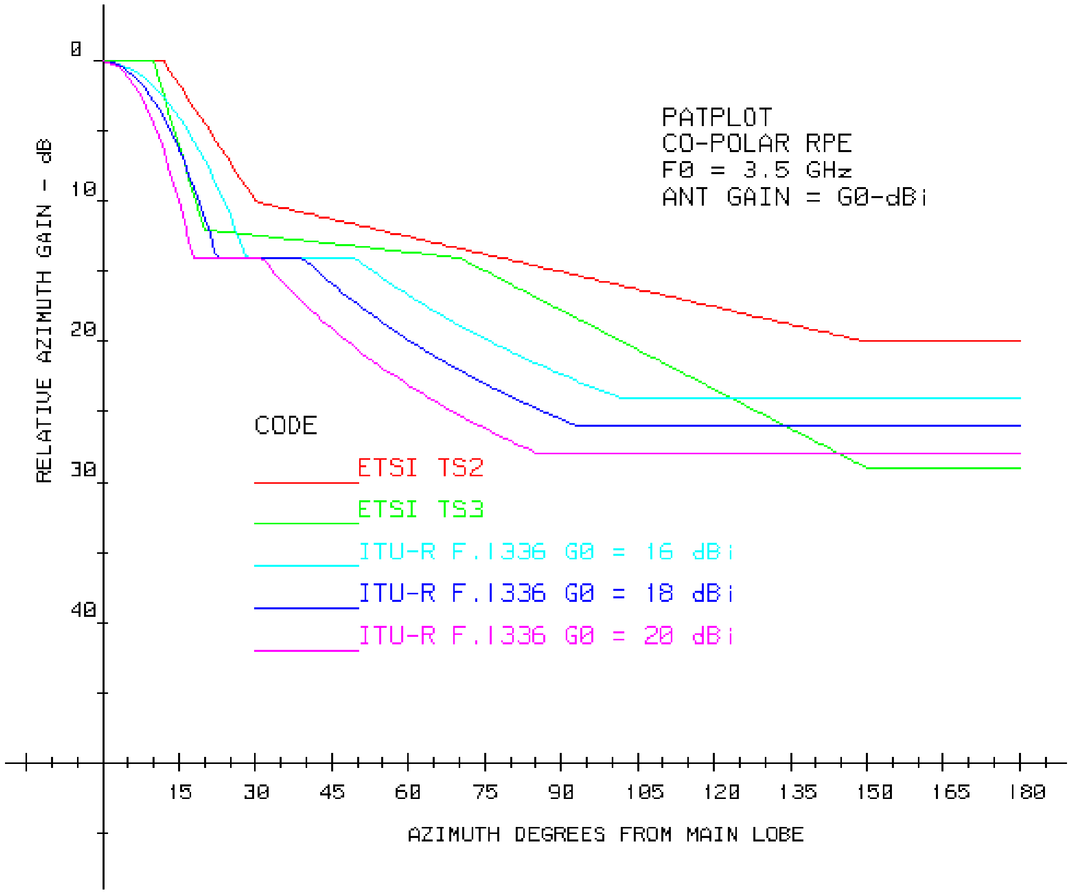


Figure 1: Antenna RPE Comparison

2.1.2 Cell coverage.

2.1.2.1 Rural scenario

The scenario examined is a LoS, relatively flat environment without significant obstructions, located in central Europe.

The main propagation modes are assumed to be free space and, possibly, spherical diffraction. The link availability will be affected by clear-air multipath.

The maximum cell radius R will be calculated from the link budget:

$$SG + G_{CS} + G_{TS} = FSPL + A_{sph} + FM \quad (1)$$

where:

SG is the "system gain" (i.e. difference in dB of TX output power and RX threshold at given BER 10^{-6})

G_{CS} and G_{TS} are CS and TS antenna gains in dB. For this evaluation we will consider G_{TS}=16 dB as worst case (resulting in smaller cell size).

FSPL is the free space attenuation loss for f=3.5 GHz given by:

$$FSPL = 92.4 + 20 \log(f\ D) = 103.28 + 20 \log(D) \quad (2)$$

A_{sph} is the spherical diffraction attenuation described in ITU-R Recommendation P.562 that depends on the height of CS and TS antennas, relative to the ground.

FM is the fade margin (excess attenuation) required to meet the yearly availability objective.

FM can be evaluated according to ITU-R P.530, which covers both the deep fade and shallow fade regions. For the purpose of the present analysis, it seems adequate to use the deep fade approximation or 10 dB, whichever is greater.

The 10 dB has been chosen as a safe value to ensure proper operation in "normal" clear air propagation.

From ITU-R P.530-8:

$$FM=-10\ \log[P_{wm} / P_0], \tag{3}$$

P_{wm} is the probability of exceeding the critical BER during the worst month. Scaling it to a yearly average, for the assumed geographical area and for 3.5 GHz radio frequency, with the conservative approach that the yearly unavailability ($un_{year}\%$) is spread over four "worst" months only, FM can be written as:

$$P_{wm}\ \% = 3 * un_{year}\ \% \tag{4}$$

$$P_0\% = 5*10^{-7} * 10^{[-0.1*(Co-Clat-Clon)]} * pl^{(1.5)} * (1+\varepsilon)^{(-1.4)} * f^{(0.89)} * D^{3.6} \tag{5}$$

Assuming C_0=3.5 (hilly terrain), C_{lon}=3 dB (Europe), C_{lat}=0 dB (medium latitude); pl=10%; ε=0;

$$P_0\% = 5*10^{-7} * 10^{[-0.1*(3.5-3)]} * 10^{(1.5)} * (1+0)^{(-1.4)} * 3.5^{(0.89)} * D^{(3.6)}$$

$$P_0\% = 4.2972*10^{-5} * D^{(3.6)}$$

$$P_0/P_{wm} = [4.2972*10^{-5} * D^{(3.6)}] / (3 * un_{year}\%)$$

Substituting (4) and (5) into (3) we obtain:

$$FM = -48.44+36*\log(D) - 10*\log(un_{year}\%) \tag{6}$$

Spherical diffraction attenuation A_{sph} can be calculated by subtracting the free space attenuation from the output of the program GRWAVE (available from ITU). A sample output for two significant cases is shown in Figure 2. Neglecting the ripple at short distances, which comes from reflections in the plane earth model, A_{sph} is approximated as:

$$A_{sph} = 0 \qquad \text{(for } D < D_0\text{)} \qquad (7a)$$

$$A_{sph} = K_2\ (D-D_0) \qquad \text{(for } D \geq D_0\text{)} \qquad (7b)$$

D_0 is taken as the point where the total attenuation equals the free space value (i.e. A_{sph} = 0 in Figure 2) where spherical diffraction attenuation starts to be significant. D_0 depends on the heights of hub and terminal antennas above ground (hc, ht). Values for a few significant cases are shown in the following Figure 2 that shows that $K_2 \cong 1.3$ dB/km is nearly invariant and that when different CS and TS antenna heights are considered, the mean height value could be used.

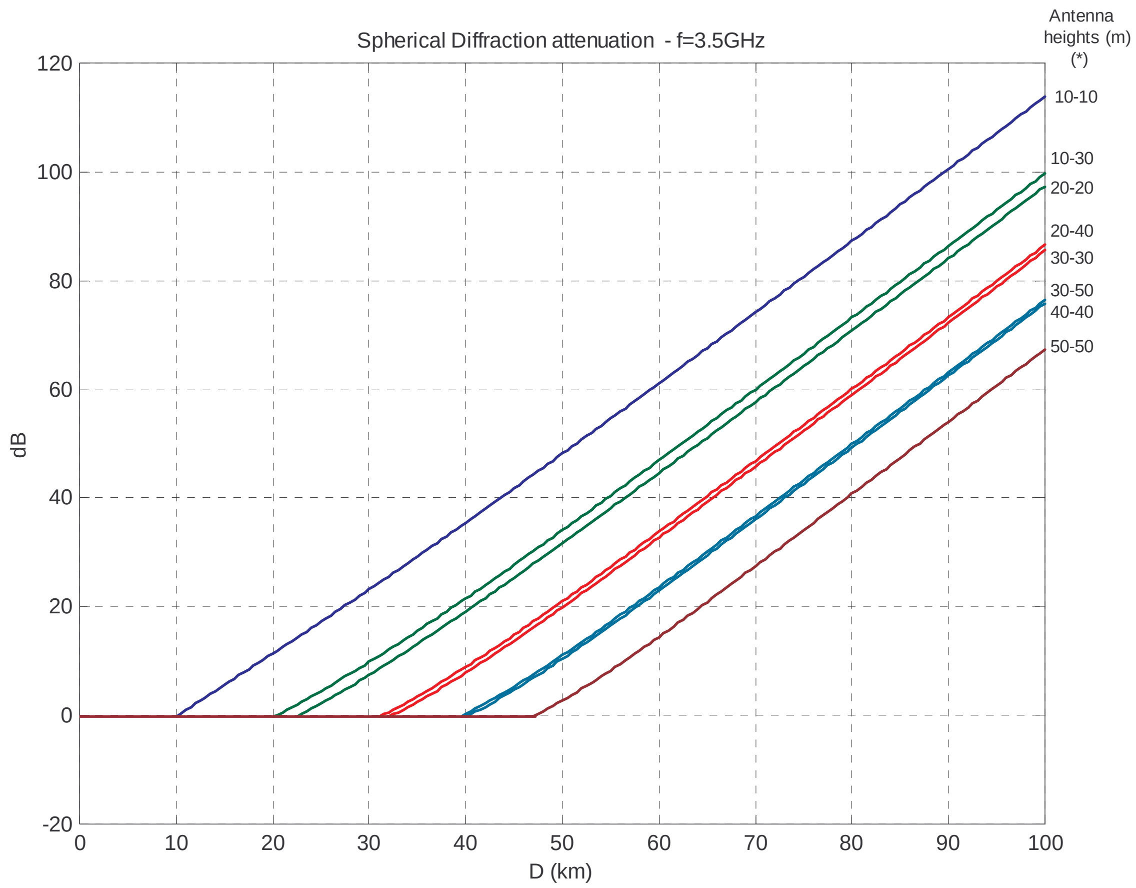


Figure 2: Additional attenuation due to spherical diffraction

Substituting (2), (6) and (7) into (1), the link budget at the cell edge (D=R) can be rewritten as:

$$SG+ G_{CS} + G_{TS} = 54.84 -10 \log(un_{year}\%) +56 \log(R) + K_2 (R-D_0) \quad (8)$$

With the assumed equipment parameters, antenna heights, and yearly availability objectives 99.99 %, and 99.999%, the maximum cell radius values are shown in Table 2.

System type	Antenna heights	Availability							
		99.99%				99.999%			
		G_{TS}=16 dB		G_{TS}=20 dB		G_{TS}=16 dB		G_{TS}=20 dB	
		R [km]	FM [dB]	R [km]	FM [dB]	R [km]	FM [dB]	R [km]	FM [dB]
A	hc =40m ht = 20m	18.7	17.3	22	19.9	12.4	20.9	14.6	23.4
	hc =30m ht = 30m	18.7	17.3	22	19.9	12.4	20.9	14.6	23.4
	hc = 30m ht = 10m	18.7	17.3	(21.2)	(19.3)	12.4	20.9	14.6	23.4
	hc =20m ht = 20m	18.7	17.3	22	19.9	12.4	20.9	14.6	23.4
	(hc =10m ht =10m)	(14.7)	(13.6)	(16.2)	(15.1)	(11.4)	(19.6)	(12.9)	(21.5)
B	hc =40m ht = 20m	13.4	12.2	15.8	14.7	8.9	15.7	10.5	18.3
	hc =30m ht = 30m	13.4	12.2	15.8	14.7	8.9	15.7	10.5	18.3
	hc = 30m ht = 10m	13.4	12.2	15.8	14.7	8.9	15.7	10.5	18.3
	hc =20m ht = 20m	13.4	12.2	15.8	14.7	8.9	15.7	10.5	18.3
	(hc =10m ht =10m)	(12)	(10.4)	(13.5)	(12.2)	(8.7)	(15.4)	(10.5)	(18.3)
Note: Values in parenthesis denote the impact of spherical diffraction attenuation									

Table 2: Cell radius and FM vs. Availability (BER 10^{-6})

The conclusions of Table 2 show that, for most cases of practical antenna height, the cell radius is limited by the system gains considered and by the free space loss only. Hence spherical diffraction is not yet affecting the propagation; moreover, antenna heights are not affecting the area coverage. The cases with CS and TS antenna heights = 10 m (see Figure 2) are the only ones where spherical diffraction attenuation has some impact by reducing the cell size. The latter cases are shown only as explanatory example of the phenomenon, however, hc = 10m is not considered realistic and therefore will no longer be taken into account in further evaluations.

2.1.2.2 Urban scenario

For urban propagation models there are not consolidated ITU models. A number of empirical and physical models are used to characterise this behaviour at UHF frequencies, but unfortunately little is known about their application to the 3.5 GHz band. The associated path attenuation, in dB, shows a Gaussian probability distribution function (p.d.f.), with mean value (here called A_{50}) and standard deviation “σ”.

Two of them, with quite different physical characteristics, are here used. They are the Hata-Okumura, here extrapolated up to~4 GHz and the one recently adopted by IEEE 802.16 for similar coexistence studies (see Annex 1).

In the Hata-Okumura the propagation mode is assumed to be free space with random attenuation due to diffraction over rooftops and multiple reflections from medium/high rise buildings (typical for Japanese cities). It gives the received field as a "locally random" variable with log-normal p.d.f. around a median value.

In IEEE 802.16 an “excess attenuation” for all TSs is introduced (mostly due to wooden/hilly areas among low rise buildings, typical for most US cities outside their relatively small downtown) increasing with distance from CS.

The following basic principles describe the IEEE model:

- The path loss (PL) can be seen as the summation of basic free space loss (FSL) and the excess loss (Lex) due to the local blockage conditions or reduction of antenna gains: PL(dB) = FSL (dB) + Lex (dB)
- The path loss can be modelled as follows: PL(dB) = A0(dB) + 10 n log(d/d0) + S(dB) , where the exponent n represents the decay of path loss and depends on the operating frequency, antenna heights and propagation environments. The reference path loss A0 at a distance d0 from the transmitter is typically found through field measurements. The shadowing loss S denotes a zero mean Gaussian random variable (in decibels) with a standard deviation (also in decibels).

The detailed evaluation of cell size and availability is reported for both models in Annex 1; Table 3 and following consideration summarise the results.

2.1.2.1.1 Hata-Okumura extended model

The results in Table 3 have been obtained for a 95% coverage using section A1.1.3 of Annex 1 (Hata-Okumura) detailed evaluation of the cell size is also made.

System Gain (dB)	**R_{max} (km) (CS height hc = 30m)**	
	γ = 16 (TS ht_{avg} = 20m)	**γ = 12 (TS ht_{avg} = 15m)**
114 (System type A)	4.35 km	3.3 km
106 (System type B)	2.7 km	2 km

Table 3 : Cell radius for 95% TSs coverage at 99.999% availability vs. system gain and TS antenna mean height ("medium cities" - Hata-Okumura extended model)

2.1.2.1.2 IEEE 802.16 model

Regarding the IEEE model, it is based on different parameters and for extracting similar coverage % figures more complex approach is necessary. Section A1.2 of Annex 1 describes the method and report examples of link availability. In addition, Appendix A to Annex 1, using Monte Carlo method, derives expected % of area coverage with the required 99.999% availability.

From those examples it might be concluded that terrain category C of IEEE models gives comparable values.

2.1.3 Interference protection factor (IPF)

The potential coexistence of different cells in adjacent frequency blocks is guaranteed when there is sufficient isolation between interfering transmitters of one cell and victim receivers of the other cell.

This required isolation, generally referred as Interference protection factor (IPF), might be obtained as aggregation (sum) of various contributions summarised as follows:

- Intrinsic Net Filter Discrimination (NFD) obtained mixing TX interferer spectrum and victim receiver selectivity of the equipment considered at their minimum foreseen frequency separation.
- NFD improvement with increasing frequency offset between interferer and victim (Guard Band between assignments)
- Antenna discriminations (both TX and RX) deriving from RPE at offset angles.
- Polarisation discrimination
- Minimum distance between interferer and victim
- Shading attenuation due to buildings or vegetation on the interfering path (on statistical bases offered in urban obstructed path propagation models).

The first two factors related to the NFD are generally "system dependent" and their evaluation requires knowledge of both interferer and victim equipment characteristics. Unfortunately the present ETSI ENs have not been designed for a "technology independent" licensing environment and do not offer mixed NFD values among the wide range of standardised technology.

As a consequence a "technology neutral" approach is hereby used in the form of the above IPF, out of which a specific example is the EIRP density Block-edge mask (BEM) concept, described in Section 2.1.4.

The BEM concept, strictly related to the NFD concept, actually summarised all the equipment/antenna related IPF contributions and might be best fit in environment where equipment characteristics are not known beforehand.

This does not imply that the BEM is always the best method, when system characteristics are known and fixed co-ordination rules might be uniquely set a more detailed approach might be more appropriate.

Also polarisation decoupling is a factor that might not be prejudged (unless different polarisations are imposed in licensing two adjacent blocks operators, limiting their free usage of the block) and in the following evaluation is not taken into account.

The relationship between NFD and BEM is equipment/antenna dependent only and is described as:

$$P_{out\text{-}density}\ (\text{dBW/MHz}) + G_{TX} - NFD = X_3\ (\text{dBW/MHz}) \qquad (9)$$

where X_3 represents the BEM out-of block requirement (see paragraph 2.1.4.1).

For convenience, in the following sections, where specific numerical examples are made on the base of representative system characteristics defined in Table 1 the parameter X_3 only is used with the understanding that NFD is easily derived from equation 9.

2.1.3.1 Channel arrangements

Prior to evaluating IPF (or BEM) requirements, possible channel arrangement should be analysed, as offered by CEPT/ERC Recommendations 14-03 (3.4-3.6 GHz) and 12-08 (3.6-3.8 GHz).

Both recommend assignments based on "number of slots" 0.25 MHz wide; apparently only symmetric assignments are foreseen and no specific mention is made of internal (go-return) guard band except for the fact that in 3.41-3.6 GHz the "odd" 10 MHz automatically create a ~ 10 MHz guard band. However such guard band disappears for the 3.5-3.6 MHz (50 MHz duplex) and for all 3.6 - 3.8 GHz.

That means that unless specific number of slots are reserved in both go and return sub-bands (wasting at least half of them), adjacent TX/RX interference is expected also for FDD systems.

Moreover, the recommendations mention that:
"where a duplex frequency allocation is required, the spacing between the lower edges of each paired sub-band shall be 100 MHz"

and also:
"P-MP equipment may be used having a duplex spacing other than exactly 50(100) MHz. However, such equipment must conform to the limits of the block allocation as defined above."

These sentences and the fact that no recommendation on sub-band for CS and TS operation is made, clearly show the intention to admit (on a non discriminatory way) TDD and FDD, symmetric and asymmetric systems.

It has been recently demonstrated by CEPT studies for 40 GHz band the best compromise method for allowing flexibility and efficient use of the spectrum with the recommended symmetrical assignment, the deployment of asymmetrical systems being made with mixed uplink/downlink sub-bands within the symmetrical assignment.

The above considerations and the small duplex spacing, lead to the conclusion that, unless the band should be assigned for predefined technology (e.g. FDD only) and spectrum waste is envisaged for creating go-return guard band, a mixed TX/RX in nearly adjacent assignments should be in any case considered.

2.1.3.2 CS-to-CS interference

A "same area, adjacent frequency blocks" scenario will be assumed (Figure 3). CS-to-CS interference is particularly dangerous, since it can cause unavailability of a whole sector[7]. Therefore a worst case analysis will be presented for it. Both CSs are supposed to face each other in line of sight (worst case situation). The fading events (mainly due to clear air multipath) are considered as completely uncorrelated. Rain attenuation is negligible at this frequency band.

It is further assumed that the allowed degradation of the victim receiver threshold due to interference is

$\Delta_{Threshold}$ = 1 dB, hence the allowed interference spectral density is:

$$I_S = N_0 - 6 = -144 + NF - 6 \text{ (dBW/MHz)}.$$

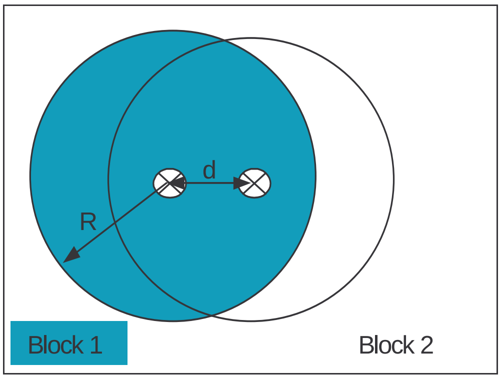


Figure 3: CS-to-CS interference scenario

As in the 40 GHz case, it may be assumed that the victim receiver has selectivity that matches the IPF or the block edge mask. Hence the main carriers of the adjacent block EIRP are always reduced below the interfering out-of-block noise floor so that their residual contribution is negligible. The allowed interfering IPF (or EIRP) is calculated for free-space propagation only, since:

- The distance between CSs is in practice short enough to exclude spherical diffraction.
- Both antennas are in relatively high locations (30m in the example) even in the urban environment. In this case the mean path loss predicted by the modified Okumura or IEEE models (see Annex 1) is near or lower than the free-space attenuation.

$$X_3 - 92.4 - 20\log(RF) - 20\log(d) + G_{RX} = -144 + NF - 6$$

where: $X_3 = P_{out\text{-}density} + G_{TX} - NFD$ represent the CS BEM out-of block requirement dBW/MHz (see paragraph 2.1.4.1), RF is the frequency in GHz, “d” the CS distance in km,

with the assumed system reference values shown in Table 1, a plot of the required X_3 value vs. “d” is shown in Figure 4, giving obviously the same result for both A and B systems, having the same CS antenna gains (16 dBi).

[7] In principle, it happens for the part of the time when the two CS are in opposite Tx /Rx modes. This will be 100% of the time in the case of two FDD systems, at least for the innermost assigned blocks where the mitigation of predefined up-link/down-link duplex blocks becomes ineffective. When at least one system operates in TDD mode it will be less than 100%. The actual interference intervals will vary because the two CS T/R periods will not be synchronised. In any case the contribution to availability of unsynchronised T/R period tends to be negligible when the multipath activity is large and propagation events last far longer than T/R periods. Therefore this aspect of T/R period impact will not be taken into account.

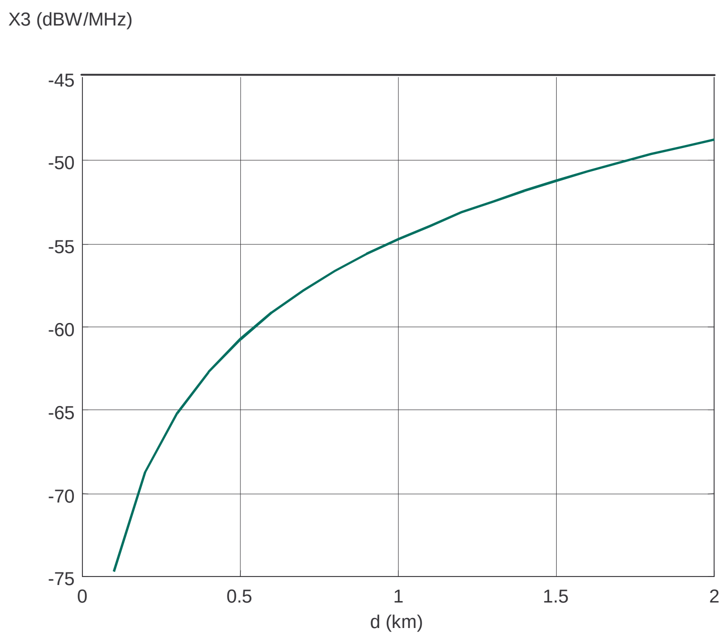


Figure 4: Required CS-to-CS spacing for un co-ordinated deployment

Just as an example if one would adopt an out-of-block emission limit compatible with the spurious emission level stated by CEPT Rec 74-01 (Spurious Emissions), i.e. -50 dBm/MHz at the antenna connector, one would get for X_3

X_3 = - 50 - 30 + G_{antCS} = - 50 - 30 +16 = - 64 dBW/MHz

This would allow a minimum uncoordinated distance of about 350m, which seems quite reasonable in a rural environment, given the typical cell radius values shown in Table 2.

On the other hand a value of:
X_3 = –73 dBW/MHz evaluated in next 2.1.3.3 paragraph as the value required for having ISOP ≤ 1% for system types B also in urban scenario, would lead to a minimum uncoordinated distance of ~ 100m.

It should be noted that for urban scenarios, the above LoS evaluation is an absolute worst-case. The additional shading attenuation probability is not a negligible factor and using some propagation models helps prove this (e.g. the IEEE 802.16 adopted one depicted in Annex 1.2 and in IEEE document available at http://grouper.ieee.org/groups/802/16/...).

2.1.3.3 CS-to-TS interference

The ISOP approach will be used, due to the random nature of this kind of interference. Also in this case complete uncorrelation will be assumed between fading events affecting the "wanted" and the interference path.

There will be an area in the victim sector where the receiver threshold degradation will exceed the assumed 1 dB limit. Its size and shape depends on the distance between CS's and the additional protection from the terminal antenna RPE. Referring to
Figure 5, we will label V the victim TS, W the "wanted" CS and I the interfering CS.

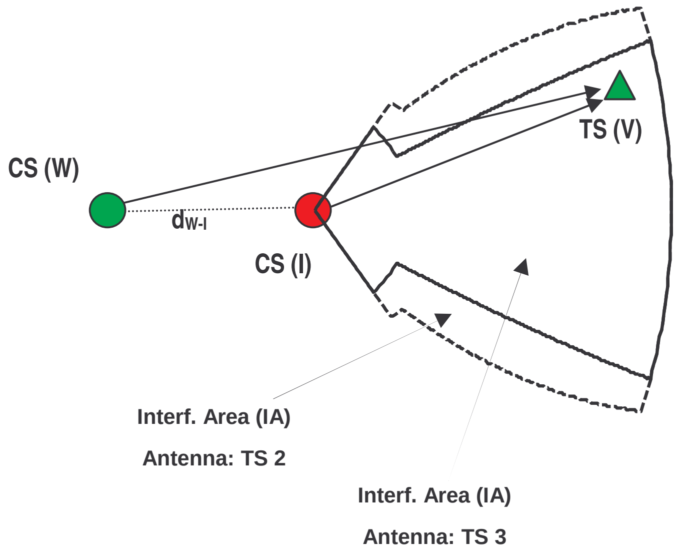


Figure 5: CS to TS interfering scenario

The area where the threshold degradation exceeds the 1 dB objective will be defined by:

$$X_3 - FSPL_{(I\text{-}V)} + G_{antTS(V)} - A_{\Phi TS(I\text{-}W)} \geq -144 + NF - 6$$

This formula is commonly used for rural scenario considering the un-correlation of deep fading events in the different paths. The same formula is still appropriate also in urban scenario. The Okumura model confirmed that the **“minimum”** attenuation (which is the one that gives the maximum interference we are looking for), at this relatively short distance, is likely to be still dominated by the free space value.

$A_{\Phi TS(I\text{-}W)}$ is the additional attenuation given by the TS victim antenna RPE at an angle equal to the difference in azimuth between the victim-to-wanted-CS and the victim-to-interferer-CS path (assuming that the victim antenna is aligned at boresight with the wanted CS).

Using the TS 2 and TS 3 antenna classes (represented by typical ITU-R F.1336 antenna RPE derived with G=16 and 20 dB, still maintaining fixed boresight gain of 16 dB), the "forbidden" interference area IA can be derived and are represented in Figure 6.

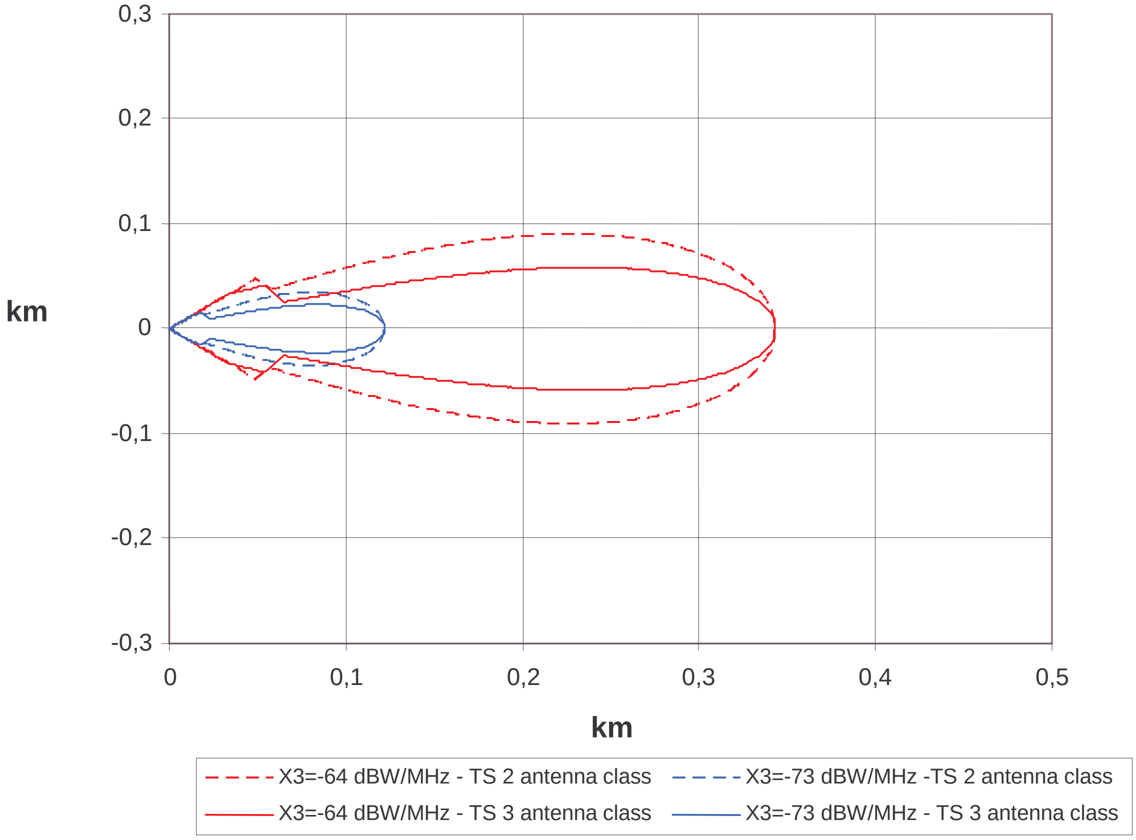


Figure 6: Interference Areas (IA) for victim TS as function of out-of-block EIRP density X3 and ITU-R TS antenna RPE

Figure 6 is representative of the worst case AI experienced when the two W and I CSs are boresight aligned and at their minimum distance (derived in section 2.1.3.2 CS to CS scenario).

ISOP is calculated following the approach in ECC Report 99, as ISOP = $(1-(1-P_1)^{N_t})*P_2*P_3$
where:

- P1 is the probability that one TS falls within the interference area where the margin degradation exceed a predefined value (here assumed 1 dB) evaluated as $P_1 = IA/A_{sector}$.
- N_t is the total number of terminals deployed in a sector.
- P_2 is the probability that the attenuation from wanted TX to victim RX and from interfering TX to victim RX are uncorrelated. In a propagation environment dominated by multipath we assume P_2=1. This is valid for “rural” scenario where the cell size is limited only by LoS propagation following Rayleigh statistics and described in ITU-R Recommendation P.530. For urban near-NLoS scenario this is not generally true; however, due to its shortness, one of the two paths (the interference one) is still here considered LoS for actually affecting the victim TS region. In addition the assumption $P_2 = 1$ is conservative.
- P_3 is the probability that operators use adjacent frequency blocks and equal coverage on the same area. It depends on the number of available blocks, the number of operators, the relative area coverage and the number of sectors per cell. Assuming 2 or 3 blocks (one per operator) and 4 sectors per cell, P3=1/6 for 2 operators, P3=~1/2 for 3 operators.

Assuming N_t = 64 or N_t = 32 (considered representative of relatively wide-band systems adopted in this frequency bands). An average P_3 = 1/4, a few values of ISOP have been calculated as examples in Table 4a) and Table 4b) with G_{CS}=16dBi, G_{TS} = 16 dBi and TS2 and TS3 antenna typical RPE (using typical ITU-R F.1336 RPE derived with gain of 16 and 20 dBi, respectively).

Scenario	X_3 (dBW/MHz)	TS Antenna	d_{U-I} min (m)	A_{Sector} (km^2)	IA (km^2)	P1	ISOP % N_T=64	ISOP % N_T=32
Rural	-64	TS2	350	274.65	0.0445	0.0162	0.258	0.129
Rural	-64	TS3	350	274.65	0.02924	0.01065	0.1698	0.085
Rural	-73	TS2	100	274.65	0.006	0.0022	0.0352	0.0176
Rural	-73	TS3	100	274.65	0.00397	0.00145	0.0231	0.0156
Urban	-64	TS2	350	14.52	0.0445	0.306	4.455	2.337
Urban	-64	TS3	350	14.52	0.02924	0.2013	3.0254	1.5615
Urban	-73	TS2	100	14.52	0.00605	0.0417	0.658	0.331
Urban	-73	TS3	100	14.52	0.00397	0.0273	0.4337	0.2178

Table 4a): ISOP % as function of out-of block EIRP density in some rural and urban scenarios –System type A (4 states)–

Scenario	X_3 (dBW/MHz)	TS Antenna	d_{U-I} min [m]	A_{Sector} (km^2)	IA (km^2)	P1	ISOP % N_T=64	ISOP % N_T=32
Rural	-64	TS2	350	141.03	0.0445	0.0315	0.499	0.251
Rural	-64	TS3	350	141.03	0.02924	0.02073	0.3296	0.1653
Rural	-73	TS2	100	141.03	0.00605	0.00429	0.0686	0.0343
Rural	-73	TS3	100	141.03	0.00397	0.00282	0.045	0.0225
Urban	-64	TS2	350	5.73	0.0445	0.7765	9.82	5.52
Urban	-64	TS3	350	5.73	0.02924	0.5107	6.985	3.778
Urban	-73	TS2	100	5.73	0.00605	0.1057	1.636	0.832
Urban	-73	TS3	100	5.73	0.00397	0.06935	1.0857	0.5489

Table 4b): ISOP % as function of out-of block EIRP density in some rural and urban scenarios –System type B (16 states)–

The above data are obtained for the worst case of W and I CS placement (boresight aligned and in closest position); however the ISOP drops rapidly as the distance increases. Figure 7 shows two examples taken from those in Table 4.

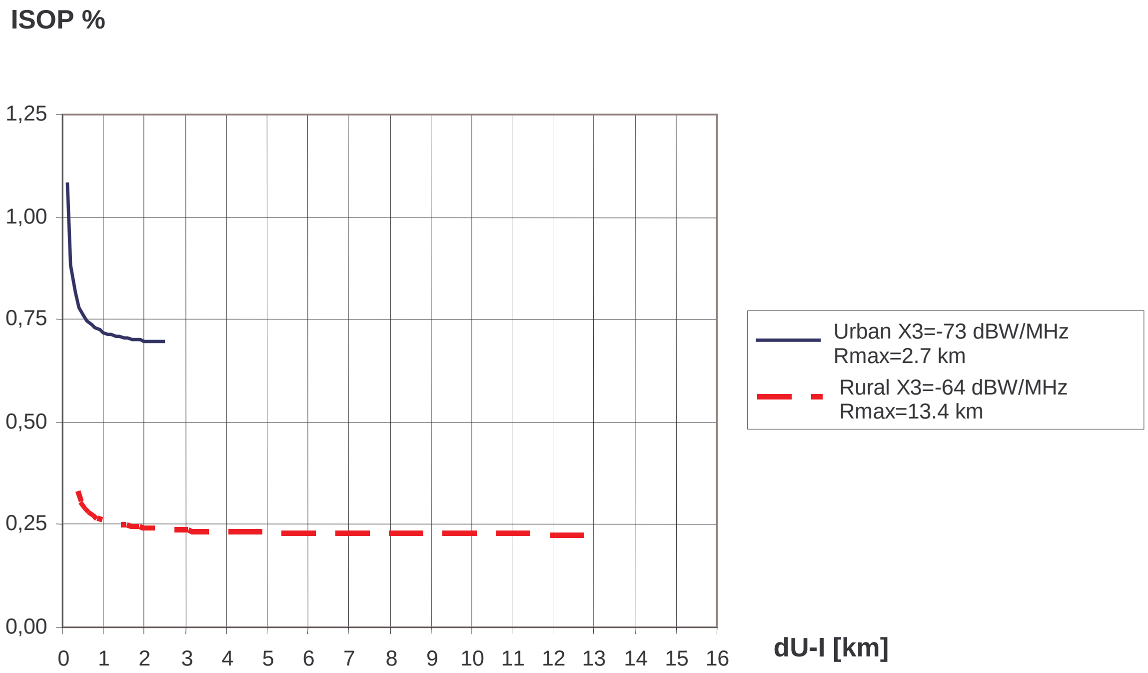


Figure 7: ISOP as function of W and I CS distance

From the above it appears that:

- The use of Class 3 TS antenna reduce the ISOP by ~25% to 35% in comparison to Class 2 one.
- In rural scenario an ISOP < 1% is obtained with the less demanding NFD (or X_3) limit. Therefore the more critical parameter might still be the CS to CS interference.
- In urban scenarios ISOP close to 1% are obtained only with the more demanding NFD (or X_3) limit. However it should be noted that, as mentioned above, this ISOP evaluation has been conservatively done with P_2=1 and worst case W and I CS positioning. In addition it does not take into consideration any excess attenuation (derived from statistical models in Annex 1) eventually experienced in the interference path. These factors would concur in reducing the actual urban ISOP results in Table 4a) and Table 4b).

2.1.3.4 TS to CS interference

This evaluation would lead to setting the required NFD (or the X_3 value of the block-edge mask) for TS.

However, the evaluation might be based only on a statistical IPF, common to the evaluation made in the section devoted to the IPF and guard-band methodology (see Annex 2) and its details are there reported.

From the detailed evaluation made in Annex 2, the required NFD or “out-of-block” EIRP density for suitably low (<1%) probability of TS interfering a victim CS, may be summarised, for the worst cases presented, in Table 5 depending on the assumed TS antenna ITU-R RPE:

TS antennas class	Required “inter-block” TS NFD (referenced to wanted EIRP density + 8 dBW/MHz in the more severe urban scenario)	Required TS “X_3” value (out-of-block EIRP density)
TS 2	~45 dB	– 37 dBW/MHz
TS 3	~43 dB	– 35 dBW/MHz

Table 5: NFD or out-of-block EIRP density requirement for ~ 1% of TS to CS interference probability in urban scenarios

2.1.4 Block-edge Mask coexistence methodology

When it is considered appropriate a complete “technology independent/uncoordinated use of the bands, the following BEM methodology is easily derived from the above general evaluation.

2.1.4.1 Initial considerations

The proposed block-edge mask shape is shown in Figure 8 (e.g. with similarity to the agreed mask for the 40 GHz band).

With respect to 40 GHz case, there is no decaying portion of EIRP density near the edge. This is due to the far narrower blocks envisaged that, for efficient use in these lower bands, might require tight roll-off and filtering for going as close as possible to the edge (see an example in Annex 3).

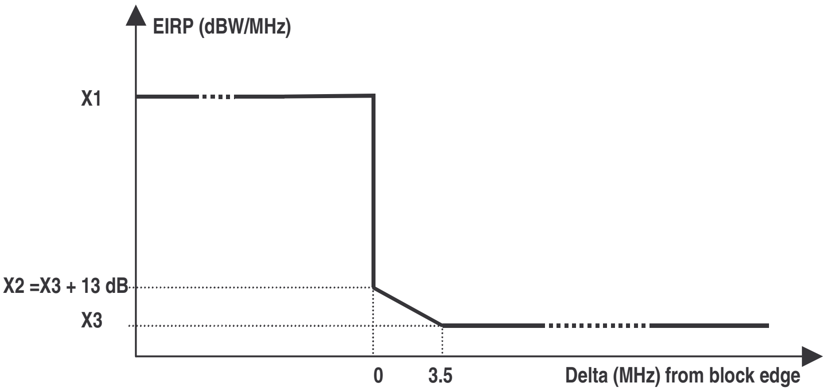


Figure 8: Block-edge mask reference values

It may be possible to tentatively set the reference points, as in Figure 8, considering that systems in the 3.5 GHz will be typically narrower than those used in the 40 GHz band.

The drop-down attenuation near the edge has been maintained to the same amount as for the 40 GHz case in order to ease TX filtering. While the size (3.5 MHz) has been chosen taking into account the typically smaller systems bandwidths. These values are not explored in the simulations carried in this report, but come from practical considerations similar to those made in the 40 GHz MWS ECC Recommendation 01-04 (i.e. this 3.5 MHz will act as “soft” guard band, discouraging its use by narrow-band systems for the expected higher interference).

X_3 value for CSs is function of the acceptable CS-to-CS and CS to TS minimum co-ordination distance. X_3 value for TSs should be derived from statistical interference protection factor (IPF) and NFD in TS to CS interference scenarios.

2.1.4.2 Conclusions and tentative BEM parameters

From the above considerations some tentative values for a BEM could be summarised in Table 6 as preliminary proposed reference points for future evaluation.

Station type	EIRP (dBW/MHz) (Note 3)		
	X1 (Note 3)	**X2**	**X3**
CS	13	X3 + 13	−64 or −73 (NOTE 1)
TS	23	X3 + 13	−35 or − 37 (NOTE 2)
NOTE 1: the − 64 dBW/MHz will result in a CS to CS minimum distance, for 1 dB maximum degradation of thresholds, of ~350 m, while the − 73 dBW/MHz allows closer distance down to ~ 100 m. NOTE 2: the −35 dBW/MHz should be used for TS using ETSI EN 302 085 class 3 or higher antennas: the −37 dBW/MHz figure should be used for TS using class 2 antennas			

Table 6: preliminary block-mask shape

The in-band EIRP upper limit could be preliminary set from the proposed reference systems data (see Table 1) which are already at or near to the maximum power. But there is some allowance for "higher gain" and/or "smart antennas" deployment (e.g. 5 dB more on CS and 15 dB more for TS, the latter with e.g. a 2 m parabolic antenna in order to cope with special cases).

2.1.4.3 Typical ETSI mask positioning and improvements on practical equipment

Using a block-edge mask regulatory concept implies that operators should meet the requirements having freedom on three elements only:

1. The EIRP level
2. The minimum frequency separation from edge of outermost channels
3. The transmit spectrum mask attenuation enhancement.

The first parameter is intended for maximising coverage, while the other two are strictly related to the actual equipment implementation. Manufacturers might improve the transmitter spectrum mask (and then the possibility of going closer to the block edge) by actually offering guaranteed masks that, at least for the CSs, are tighter than the minimum ETSI requirement.

Managing these three elements, equipment manufacturer and an operator can define systems parameters that better fit the network requirements addressed (e.g. for rural or for urban applications).

Annex 3 shows examples of filtered output masks based on currently available filter technology. Those examples also illustrate the matching of concept of absolute EIRP density mask (BEM) defined in this report and of relative power density mask currently reported in ETSI ENs.

3 ”ADJACENT AREA - SAME FREQUENCY BLOCK” INTERFERENCE SCENARIO

3.1 Power Flux Density Limits for adjacent FWS service areas

This document focuses on initial inter-operator co-ordination guidelines that would support assignments to FWA operators in adjacent sub-bands and adjacent geographic areas. These guidelines consist of service boundary PFD limits to assist in co-existence between neighbouring service areas and guard bands to assist with co-existence between adjacent frequency blocks in the same area. The PFD limits are linked with a co-ordination distance, which is the distance from the service area boundary within which transmitter stations should be co-ordinated with adjacent area operators.

The methodology used in this report follows the same approach as for the 40 GHz band, which was base for the relevant Annex 4 of draft ERC Recommendation (01)04.

The specific propagation behaviour in 3.5 GHz band was taken into account; in particular the spherical diffraction attenuation has been introduced as function of the antenna height. Due to the relatively large radius of first Fresnel zone (≈ 50 m) and the typical horizontal pointing of FWA antennas, the spherical diffraction attenuation will play significant role in defining the respective area and the PFD level for triggering co-ordination.

The findings of this section may be as follows:
FWA Central Stations (CS) transmitters should be co-ordinated when the **PFD** generated at the network's service area boundary exceeds the value of PFD [dBW/MHz/m^2] shown in Figure 11

The co-ordination distance and PFD at the boundary strongly depend on the antenna (interfering TX and victim RX) heights.

The values derived from Figure 11 can be used to determine co-ordination distances. For typical values of EIRP expected in the 3.5 GHz band, co-ordination distances are evaluated as ≈ 60 to 80 km for P-MP CS (see Figure 10).

Terminal Stations' (TS) EIRP being similar to that of CS there is no practical difference apart from the typically lower height of their antenna.

Evaluated EIRP = 20 dBW/MHz and antenna heights 20 to 50 m for CS and 10 to 40 for TS.

The range of distance and relevant PFD may be reduced or fixed in case administrations may wish to limit upper-bounds for both EIRP and antenna heights above the ground or to define down-tilt angles in case that height is exceeded.

This section reviews the methodology behind these figures and proposes the principle of boundary PFD limits as an appropriate means of controlling the interference environment between operators assigned same frequency block(s) in neighbouring geographical areas.

The proposed methodology might be also suitable for FSS co-ordination.

3.1.1 Assumptions

In order to cater for the variety of technologies possible for FWA no assumptions were made regarding duplex method or multiple access method. To generate the broadest of guidelines the assumption was merely that an interfering transmitter is deployed in one service area and a victim receiver is operating on the same frequency, but located in an adjacent service area.

In Table 7, equipment characteristics are reported for interference analysis and for a consequent tentative technology independent regulatory framework. Those values are not regarded as "typical" for most current system available on the market, but cater for due allowance for some special cases and possible further technology developments.

Nominal channel bandwidth:	7 MHz[8]
Central station EIRP:	20 dBW/MHz[9]
Central station antenna gain:	18 dBi[10]
Central station antenna radiation pattern (90º):	EN 302 085 class C2
Central station antenna height	20 to 50 m [11]
Terminal station $EIRP_{TX}$:	20 dBW / MHz [12]
Terminal station antenna gain	18 dBi
Terminal station antenna 3dB beam width	~ ±10°
Terminal station antenna radiation pattern:	EN 302 085 class TS2
Terminal station antenna height	10 to 40 m [13]
Typical Central Station and Terminal station receiver threshold (10^{-6} BER)	-84 dBm (4QAM) -76 dBm (16QAM)
Nominal ATPC regulated up-link receiver level	6 dB above 10^{-6} BER threshold
Receiver noise figure	8 dB [14]
Interference limit (kTBF – 10 dB) [15]	-146 dBW / MHz

Table 7: Summary of system characteristics assumed for defining the proposed regulatory framework

In addition the following propagation characteristics have been assumed:

- Line of sight path unless otherwise stated.
- No atmospheric attenuation at 3.5 GHz.
- Spherical diffraction attenuation (1st Fresnel zone partially obstructed due to limited antenna height) calculated following ITU-R Rec. P.562.
- ATPC effect at 3.5 GHz should also be taken into account; however, it is assumed that ATPC, in these lower bands, will be operated by multipath and not by rain, therefore correlation between interfering and victim paths attenuation is negligible.

[8] This channel spacing is considered the most representative for being used in the calculation. It is considered that the larger channel systems would determine the coexistence rules. Nevertheless lover spacing channels (e.g. from 1.5 MHz up), also widely popular, should more easily fit in that possible framework.

[9] This value includes allowance for feeder losses for full indoor applications. The assumed EIRP is intended to make room for the highest values allowed by present technology, used in particular applications (e.g. very large coverage in remote areas or when non LoS area should be covered at best), nevertheless network considerations would generally lead to lower EIRP. In this case it is also intended that the latter systems would more easily meet any regulatory limit.

[10] Even if antenna gain might be slightly lower in typical applications, antenna technology is in fast evolution; therefore 18 dB has been used for taking into account a not infrequent worst case, while 16 dB has been assumed as typical value in previous section of this report dealing with “same area – adjacent block”.

[11] Antenna height would impact the cell coverage but also the pfd at area boundaries. It is current practice for limiting the latter, when high antenna location is used, to down-tilt the antenna itself for remaining in the boundary pfd limits set by the Administration.

[12] This is the worst case, assuming symmetrical up-link/down-link capacity.

[13] In principle there should be no limitation to TS antenna height, it being dependent on the customer location. However, the same consideration made for CS antenna regarding the higher value still applies. For the lower limit, we should consider that second generation FWA systems might employ techniques which enable them to operate without a clear LoS path. The desire for low cost, simple (self) installs has resulted in system performance being improved to allow the TS to be deployed within buildings. Hence, TS heights may be less than 7 meters, and are rarely higher than 2 meters above the subscribers’ building height.

[14] Typical front ends noise figure in this band are lower (e.g. ~5 dB). The 8 dB value included allowance for feeder losses and possible narrow-band filters for enhanced selectivity required by dense environment as assumed in this report.

[15] For the “adjacent area- same frequency block” scenario a more stringent requirement is used (i.e. frequency reuse by another operator should be more protected than when operators use adjacent blocks of frequency).

3.1.2 Methodology

The PFD threshold has been determined assuming a single interferer and unobstructed LOS, directly aligned path between interferer and victim essentially a "minimum coupling loss" approach. The PFD limit is then used to derive an appropriate maximum co-ordination distance.

The threshold can then be tested using Monte Carlo statistical analysis to check its validity in a typical multiple interferer environment.

3.1.3 Central Station to Central Station

3.1.3.1 Worst case single interferer scenario: 3.5 GHz calculations

Assuming a 18 dBi victim antenna gain, the minimum separation between the two CSs (R_{min}) vs. the interfering station $EIRP_{int}$, can be derived from the link budget equation, i.e.,

$$P_{RX} = EIRP_{int} – FSPL – A_{sph} + G_{RX}$$

where P_{RX} is the interference power at the receiver input

FSPL is the free space path loss $=20 \log(4\pi R_{min}/\lambda)$

A_{sph} is the spherical diffraction attenuation depending on the heights (***ha*** and ***hb***) of the two CS antennas relative to the ground. This has been calculated following ITU-R Rec. P.562 and approximated as:

$$A_{sph} = 0 \text{ dB } D < D_0 \text{ (km)}$$

$$A_{sph} = 1.3\ (D-D_0) \text{ db } D \geq D_0 \text{ (km)}$$

D_0 is the maximum distance where the total calculated attenuation equals the free space attenuation

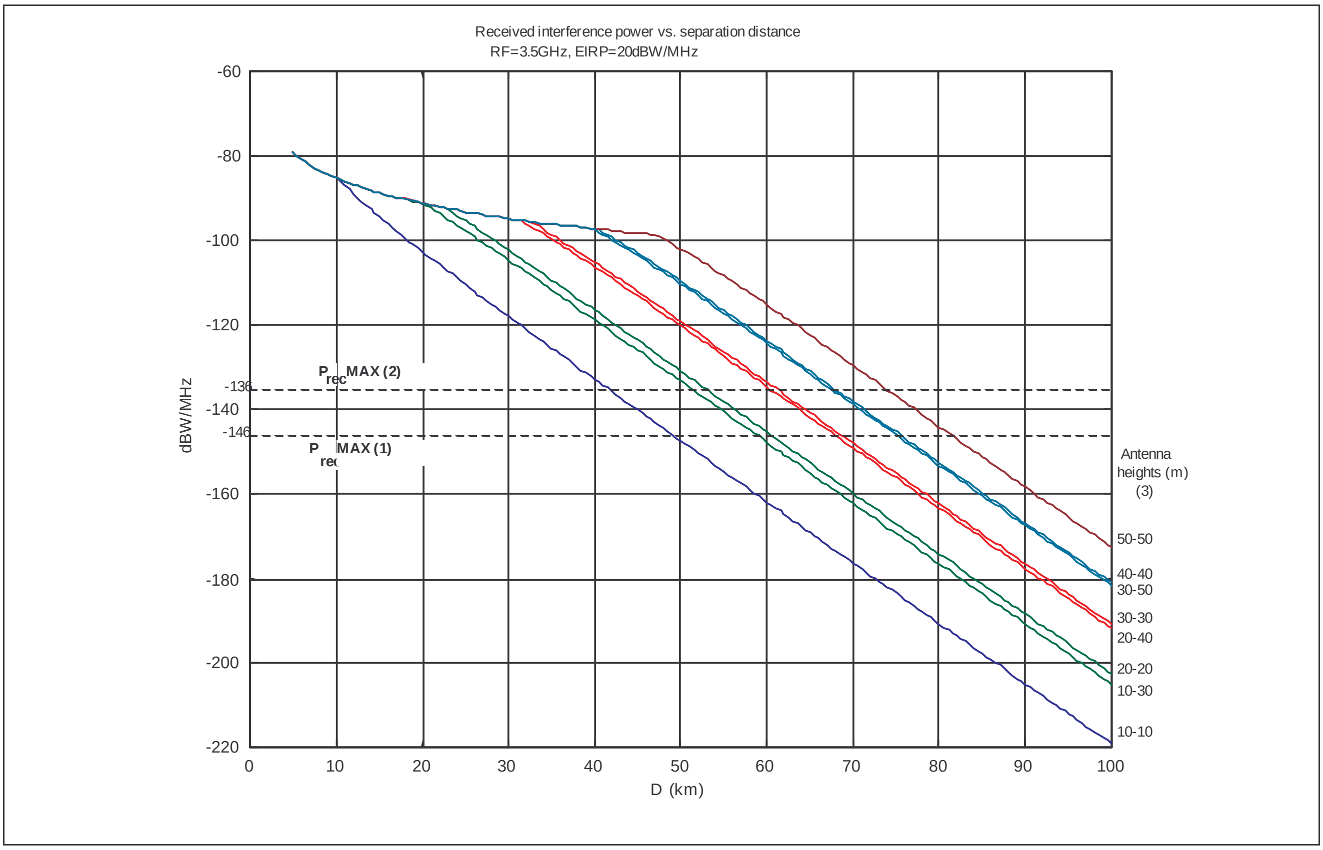
G_{RX} is the receiver antenna gain in the direction of the interferer

$$P_{RX} \text{ Max (dBW/MHz)} = - 146 = EIRP_{int} – 92.5 –20\log(3.5) –20\log(D) – A_{sph} + 18$$

Figure 9 shows the received interference power as a function of the separation distance from the interfering transmitter for $EIRP_{int}$= 20dBW/MHz and some different cases of antenna heights (ranging from 20m to 50 m). The curves for different EIRP values can be obtained by simple shift of the same amount.

In Figure 9 flat terrain has been assumed and it shows that in case of different interferer/interfered antenna height, the mean value of the two can be taken into account (e.g. ha=20m and hb=40m correspond to the case ha=hb=30m).

Flat terrain is assumed to be close to the worst case; it is not likely that operator boundaries lie along a relatively narrow valley and, even in that case, antennas would be "ground-grazing" aligned.



(1) P_{REC}MAX proposed for CSs and TSs at nominal operating EIRP (6 dB above threshold)
(2) P_{REC}MAX proposed for TSs (with ATPC enabled) at maximum EIRP
(3) Each curve is valid also for any mixed antenna heights with the same sum value (e.g. 30-30 is valid also for 20-40, 20-30 is valid for 25-25 and so on)

Figure 9: Received interference power vs. separation distance for the CS to CS interference scenario (3.5 GHz, line of sight)

In Figure 9 two limits are shown. The first (-146 dBW/MHz) is valid for little or no degradation of the victim CS receiver.

The second (-136 dBW/MHz) is proposed for TSs at the maximum EIRP (during the small percentage of time when ATPC is required to operate to counteract multipath attenuation) as discussed later.

The minimum separation, required to meet the –146 dBW / MHz interference criterion defined above, between directly aligned CSs under clear LOS air conditions is shown in Figure 10 as a function of EIRP, with the antennas height as parameter.

Within practical antenna heights range (20 to 50 m) the minimum separation distance ranges from 58 to 80 km.

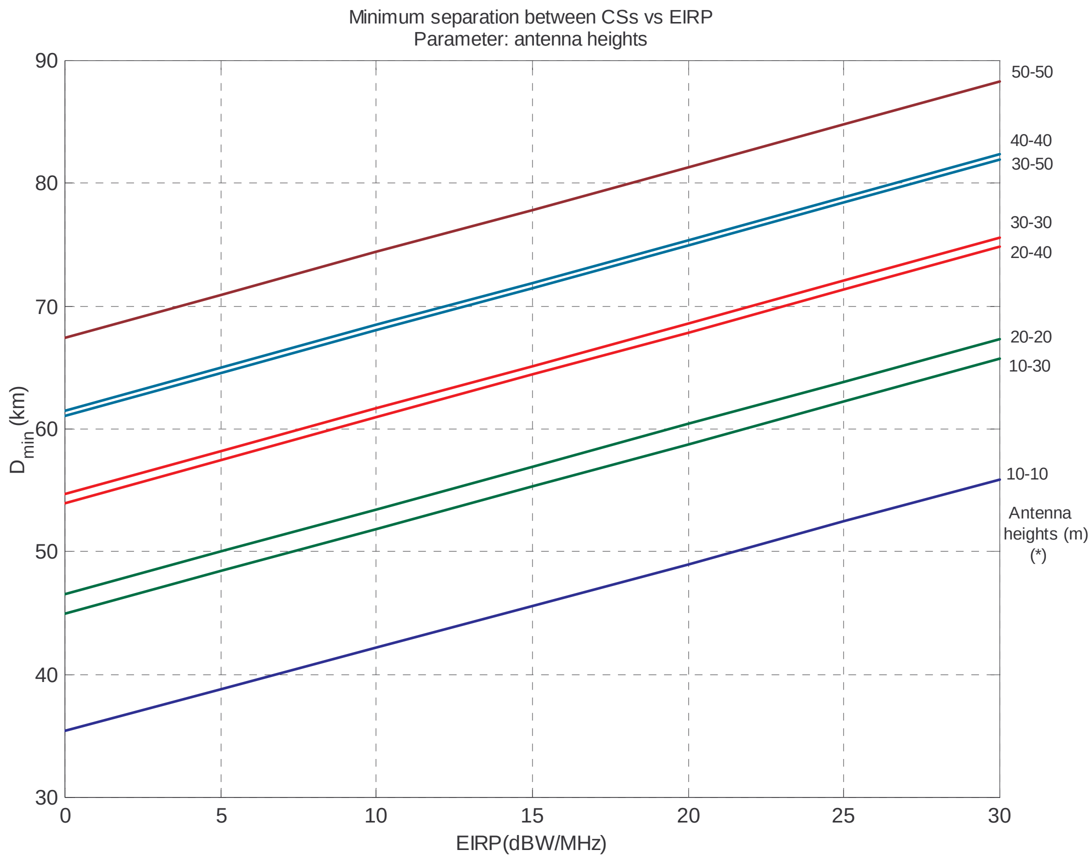


Figure 10: Minimum separation between CSs vs. EIRP for the CS to CS interference scenario (3.5 GHz, line of sight)

If the required separation distance is apportioned equally between the two regions, this will require each operator to ensure any CS *directly aligned* with an adjacent operator's service area boundary is located at least ($D_{min}/2$) km away from the adjacent service area boundary.

The interference power produced by a CS $D_{min}/2$ km away is calculated again as:

$$P_{rec}(D_{min}/2) = EIRP_{tx} - FSPL(D_{min}/2) - A_{sph}(D_{min}/2) + G_{rec}$$

The PFD at this distance can be determined using the formula:

$$PFD = P_{rec} - A_e,$$

where:

$A_e = G_{rec} + 10 \log(\lambda^2/4\pi)$ is the receiving antenna effective aperture

$A_e = -14.3$ dB m^2 evaluated at 3.5 GHz with G_{rec}=18 dB

The PFD at $D_{min}/2$ is shown in Figure 11 as a function of $EIRP_{tx}$ for different antenna heights.

Therefore the PFD at the service area boundary should not exceed the values derived from the above relationships, and summarised in Figure 11.

Data in Figure 11 are obtained with $P_{rec}(D_{min}/2)$ evaluated assuming the potential receive antenna height at $D_{min}/2$ to be the same than that at D_{min} (not taking into account any earth surface curving).

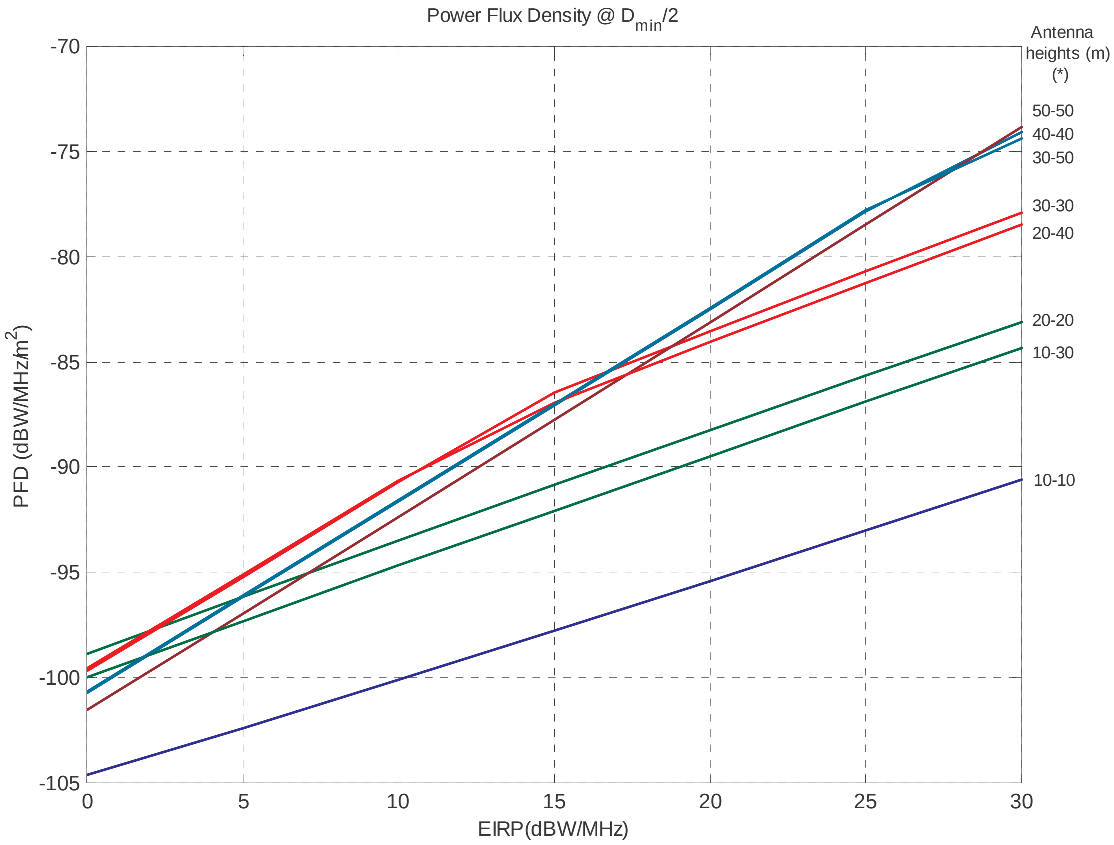


Figure 11: PFD (Φ) at D_{min}/2 (half the minimum distance derived from Figure 10 between CSs vs. $EIRP_{tx}$

3.1.3.2 Conclusions and possible self-regulation method for CSs co-ordination distance

Unlike what commonly happens in HDFS frequency bands, where line of sight applications give enough clearance from 1st Fresnel zone for not considering spherical diffraction attenuation, the above discussion has shown that, in the 3.5 GHz band, the co-ordination distance, besides $EIRP_{tx,}$, depends on antenna heights of both interfering and victim CS.

In such a way an operator, according to its own actual deployed maximum $EIRP_{tx}$ and antenna height, and assuming victim receiver antenna height at the maximum foreseen (e.g. 50 m), should:

- # evaluate the minimum co-ordination distance (D_{min} from Figure 10)
- # verify that the PFD at D_{min}/2 (service boundary) does not exceed the limits given in Figure 11.

This does not mean that CSs cannot be located closer than D_{min}/2 to the boundary. However, the PFD at the boundary should be no greater than that produced via an unobstructed path by a directly aligned transmitter radiating the same EIRP. With an antenna height at a distance D_{min}/2 from the adjacent service area boundary, in order to allow a similar transmitter (with the same EIRP and with the tallest antenna mast) at the same D_{min}/2 from service boundary.

In this case administrations may wish to limit CSs transmitters in both $EIRP_{tx}$ and maximum antenna height (automatically limiting the maximum co-ordination distance) or to define down-tilt angles in cases when height is exceeded.

At closer distances to the boundary, additional protection in the form of reduced EIRP in the direction of the boundary or shielding from terrain or other obstacles will be required. The extent of additional protection required would be subject of further studies.

3.1.4 Terminal Station to Central Station

3.1.4.1 ATPC impact

The TS is assumed to have ATPC. Under normal conditions each TS is assumed to have its EIRP level set to deliver a signal to the CS 6 dB above the receiver threshold.

Fadings from clear-air multipath on interfering and victim paths are assumed to be uncorrelated. Actually, slight correlation may be expected for directly aligned line of sight interference scenario but a very rough estimate of the percentage of time, where both the useful and the interference path might be contemporarily faded, gives negligible values (based on ITU-R P.530-8 paragraph 2.3.6).

3.1.4.2 Worst case single interferer scenario, 3.5 GHz calculations

For the worst-case interference scenario, it is assumed that the interfering TS is directed towards a CS located at the network service area boundary, pointing into its own service area. The worst-case interference arises when the TS is at the maximum distance from its CS.

This maximum cell size can be determined by considering the downlink power budget, assuming a CS EIRP of 20 dBW / MHz.

This evaluation, assuming multipath environment in rural (flat terrain) scenario, may be found in the previous section “Same area – Adjacent Block scenario” of this report and is summarised, with the fade margin (FM) in Table 8 as function of required availability.

Rural Scenario				
System Type	**Availability**			
	99.99%		**99.999%**	
	R_{max} (km)	**FM_0 (dB)**	**R_{max} (km)**	**FM_0 (dB)**
A	18.7 km	17.3	12.4 km	20.9
B	13.4 km	12.2	8.9 km	15.7

Table 8: Typical cell size in rural scenarios

Therefore, the worst-case interference scenario occurs when the interfering TS is at a distance $D_{int} = D_{min}/2 + R_{max}$ from the directly aligned victim CS, where D_{min} is derived from Figure 10 and R_{max} can be taken from Table 8.

With the assumption made of fading uncorrelation, two requirements need to be considered:

a) Interfering TS operating at the "normal" EIRP set by ATPC (unfaded percentage of time ~99.X %)
$EIRP_{ATPC} = EIRP_{max} - FM_0 + FM_{ATPC}$
FM_0 is the fade margin corresponding to maximum transmitted power (from Table 8). In this case (most of the time) the received interference power, into the victim CS, should not exceed the required limit (kTBF - 10dB) for not impairing the victim performance and availability.

b) Interfering TS operating at maximum EIRP (faded percentage of time ~ (100-99.X) %)
Due to uncorrelation, the victim CS would receive normal level, depending on the availability objective and the ATPC range, from the useful link (for a percentage of time usually less than 1%) In this case a higher interference level can be tolerated without impairments.
Assuming that also victim system will work at 6 dB above threshold, we may tolerate up to 3 dB of noise floor degradation (i.e. up to kTBF= -136 dBW/MHz).
Assuming the TS delivering the assumed maximum EIRP of 20 dBW / MHz, the received signal level at the victim CS at this distance is derived from Figure 9, for the rural scenario.

3.1.4.3 Examples:

Example 1

Type B interfering system, height of interfering TS h_t = 10 m, height of victim CS h_c = 30 m, availability 99.99%.

R_{max} = 13.4 km FM_0 = 12.2 dB D_{min} = 68 km (for CS to CS interference assuming hc = 30 m on both sides)

$$D_{int} = 13.4 + 68/2 = 47.4 \text{ km}$$

$$EIRP_{ATPC} = 20 – 12.2 + 6 = 13.8 \text{ dBW/MHz}$$

From Figure 9 (at D_{int} and scaled to the actual EIRP level) it is possible to derive:
For case a) an interfering power I =~ -132 – (20 - $EIRP_{ATPC}$) = - 138.2 dBW/MHz
For case b) an interfering power I =~ -132 dBW/MHz.

Both these levels are higher than requirement.

In case a) in order to receive an interfering power of -146 dBW/MHz, the CS of the interfering system should be placed at a distance Dx from the border, so that:
D(a) + R_{max} + D_{min}/2 =~ 54 km (from Figure 10, at EIRP = 13.8 dBW/MHz)
D(a) = 54 – 13.4 - 34 = **~ 6.6 km**

for case b), in order to receive an interfering power of -136 dBW/MHz (=kTBF), the CS of the interfering system should be placed at a distance Dy from the border, so that:
D(b) + R_{max} + D_{min}/2 =~ 52 km (from Figure 9 with P_{rec} Max set to –136 dBW/MHz)
D(b) = 52 – 13.4 - 34 = **~ 4.6 km**

Therefore the minimum distance where a CS (supporting far system type B TSs with height lower than 10 m and victim CS height lower than 30 m) could be placed is 6.6 km.

Example 2
Type B interfering system, height of interfering TS h_t = 20 m, height of victim CS h_c = 40 m, availability 99.99%.

R_{max} = 13.4 km FM_0 = 12.2 dB D_{min} = 75 km (for CS to CS interference assuming hc = 40 m on both sides)

D_{int} = 13.4 + 75/2 = 50.9 km

$EIRP_{ATPC}$= 20 – 12.2 + 6 = 13.8 dBW/MHz

From Figure 9 (at D_{int} and scaled to the actual EIRP level) we would derive:
For case a) an interfering power I =~ -121 – (20 - $EIRP_{ATPC}$) = - 127.2 dBW/MHz
For case b) an interfering power I =~ -121 dBW/MHz.

Also in this example, both these levels are higher than requirement.

In case a) in order to receive an interfering power of -146 dBW/MHz, the CS of the interfering system should be placed at a distance Dx from the border, so that:
D(a) + R_{max} + D_{min}/2 =~ 64 km (from Figure 10, at EIRP = 13.8 dBW/MHz)
D(a) = 64 – 13.4 - 37.5 = **~ 14.8 km**

for case b), in order to receive an interfering power of -136 dBW/MHz (=kTBF), the CS of the interfering system should be placed at a distance Dy from the border, so that:
D(b) + R_{max} + D_{min}/2 =~ 62 km (from Figure 9 with P_{rec} Max set to –136 dBW/MHz)
D(b) = 62 – 13.4 - 37.5 = **~ 11.1 km.**

Therefore the minimum distance where a CS (supporting system type B TSs with height lower than 20 m and victim CS height lower than 40 m) could be placed is 14.8 km.

Example 3
Type A interfering system, height of interfering TS h_t = 20 m, height of victim CS h_c = 40 m, availability 99.99%.

R_{max} = 18.7 km FM_0 = 17.3 dB D_{min} = 75 km (for CS to CS interference assuming hc = 40 m on both sides)

D_{int} = 18.7 + 37.5 = 56.2 km

$EIRP_{ATPC}$= 20 – 17.3 + 6 = 8.7 dBW/MHz.

From Figure 9 (at D_{int} and scaled to the actual EIRP level) derive:
For case a) an interfering power I =~ -129 – (20 - $EIRP_{ATPC}$) = - 140.3 dBW/MHz
For case b) an interfering power I =~ -129 dBW/MHz

Also in this example, both these levels are higher than requirement.

In case a) in order to receive an interfering power of -146 dBW/MHz, the CS of the interfering system should be placed at a distance Dx from the border, so that:

$D(a) + R_{max} + D_{min}/2 = \sim 61$ km (from Figure 10, at EIRP = 8.7 dBW/MHz)

D(a) = 61 - 18.7 - 37.5 = **~ 4.8 km.**

For case b), in order to receive an interfering power of -136 dBW/MHz (=kTBF), the CS of the interfering system should be placed at a distance Dy from the border, so that:

$D(b) + R_{max} + D_{min}/2 = \sim 62$ km (from Figure 9 with P_{rec} Max set to –136 dBW/MHz)

D(b) = 62 - 18.7 - 37.5 = **~ 5.8 km.**

Therefore the minimum distance where a CS (supporting system type A TSs with height lower than 20 m and victim CS height lower than 40 m) could be placed is 5.8 km.

3.1.4.4 TS to CS Conclusions

From the above examples, a CS, even if pointing away from the border, could not be indifferently placed nearer than the co-ordination distance evaluated in Figure 9 and Figure 10. The terminals PFD will become determinant and engineering of the cell (reduced EIRP and sector beams pointing) should be used to ensure that also TSs PFD (in the direction of the boundary) does not exceed the values derived from Figure 11.

Figure 12 shows an example of such methodology based on previous examples 2 and 3.

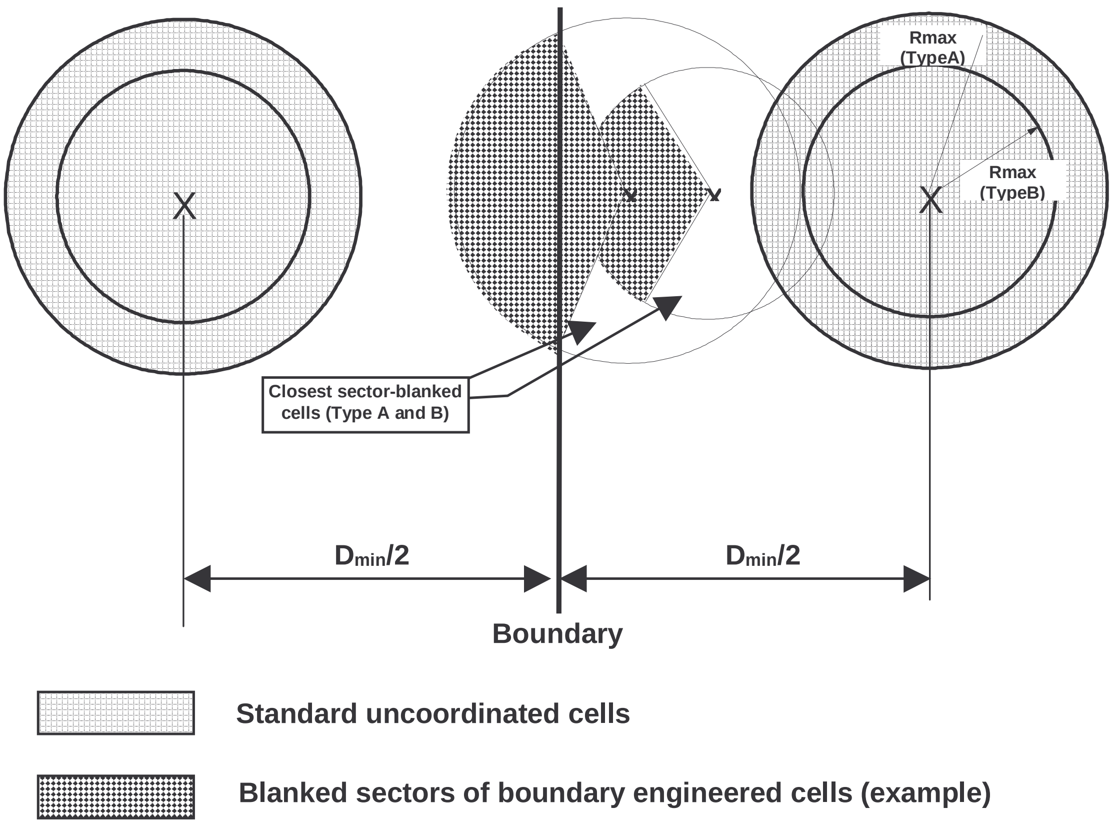


Figure 12: Example of cell sector engineering at service boundary (assuming h_c = 40 m on both service areas; for $D_{min}/2$ see Figure 10)

3.1.5 Terminal Station to Terminal Station

This kind of interference, unlike the cases where a CS is involved, would only impair the operation of one terminal; therefore a worst case approach is considered as too stringent. Due to the random nature of this kind of interference, a statistical Monte Carlo approach seems more adequate. A possible scenario could be two CSs located at both sides of the boundary, each pointing into its own service area. Each TS will have its EIRP level set to deliver a signal to the CS 6 dB above the receiver threshold, except one (different in each trial) which would have maximum EIRP, to simulate the occurrence of a fading event.

However this effect, at least for PMP architectures with directive TS antennas, is not generally considered a limiting factor for coexistence (when compared to the other interference cases). This evaluation may require further work in case of mixed PMP and MESH architectures.

3.2 Conclusions on adjacent areas boundary co-ordination

It is therefore recommended that co-ordination between operators using same frequency block(s) in the 3.5 GHz band in adjacent geographic areas should take place for any transmitter (CS and TS assumed to supply very similar EIRP) that produces a PFD derived from Figure 11 or greater at the service area boundary. The distance from the service area boundary that will be subject to co-ordination, as a function of transmitter EIRP, is indicated in Figure 12.

The proposed PFD guidelines can be tested in Monte Carlo simulations to assess their validity in multiple interferer scenarios.

4 CONCLUSIONS OF THE REPORT

This Report has considered a number of facts as initial considerations for deriving the coexistence study:

1. Presently ECC Recommendations 14-03 and 12-08 for the bands 3.6 GHz and 3.8 GHz do not give harmonised and detailed suggestion to administration for implementing FWA (such as those produced for 26, 28 and 40 GHz). Those ECC Recommendations offer only channel arrangements.
2. The band is limited and wasted guard-bands might drastically reduce the number of licensed operators, limiting the potential competition for new services.
3. Legacy systems (P-P and already licensed FWA) are present in these bands. “Block assignment” methods of different sizes (for different applications) are generally used for licensing FWA.
4. Sharing issues with FSS, radiolocation (in adjacent band), ENG/OB exist and should be taken into account.
5. At least for CSs, ETSI ENs in these bands are not presently designed for a technology neutral deployment (this is done only in the 40 GHz MWS EN 301 997) therefore do not contain system controlling parameters, in terms of EIRP, which would be useful for the desired “technology neutral” and “uncoordinated” deployment
6. The suggested guard-bands/mitigation(s) would depend on system bandwidth/characteristics. Presently, in this band, it is not possible to identify a “typical” system bandwidth on which base the definition of a guard-band. Symmetric/asymmetric, narrow/wide/broad band services[16], TDD/FDD, P-MP/Mesh architectures are already available on the market, each one with its own benefits and drawbacks, fitting to specific segments of the whole FWA market. It should be noted that e-Europe initiatives call for faster Internet applications (i.e. requiring relatively wide-band FWA) to be available on the whole European territory.
7. Typical block size ~ 7 to 14 MHz (e.g. from a block of channels based on 3.5 MHz raster) or ~10 to 15 MHz (e.g. when a basic 0.5 MHz raster is used) is considered practical for new wide/broad band services demand. Nevertheless the conclusions should be valid for wider block sizes (e.g. up to ~ 28/30 MHz) depending on the band availability in each country.
8. Also for “conventional” symmetric FDD the central-gap between go and return sub-bands do not exist in ECC Recommendations 14-03 and 12-08; therefore situation with TX/RX happening on adjacent channels exist (unless specifically addressed by single administrations in licensing rules).
9. It is also shown that, for PMP TSs, the antenna RPE plays a fundamental role in the coexistence; the more directive is the antenna of TSs, the less demanding might be their NFD (or the EIRP density BEM) required (offering a flexible trade-off to the market).

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16 Narrow band services are considered here as < 64 kbit/s, wide-band from 64 to 1.5 Mbit/s and broadband above 1.5 Mbit/s

10. MP-MP (MESH) architectures have not been considered in this Report. In particular it is recognised that, for MESH architectures, a number of assumptions (e.g. on the omni-directional/directional antenna use) need to be defined in order to devise the typical intra-operator, mixed MP-MP/PMP interference scenarios for which simulations would habe to be carried.

Based on the above inputs, this Report recommended Interference Protection Factor/ isolation values ensuring acceptable coexistence levels between systems.

It has been shown that the required IPF levels can be achieved, depending on situations, by a combination of basic equipment NFD and appropriate additional isolation factor (e.g. suitable guard bands and/or mitigation(s) techniques).

In the case of a block assignment and where a guard band approach is not retained, these IPF levels can be ensured with additional EIRP BEM. This is deemed convenient for “technology independent” deployment and eventually feasible from a cost-effective equipment point-of-view. Especially when considering that the additional EIRP constraint (with respect to ETSI EN) might burden only CS design.

In addition, basic rules has been set for the co-ordination distance and PFD boundary levels between operators re-using the same block in adjacent geographical areas. In this field, the importance of limiting CS antenna height (or down-tilt angle) as possible licensing parameter is highlighted in order of having sensible co-ordination distances (i.e. limited by spherical diffraction attenuation).

ANNEX 1: URBAN AREA PROPAGATION MODELS

A1.1 The Okumura-Hata model used in this Report

A1.1.1 Tentative extrapolation of the Okumura-Hata propagation model for A_{50} up to 3.5 GHz

Important remark on terrain classification:
The original Okumura experimental data are said by the authors to refer to an "urban area", with a further subdivision into "large city" and "medium city" for what concerns the terminal antenna height gain G_t.

Okumura also gives diagrams of correction factors for "suburban" and "open" areas.

It should be noted that this classification was based on the characteristics of the Tokyo area.

It is considered that the "medium city" model is better suited to describe the typical European suburban areas. Moreover, the correction factor for "open areas" is said to give rather optimistic results (see [2] and [3]).

For the above reasons, the Report was limited to the "urban" models (large and medium cities) and numerical examples to “medium cities” only.

Further extrapolations can be of course done in the same way for other environments.

The empirical Hata propagation model, based on field measurements reported by Okumura [1], is a well-established one, widely used at UHF bands.

An extension of the model toward higher frequencies is found in COST-231 report, however this model, although probably useable up to 3 GHz, addresses typical mobile scenarios, with very small peripheral antenna heights.

For a point-to-multipoint 3.5 GHz scenario a slightly different approach has been sought, starting from curves derived from Okumura's measurements, as published in [1].

According to Okumura, the median path attenuation is given by:

$$A_{50}=A_{fs} + A_{bm} - G_c - G_t$$

where:

A_{fs} :is the free space attenuation, (FSPL in this document

A_{bm} :is the "basic median path loss" (Figure 13) for which Okumura provides extensive experimental data up to 3 GHz only, obtained with a base station antenna height h_c = 200m and a peripheral station height h_t = 3m,

G_c is the "central (base) station height gain factor" (Figure 15) for different h_c values,
and
G_t is the "terminal (peripheral) station height gain factor" (Figure 14) for different h_t values.

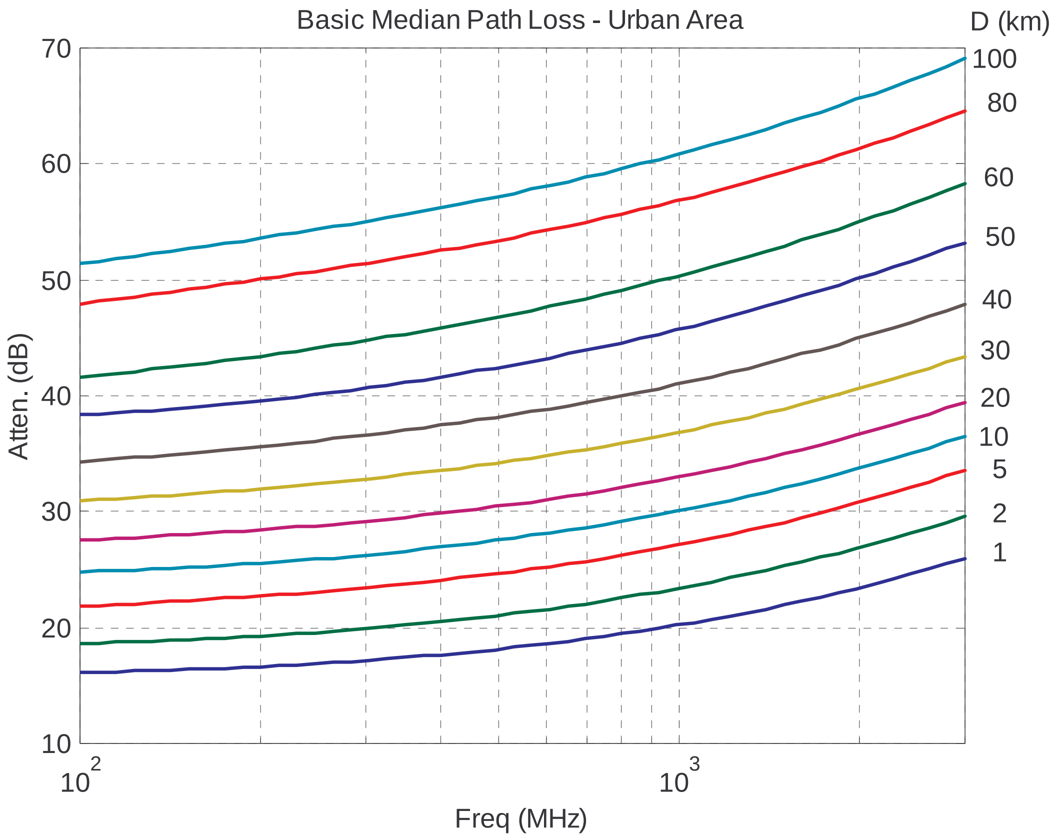

Figure 13: Okumura experimental data for A_{bm} vs. frequency

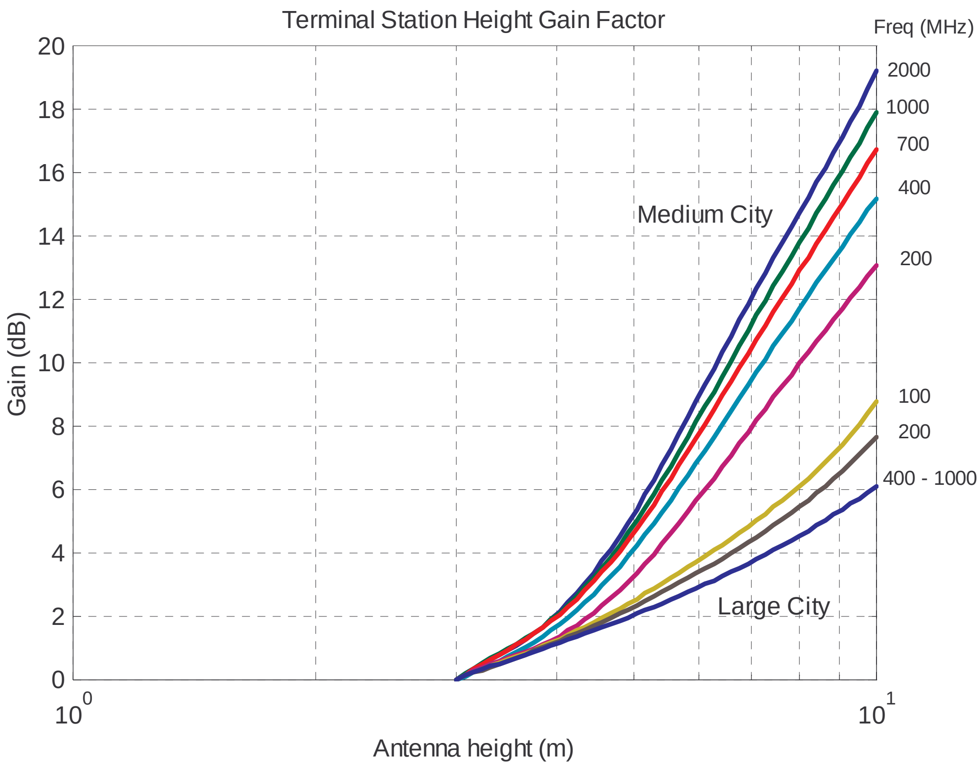

Figure 14: Okumura experimental data for G_t vs. h_t

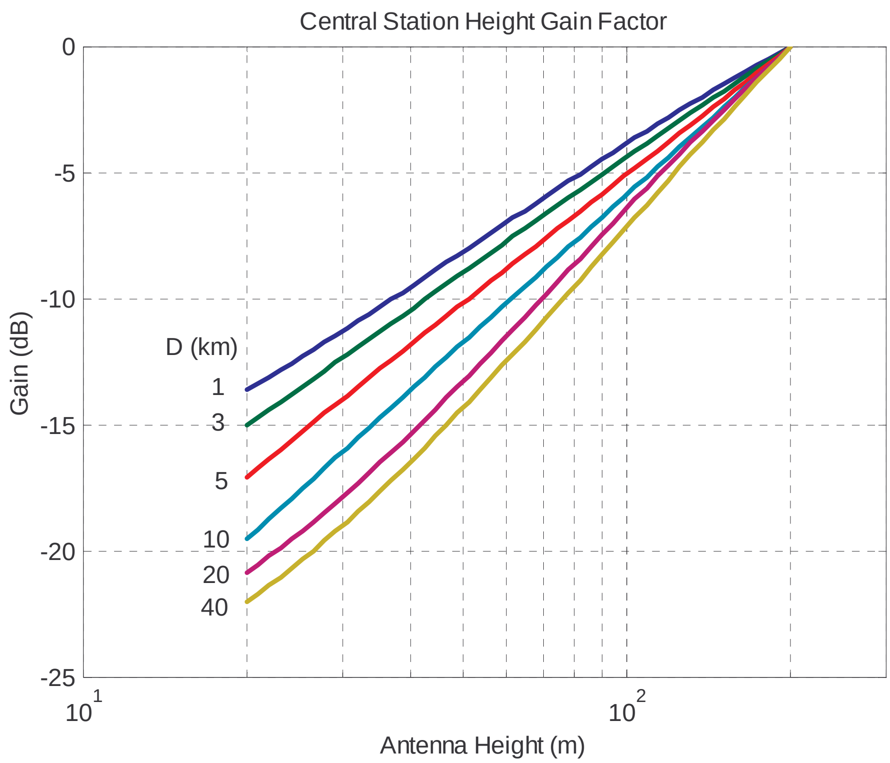

Figure 15: Okumura experimental data for G_c vs. h_c

In this Report's extrapolation exercise, the curves of A_{bm}(RF,D) have been fitted in the least square sense between 700 and 3000 MHz in frequency.

The curves of $G_c(h_c,D)$ have been fitted from 1 to 10 km in distance, for central station antenna heights between 20 and 200 m.

The curves of $G_t(h_t,RF)$ have been fitted from 700 to 2000 MHz in frequency, for terminal station antenna heights between 5 and 10 m.

The calculated RMS error was less than 0.2 dB for each individual fitting.

The resulting extrapolated expressions are given below:

$$A_{fs} = 92.4 + 20 \log(D) + 20 \log(RF)$$

$$A_{bm} = 20.41 + 9.83 \log(D) + 7.894 \log(RF) + 9.56 [\log(RF)]^2$$

$$G_c = \log(h_c/200) \{13.958 + 5.8 [\log(D)]^2\}$$

$$G_t = [42.57+13.7 \log(RF)] [\log(h_t)-0.585] \quad \text{(for medium city environment)}$$
$$G_t = 0.795 h_t - 1.862 \quad \text{(for large city environment)}$$

where RF is in GHz, D in km, h_c and h_t in m.

For comparison with Hata's original formula, the explicit formula for the median attenuation A_{50} resulting from the above extrapolation is given as (this time with RF in MHz):

$$A_{50} = 147.376 + 29.83 \log(D) - 13.958 \log(h_c) - 29.466 \log(RF) + 9.56 [\log(RF)]^2 + \\ +[13.34 - 5.8 \log(h_c)] [\log(D)]^2 - [1.47 + 13.7 \log(RF)] [\log(h_t) - 0.585)] \quad (10)$$

to be compared with the original Hata formula:

$$A_{50Hata} = 69.55 + [44.9 - 6.55 \log(h_c)] \log(D) - 13.82 \log(h_c) + 26.16 \log(RF) + \\ - [1.1 \log(RF) -0.7] h_t + [1.56 \log(RF) -0.8] \quad (11)$$

In both cases the terms in *italic* refer to the terminal antenna height gain for a "medium city" environment.

A1.1.2 Confidence check on the proposed extrapolation

The value of A_{50} in (12) has been computed for 39083 different sets of the parameters of relevance (D, RF, h_c, h_t) with the proposed formulas in the original ranges for which the Okumura approach was considered valid:

RF	1000 to 2000 MHz	h_c	20 to 100 m
D	1 to 10 km	h_t	5 to 10 m

All the differences from the values of the Okumura curves derived from (13) were calculated.

The resulting RMS error was 0.3164 dB (Figure 16), which was judged a fairly acceptable figure for the model extrapolation effectiveness.

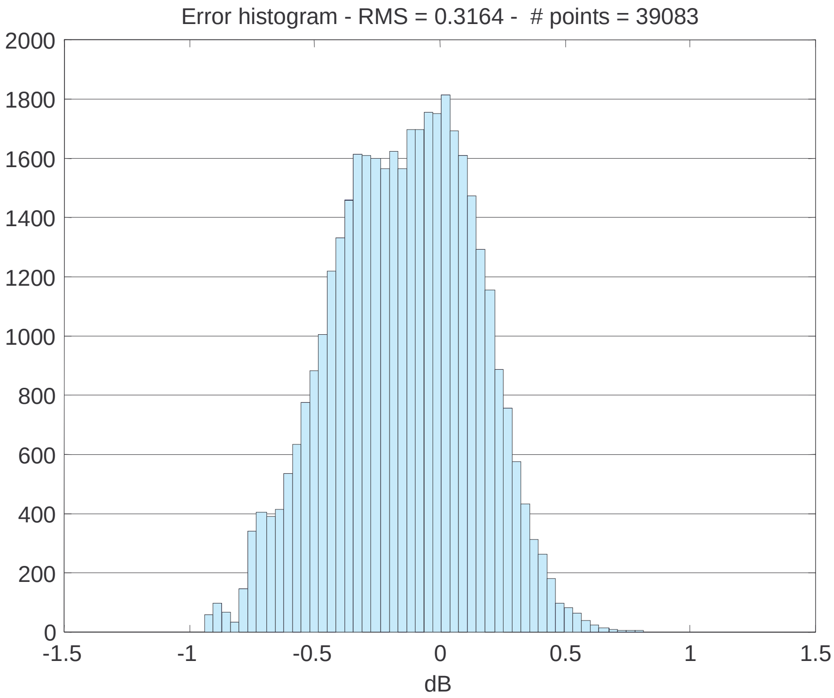

Figure 16 : Confidence check on the proposed methodology (39083 cases)

A1.1.3 Practical application to the proposed scenario

In this Report A_{50} is evaluated from the extrapolation of the Okumura empirical model described in previous sections.

Regarding σ, a discussion can be found in paragraph 9.5 of [3]. The formula presented there may be accepted.

Clear-air multipath cannot in principle be disregarded, although very little is known about its occurrence in urban areas. The usual model (ITU-R Recommendation 530) will be used for lack of a better one.

In this case, the link budget may be written as:

$$SG + G_{TX} + G_{RX} = A_{50} + A_{sh} + FM \qquad (12)$$

where:

- SG, G_{TX} and G_{RX} are the same as in formula 1 for the rural case.
- $FM=10 \log(P_0) -10 \log(un_{year}) +36 \log(D)$ (similarly to formula 6 for the rural case).
- A_{50} is the mean path loss, and is a function of distance, CS and TS antenna heights and frequency.
- A_{sh} is the "shadowing loss", random component with normal p.d.f. about A_{50} and standard deviation σ.

According to the method described in section A1.1, A_{50} is given (for medium city environment) by:

$$A_{50} = 147.376 + 29.83 \log(D) - 13.958 \log(h_c) - 29.466 \log(f) + 9.56 [\log(f)]^2 + \\ + [13.34 - 5.8 \log(h_c)] [\log(D)]^2 - [1.47 + 13.7 \log(f)] [\log(h_t) - 0.585)] \qquad (13)$$

where D is the distance in km, h_c and h_t the CS and TS antenna heights in meters and f the frequency in GHz.

The standard deviation "σ" of A_{sh} is given by:

$$\sigma = 0.65\,[\log(f)]^2 - 1.3\log(f) + A \qquad (14)$$

with f in MHz, A=5.2 dB (urban) or 6.6 dB (suburban) as given in [1].

Due to the random nature of A_{sh} , the maximum radius R may be found by evaluating the probability that (A_{50} + A_{sh}) exceeds (SG + G_{TX} + G_{RX} - FM) . This is a function of D, whose integral over the area of a circle with radius R gives the average uncovered area in the cell.

The following diagram shows the results of calculations with the assumed equipment parameters and antenna heights h_c=30m and h_t=10, 20, 30 m

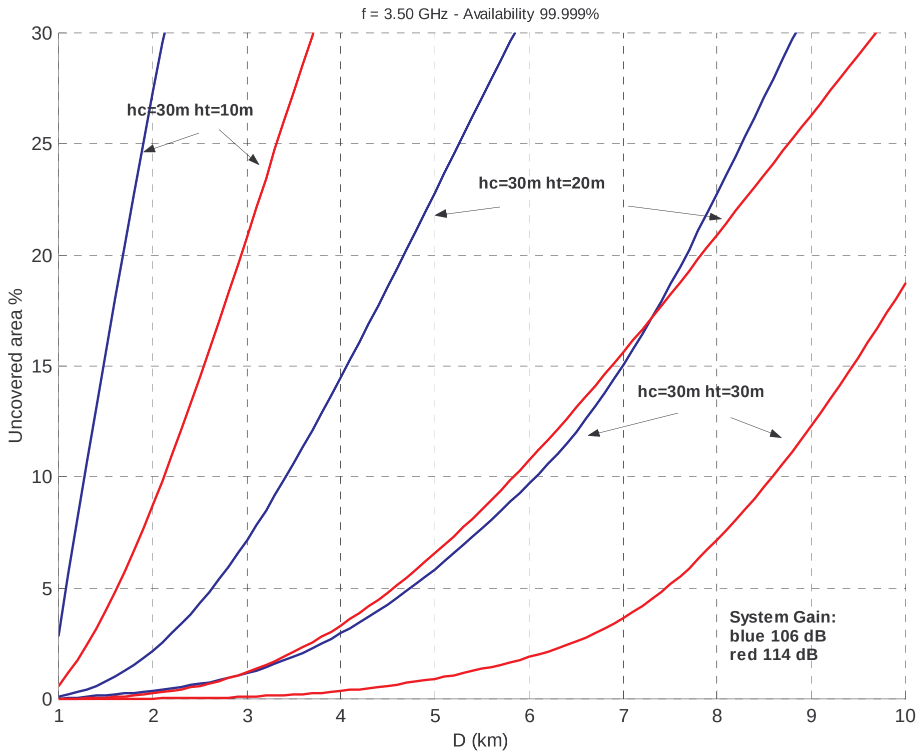

Figure 17: Example of Cell radius (D) versus area coverage in urban scenario

From Figure 17 it may be seen that again the antenna heights play a fundamental role, Rmax for a system Type A would range from 1.6 to 7.5 km and system type B from 1.1 to 4.5 km, according to the TS antenna height.

It should be noted that this diagram applies to an urban scenario, where buildings are assumed to be spread in height from minimum to a maximum for the uncovered percentage area.

In addition, the Okumura model assumes that terminals (mobile) are spread randomly on the territory without any attempt for looking for “line-of-sight” connection; in Fixed applications countermeasures (masts or roof positioning) are generally sought.

Therefore the following considerations, on the covered percentage of TSs, are valid in a context of real “consumer” terminals (i.e. bought and installed by the user, wherever he likes). This would be considered a very worst case for typical FWA systems.

It has to be further considered that in an actual scenario the heights of the buildings will show a random distribution. ITU-R Recommendation P.1410 suggests a Rayleigh p.d.f., with parameter γ

The actual cell radius can be roughly estimated as follows, from the above data:

- divide the range of building heights into 3 segments: below 15m, 15 to 25m, above 25m
- evaluate the relative weight of each segment (dependent on the parameter γ)
- calculate the radius R_{max} as the weighted sum of the values from Figure 17, at the wanted coverage objective.

Results in Table 9 have been obtained for 95% coverage:

System Gain (dB)	**R_{max} (km)**	
	γ = 16 (h_{avg} = 20m)	**γ = 12 (h_{avg} = 15m)**
114 (System type A)	4.35 km	3.3 km
106 (System type B)	2.7 km	2 km

Table 9 : Cell radius for 95% TSs coverage at 99.999% availability Vs system gain and TS antenna mean height (Okumura-Hata model)

A1.2 The IEEE 802.16 model

A1.2.1 Channel Model Considerations and Constraints

In the IEEE 802.16 models, coverage and availability highly depend on the channel models used and on the selected terrain category. This is mainly characterized by the mean excess loss and additional factors (e.g.: log-normal shadowing and Rice fading factor) contributing to further refinement[17].

For excess path loss, the three categories of terrain type identified are:

Category A: hilly with moderate to heavy tree densities.
Category B: intermediate path loss conditions.
Category C: mostly flat with light tree densities.

For these three categories, empirical equations have been developed for median excess path loss referenced to a LOS distance of 100 m. The equations identify the excess path loss exponent and include correction terms for TS and CS antenna heights. A log-normal shadowing factor s is also identified with s ranging from 8.2 to 10.6 dB.

In conjunction with the three terrain categories, reference [4] identifies six channel models, these being denoted as SUI-1 through SUI-6.

Also identified for the channel models is a characterisation of Rician fading. Rician fading results from motion of the reflective facets (diffuse reflections). Rician fading differs from Rayleigh in that a primary signal component is present. Rician fading is characterised by Rice parameter K, this being the ratio of the primary signal power to that of the diffuse power. Figure 18 illustrates excess percentage E vs. K in dB. Note that K = 0 dB is approximately within 1 dB of Rayleigh.

---

[17] *The path loss can be seen as the summation of basic free space loss (FSL) and the excess loss (Lex) due to the local blockage conditions or reduction of antenna gains: PL(dB) = FSL (dB) + Lex (dB). The path loss can be modeled as follows: PL(dB) = A0(dB) + 10 n log10 (d/d0) + S(dB) , where the exponent n represents the decay of path loss and depends on the operating frequency, antenna heights and propagation environments. The reference path loss A0 at a distance d0 from the transmitter is typically found through field measurements. The shadowing loss S denotes a zero mean Gaussian random variable (in decibels) with a standard deviation (also in decibels).*

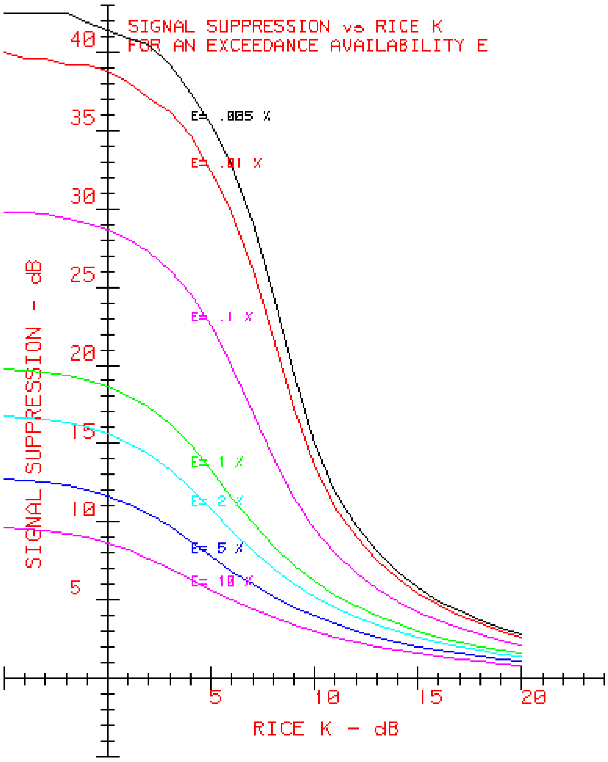

Figure 18 Signal Suppression Excess E vs. Rice K

Figure 19 illustrates the median value of Rice K vs. distance based on the empirical equations described in [4]. The plots are referenced to a TS antenna elevation of 10 m and to TS antenna beam widths of 15 degrees and 35 degrees. These beam widths respectively correspond to those of “representative” and ETSI TS2 antennas. At R_{max} = 2 - 2.7 km, the mean values for Rice K are roughly 8 dB and 11 dB. The difference results from antenna beam width, the ETSI TS2 antenna yielding lower values of K. **These Rice K values correspond very closely to those recommended in [4] for the SUI-1 and SUI-2 channel models that are respectively 12 dB and 9 dB**. The SUI values will subsequently be employed for coexistence simulation analysis.

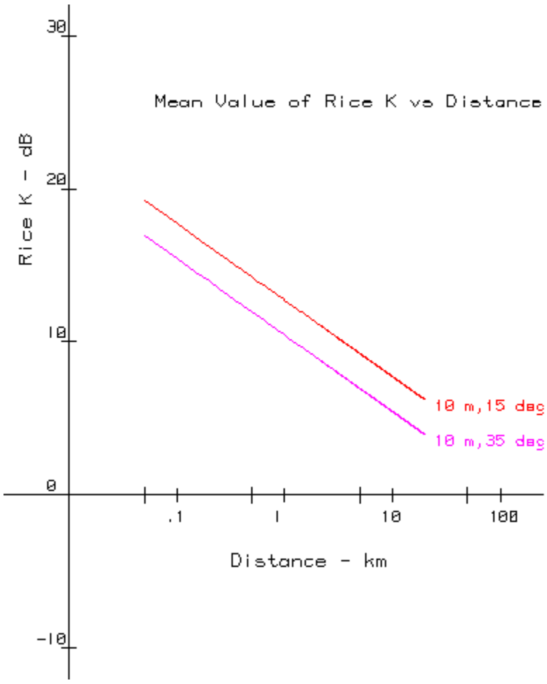

Figure 19: Mean Values of Rice K vs. Distance

The measured data for Rice K reported on in [4] has been described to have a significant variation about the mean value with a log-normal sigma of 8 dB. Figure 20 illustrates a computational estimate for the spread of K when this is taken into account. Rice K values were computed for 50 m distance increments. Note that the distance scale is logarithmic.

Only mean values for K will be employed in the subsequent simulations.

The measured data in [4] reported a transmission distance d variation in K as d^{γ}, where $\gamma = -0.5$. For the simulations, this adjustment is taken into account for each interference and victim link distance.

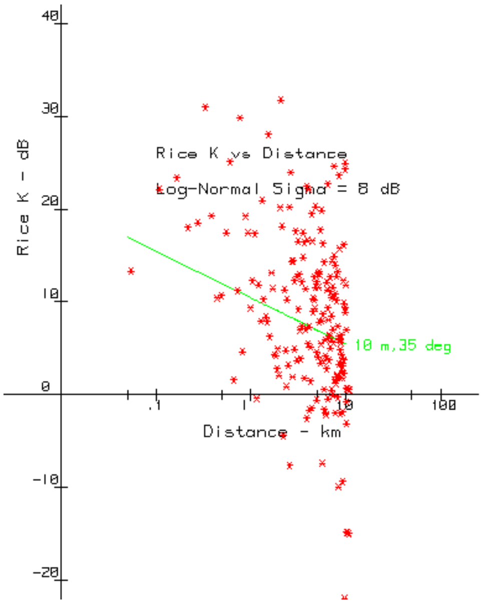

Figure 20: Illustrative Spread of Rice K vs. Distance for a Log-Normal Sigma of 8 dB

For the Monte Carlo simulations an estimate of the up-fade or down-fade adjustment to signal level is required for each interference or victim link. These are developed based on the random deviate acceptance/rejection method described in [5]. Here, we note that the diffuse components of the Rician signal envelope are Rayleigh distributed, but the envelope is modified by the addition of a randomly phased primary signal component. The relative value of the primary signal to that of the diffuse Rayleigh distributed component is set by the specified value for K.

Figure 21 illustrates the probability distribution function (p.d.f.) for Rice K based on this procedure. Cell edge SUI-1 and SUI-2 values for Rice K of 12 dB and 9 dB are illustrated. K =0 dB is illustrated for reference. Again, it may be noted that it is very close to Rayleigh. K = 20 dB is also illustrated for reference. Here, it is apparent that the likelihood of a deep fade is very small.

For the simulations, setting K to 20 dB corresponds very closely to the unfaded case.

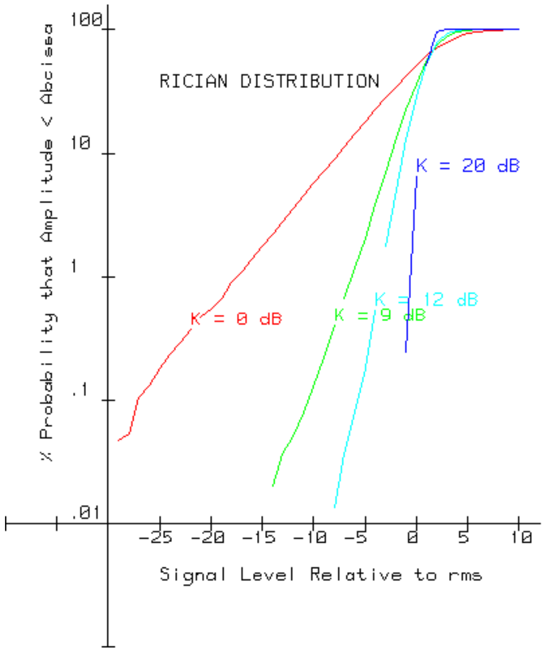

Figure 21: Rice K p.d.f. vs. Signal Level as Developed from Random Deviates

A1.2.2 Urban area availability/coverage at 3.5 GHz

For the three IEEE 802.16 model terrain categories, empirical equations have been developed for median excess path loss referenced to a LOS distance of 100 m. The equations identify the excess path loss exponent and include correction terms for TS and CS antenna heights. A log-normal shadowing factor σ is also identified with σ ranging from 8.2 to 10.6 dB.

Based on the empirical equations, computed median excess loss is shown in Table 10a) through Table 10c) as a function of the cell radius (R_{max}). The estimates are based on respective CS and TS antenna heights of 30 m and 10/15/20 m. Log-normal shadowing is excluded.

Table 11a) through Table 11f) further illustrate some link availability estimates based on link budgets for system types A and B characteristics defined in **Table 1** (developed for TS antenna heights = 10, 15 and 20 m).

Based on a link budget analysis referenced against the assumed transmission parameters, it is concluded that, at least for system type B, acceptable system operation is possible only for terrain category C. For the other two terrain categories, excess median loss is such that cell edge receive signal levels are less than the threshold requirements, even ignoring any fading. Thus, even with perfect multiple-input / multiple-output (MIMO) diversity to combat fading, link availability objectives could not be achieved.

In Appendix 1 to this Annex 1, further simulations, using Monte Carlo technique, derive statistical percentage of Excluded Cell Area coverage with the required availability.

Terrain Category	Excess Path Loss Exponent	Excess Loss (dB) R_{max}= 2 km	Excess Loss (dB) R_{max}= 2.7 km	Excess Loss (dB) R_{max}= 3.3 km	Excess Loss (dB) R_{max}= 4.35 km
A	**4.78**	30.3	33.9	36.4	39.7
B	**4.38**	24.8	27.9	30	32.9
C	**4.12**	15	17.8	19.6	22.2

Table 10a: Path Median Excess Loss (MEL) (CS=30 m; TS=10 m)

Terrain Category	Excess Path Loss Exponent	Excess Loss (dB) R_{max}= 2 km	Excess Loss (dB) R_{max}= 2.7 km	Excess Loss (dB) R_{max}= 3.3 km	Excess Loss (dB) R_{max}= 4.35 km
A	**4.78**	28.4	32	34.5	37.8
B	**4.38**	22.9	26	28	30.9
C	**4.12**	11.5	14.3	16.1	18.6

Table 10b: Path Median Excess Loss (MEL) (CS=30 m; TS=15 m)

Terrain Category	Excess Path Loss Exponent	Excess Loss (dB) R_{max}= 2 km	Excess Loss (dB) R_{max}= 2.7 km	Excess Loss (dB) R_{max}= 3.3 km	Excess Loss (dB) R_{max}= 4.35 km
A	**4.78**	27	30.7	33.1	36.4
B	**4.38**	21.6	24.6	26.7	29.6
C	**4.12**	9.0	11.7	13.6	16.1

Table 10c: Path Median Excess Loss (MEL) (CS=30 m; TS=20 m)

The following Table 11a) through Table 11f) illustrate some link availability estimates based on link budgets for system types A and B characteristics defined in **Table 1** (developed for TS antenna heights = 10, 15 and 20 m).

Terrain Category	Cell Radius (km)	Mean Excess Loss (dB)	Fade Margin (dB)	Link Availability (%)				
				K=5 dB	K=8 dB	K=10 dB	K=12 dB	K=15 dB
A	2.0	30.3	6.3	-----------	-----------	98.0	99.6	99.995
	2.7	33.9	0.3	-----------	-----------	-----------	-----------	-----------
B	2.0	24.8	12.3	-----------	99.6	99.96	99.998	-----------
	2.7	27.9	6.3	-----------	-----------	98.0	99.6	99.996
C	2.0	15	21.6	99.6	99.96	99.999	-----------	-----------
	2.7	17.8	16.4	99.0	99.9	99.994	-----------	-----------

Table 11a: Link Availability for a Type A System with MEL and Rician Fading
TS Antenna Elevation = 10 m

Terrain Category	Cell Radius (km)	Mean Excess Loss (dB)	Fade Margin (dB)	Link Availability (%)				
				K=5 dB	K=8 dB	K=10 dB	K=12 dB	K=15 dB
A	2.0	28.4	8.2	-----------	-----------	99.4	99.94	99.9998
	2.7	32	2.4	-----------	-----------	-----------	-----------	99.997
B	2.0	22.9	13.9	98.2	99.6	99.98	99.999	99.9998
	2.7	26	8.4	-----------	-----------	99.4	99.96	99.999
C	2.0	11.5	25.2	99.88	99.99	99.999	99.9998	-----------
	2.7	14.3	19.8	99.6	99.96	99.998	99.9998	-----------

Table 11b: Link Availability for a Type A System with MEL and Rician Fading
TS Antenna Elevation = 15 m

Terrain Category	Cell Radius (km)	Mean Excess Loss (dB)	Fade Margin (dB)	Link Availability (%)				
				K=5 dB	K=8 dB	K=10 dB	K=12 dB	K=15 dB
A	2.0	27	9.8	-----------	98.8	99.82	99.99	99.9998
	2.7	30.7	3.5	-----------	-----------	-----------	-----------	99.2
B	2.0	21.6	15.3	98.8	99.86	99.99	99.9998	-----------
	2.7	24.6	9.6	-----------	98.8	99.8	99.98	99.9998
C	2.0	9	27.6	99.92	99.994	99.9998	-----------	-----------
	2.7	11.7	22.4	99.6	99.98	99.999	99.9998	-----------

Table 11c: Link Availability for a Type A System with MEL and Rician Fading
TS Antenna Elevation = 20 m

Terrain Category	Cell Radius (km)	Mean Excess Loss (dB)	Fade Margin (dB)	Link Availability (%)				
				K=5 dB	K=8 dB	K=10 dB	K=12 dB	K=15 dB
A	2.0	30.3	-1.7	-----------	-----------	-----------	-----------	-----------
	2.7	33.9	-7.7	-----------	-----------	-----------	-----------	-----------
B	2.0	24.8	3.9	-----------	-----------	-----------	-----------	99.6
	2.7	27.9	-1.7	-----------	-----------	-----------	-----------	-----------
C	2.0	15	13.6	98.0	99.6	99.96	99.999	99.9998
	2.7	17.8	8.4	-----------	-----------	99.4	99.96	99.9993

Table 11d: Link Availability for a Type B System with MEL and Rician Fading
TS Antenna Elevation = 10 m

Terrain Category	Cell Radius (km)	Mean Excess Loss (dB)	Fade Margin (dB)	Link Availability (%)				
				K=5 dB	K=8 dB	K=10 dB	K=12 dB	K=15 dB
A	2.0	28.4	0.2	-----------	-----------	-----------	-----------	-----------
	2.7	32	-5.6	-----------	-----------	-----------	-----------	-----------
B	2.0	22.9	5.6	-----------	-----------	-----------	99.2	99.986
	2.7	26	-0.2	-----------	-----------	-----------	-----------	-----------
C	2.0	11.5	17	99.2	99.92	99.994	99.9998	-----------
	2.7	14.3	11.8	----------	99.4	99.94	99.998	99.9998

Table 11e: Link Availability for a Type B System with MEL and Rician Fading
TS Antenna Elevation = 15 m

Terrain Category	Cell Radius (km)	Mean Excess Loss (dB)	Fade Margin (dB)	Link Availability (%)				
				K=5 dB	K=8 dB	K=10 dB	K=12 dB	K=15 dB
A	2.0	27	1.8	-----------	-----------	-----------	-----------	-----------
	2.7	30.7	-4.5	-----------	-----------	-----------	-----------	-----------
B	2.0	21.6	7.3	-----------	-----------	99.0	99.88	99.999
	2.7	24.6	1.6	-----------	-----------	-----------	-----------	-----------
C	2.0	9	19.6	99.4	99.96	99.998	99.9998	-----------
	2.7	11.7	14.4	98.4	99.82	99.986	99.9989	99.9997

Table 11f: Link Availability for a Type B System with MEL and Rician Fading
TS Antenna Elevation = 20 m

APPENDIX A TO ANNEX 1: COVERAGE AREA AVAILABILITY FOR THE IEEE 802.16 SUI CHANNEL MODELS USING MONTE CARLO SIMULATION TECHNIQUES

A.a) Simulation Model

The simulation model is illustrated on Figure 22. The cell is subdivided into segments whose angular width is θ . Within each segment, angular arcs are positioned at R_j multiples of 0.1 R_{max} where R_{max} is the radius of the cell. There are thus 10 arcs within each segment. Hence, there are 10 bounded sub-area limits within each segment. The area limits of each may be readily computed.

TS are assumed to be centrally positioned within each sub-area. For each TS, the transmission distance is computed. The impairments relative to LOS are then added. These include Mean Excess Loss (MEL), the random variations to MEL due to log-normal shadowing and the impact of Rician fading.

For a given simulation, MEL and Rician K are set to the values specified for the SUI channel models. A standard deviation of σ = 9 dB is set for log-normal shadowing. This is a mid-range value of the range set for the SUI models. A random deviate procedure is employed to create shadow loss and Rician K signal variations. For MEL estimates, the CS antenna elevation was set to 30 m and the TS antenna elevation and gain set to the indicated values.

Setting θ = 1 degree results in 3600 estimates of signal level. When the signal level of an estimate is found to be less than the specified performance threshold, the sub-area associated with the estimate is accumulated in an "excluded area" running total. At the completion of a simulation, the ratio of the running total to the cell area defines the % of the cell that cannot meet coverage requirements for 99.999% availability.

The TS antenna RPEs are those derived from ITU-R F.1336 (see Figure 1), while antenna gain is kept fixed at 16 dBi as for general system assumptions in **Table 1**.

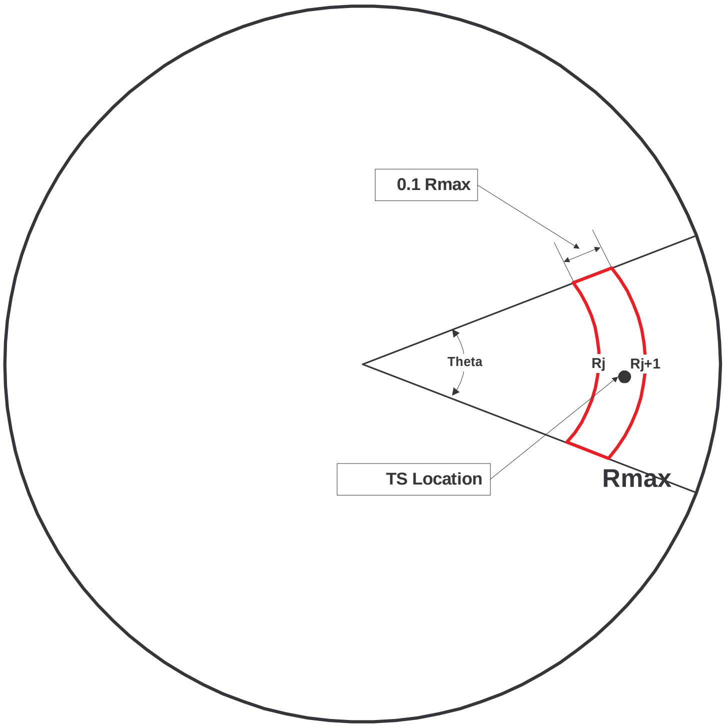

Figure 22: Simulation Model

A.b) Mean Excess Loss (MEL) only

When only MEL was considered, there were no exposures found that exceeded the performance threshold of Type A Systems. Table 12 and Table 13 illustrate the simulation results for covered areas of Type B systems. Log-normal shadowing and Rician fading are excluded.

SUI Terrain Category	Excluded Area (%)		
	TS antenna class TS 2 *(ITU-R RPE G=+16 dBi)*	**TS2/TS3 intermediate RPE** *(ITU-R RPE G= +18 dBi)*	**TS antenna class TS 3** *(ITU-R RPE with G= +20 dBi)*
A	18.8	0	0
B	0	0	0
C	0	0	0

Table 12: Type B System MEL Excluded Area for R_{max}= 2.0 km, TS Antenna Elevation = 10 m

TS Antenna Elevation (m)	SUI Terrain Category	Excluded Area (%)		
		TS antenna class TS 2 *(ITU-R RPE G=16 dBi)*	**TS2/TS3 intermediate** *(ITU-R RPE G= +18 dBi)*	**TS antenna class TS 3** *(ITU-R RPE with G=20 dBi)*
10	**A**	51	37.3	35.5
	B	19	0	0
	C	0	0	0
15	**A**	39.6	36	19
	B	0	0	0
	C	0	0	0
20	**A**	36	19	0
	B	0	0	0
	C	0	0	0

Table 13: Type B System MEL Excluded Area for R_{max} = 2.7 km

A.c) Mean Excess Loss and Log-Normal Shadowing

Table 14 through Table 17 show the results of the simulations when both MEL and log-normal shadowing are considered. As previously noted, the standard deviation for the log-normal fading was set to σ = 9 dB.

With the inclusion of log-normal shadowing, it is apparent that even a Type A system will begin to experience coverage problems. This is constrained to Terrain Category A and R_{max} = 2.7 km.

Due to reduced threshold, coverage issues for Type B systems are significantly increased. Referenced to Table 16 and Table 17, both 2.0 km and 2.7 km cell radius designs exceed coverage objectives in Terrain Categories A and B.

TS Antenna Elevation (m)	SUI Terrain Category	Excluded Area (%)		
		TS antenna class TS 2 ***(ITU-R RPE G=16 dBi)***	**TS2/TS3 intermediate** ***(ITU-R RPE G= +18 dBi)***	**TS antenna class TS 3** ***(ITU-R RPE with G=20 dBi)***
10	**A**	**8.9**	**5.7**	**2.8**
	B	**2.8**	**1.9**	**1.2**
	C	**0.2**	**0**	**0**
15	**A**	**5.9**	**3.9**	**1.5**
	B	**1.9**	**1.1**	**0.45**
	C	**0**	**0**	**0**
20	**A**	**4.1**	**2.6**	**1.5**
	B	**1.6**	**0.6**	**0**
	C	**0**	**0**	**0**

Table 14: Type A System Excluded Area Due to MEL and Log-Normal Shadowing (R_{max} = 2.0 km)

TS Antenna Elevation (m)	SUI Terrain Category	Excluded Area (%)		
		TS antenna class TS 2 *(ITU-R RPE G=16 dBi)*	**TS2/TS3 intermediate** *(ITU-R RPE G= +18 dBi)*	**TS antenna class TS 3** *(ITU-R RPE with G=20 dBi)*
10	**A**	22.0	16.8	13.4
	B	8.7	6.3	4.3
	C	0.7	0.5	0
15	**A**	17.2	11.85	9.4
	B	6.9	4.0	3.5
	C	0	0.36	0
20	**A**	12.8	8.1	6.2
	B	5.5	2.9	2.3
	C	0	0	0

Table 15: Type A System Excluded Area Due to MEL and Log-Normal Shadowing (R_{max} = 2.7 km)

TS Antenna Elevation – m	SUI Terrain Category	Excluded Area (%)		
		TS antenna class TS 2 *(ITU-R RPE G=16 dBi)*	**TS2/TS3 intermediate** *(ITU-R RPE G= +18 dBi)*	**TS antenna class TS 3** *(ITU-R RPE with G=20 dBi)*
10	**A**	26.8	20.1	16.8
	B	12.8	9.7	6.2
	C	1.9	1.4	1.0
15	**A**	20.3	16.0	11.9
	B	9.0	6.9	4.2
	C	0.8	0.46	0
20	**A**	17.3	13.1	9.3
	B	7.6	5.0	4.2
	C	0.5	0	0

Table 16: Type B System Excluded Area Due to MEL and Log-Normal Shadowing (R_{max} = 2.0 km)

TS Antenna Elevation (m)	SUI Terrain Category	Excluded Area (%)		
		TS antenna class TS 2 *(ITU-R RPE G=16 dBi)*	**TS2/TS3 intermediate RPE** *(ITU-R RPE G= +18 dBi)*	**TS antenna class TS 3** *(ITU-R RPE with G=20 dBi)*
10	**A**	44.6	39.9	33.4
	B	29	23.0	19.0
	C	5.9	4.0	3.2
15	**A**	39.2	33.6	26.4
	B	21.7	17.5	13.3
	C	3.1	1.8	1.2
20	**A**	35.4	29.2	23.3
	B	18.8	13.0	9.4
	C	1.8	0.6	0.6

Table 17: Type B System Excluded Area Due to MEL and Log-Normal Shadowing (R_{max} = 2.7 km)

A.d) Mean Excess, Log-Normal Shadowing and Rician Fading

Generally speaking, it is not appropriate to inter-relate space and time availability. However, in the NLOS transmission environment, Rician fading is constantly present. In the event that there is no motion associated with the reflective facets, it simply means that we are in a fixed up or down fade, subject to the vector addition of all of the signal components.

In order to examine the significance of Rician fading, its impact was examined for each of the SUI channel models by running 10 simulations for each channel model. The range of variation in the excluded area was noted and these are presented in Table 18 and Table 19 for R_{max} = 2 km. Table 20 and Table 21 examine the same scenarios for R_{max} = 2.7 km.

SUI Channel Model	Terrain Category	Rice K (dB)	Excluded Area Spread (%)
SUI-1	**C**	12	0.0 - 0.15
SUI-2	**C**	8	0.0 - 0.1
SUI-3	**B**	5	1.7 - 2.8
SUI-4	**B**	0	3.1 -4.2
SUI-5/6	**A**	0	6.9 - 8.5

Table 18: Impact of Rician Fading on Type A Systems (R_{max} = 2 km)

SUI Channel Model	Terrain Category	Rice K (dB)	Excluded Area Spread (%)
SUI-1	**C**	12	0.32 - 0.78
SUI-2	**C**	8	0.39 - 0.79
SUI-3	**B**	5	8.5 -9.8
SUI-4	**B**	0	11.0 - 12.4
SUI-5/6	**A**	0	20.6 - 22.9

Table 19: Impact of Rician Fading on Type B Systems (R_{max} = 2 km)

SUI Channel Model	Terrain Category	Rice K – (dB)	Excluded Area Spread (%)
SUI-1	**C**	12	0.04 - 0.36
SUI-2	**C**	8	0.16 - 0.46
SUI-3	**B**	5	5.4 - 6.7
SUI-4	**B**	0	7.2 - 9.2
SUI-5/6	**A**	0	16.6 - 20.1

Table 20: Impact of Rician Fading on Type A Systems (R_{max} = 2.7 km)

SUI Channel Model	Terrain Category	Rice K - dB	Excluded Area Spread (%)
SUI-1	**C**	12	1.9 - 2.8
SUI-2	**C**	8	2.0 - 3.2
SUI-3	**B**	5	20 -22.1
SUI-4	**B**	0	22.8 -25.2
SUI-5/6	**A**	0	38.0 -40.9

Table 21: Impact of Rician Fading on Type B Systems (R_{max} = 2.7 km)

A.e) Sensitivity Analysis for Mean Excess Loss and Log-Normal Shadowing

For the SUI Channel models, the measured data [6] identified a standard deviation for log-normal shadowing between 8.2 dB and 10.6 dB. In the preceding, a mid-range value of 9 dB was employed. Standard deviations of 5.2 dB and 6.6 dB have been considered in the current SE19 report. Table 22 identifies the simulation results when these standard deviation values are employed. Rician fading is excluded. The simulation results apply only to a Type B system and R_{max} = 2.7 km. They can be compared against the appropriate columns of Table 16 and Table 17

SUI Terrain Cat.	Excluded Area (%)			
	R_{max} = 2.0 km		R_{max} = 2.7 km	
	σ = 5.2 dB	σ = 6.6 dB	σ = 5.2 dB	σ = 6.6 dB
A	8.76	11.9	29.2	30.75
B	0.71	2.8	9.5	12.0
C	0	0.5	0.1	0.46

Table 22: Excluded Area vs. Log-Normal σ for Type B systems and R_{max} = 2.7 km

A.f) Simulation Caveat

Sections A.d) and A.e) do not cover all of the combinations as Sections A.b) and A.c): they are just “mid-range” values illustrative sensitivity analysis examples, with TS antenna height = 15 m and TS antenna gain = +18 dBi).

A close examination of the Tables might imply that there are some inconsistencies in the Table entries. However, this is not the case. For example, examine Table 13 and Table 17 for Terrain Type A and R_{max} =2.7 km. It may be noted that the Excluded Area is less when the MEL plus log-normal shadowing loss is considered compared to that just resulting from MEL. However, this is a quite possible result of simulation. The shadowing loss exhibits a random +/- variation about the mean value that can enhance the signal level of some links. The same may be said about Rician fading for which both up and down fades can occur.

ANNEX 2: TS TO CS INTERFERENCE EVALUATION

A2.1 Rural scenario

A2.1.1 System Model and Simulation Methodology

In subsequent sections, estimates of interference susceptibility are based on Monte Carlo simulations that identify the spatial probability of a victim link experiencing an excessive level of interference. Graphically, the simulation results are presented as an interference grade of service (GOS) probability shown as a Cumulative Distribution Function (CDF) vs. C/I.

The TS to CS system model is illustrated on Figure 23. It is computationally convenient to consider the overlaid sector/cell as being the victim. This is parametrised at some separation distance S between the two CS sites. Within the victim sector, all TS locations are assumed to employ distance proportional ATPC. Thus, all received signal levels from victim TS links are assumed to arrive at the victim CS at the same level of signal strength. Thus, it is only necessary to set a victim TS to CS signal level based on that of a single cell-edge victim link located at distance R_{max}.

Even for the rural environment, the link margin is modest; thus no cell edge ATPC is assumed. It is important to note that there is no valid technical reason to apply cell edge ATPC except for interference exposures associated with TS to TS couplings. These are considered to be quite rare. Maximising cell edge signal level reduces the sensitivity of CS to CS couplings (not examined in this report).

The number of randomly located interference TS locations within a sector is set to N_t. = 64. There is no statistical measurement data available to identify how these TS locations should be located. Two extreme possibilities can be considered. The first assumption might be to assume that the TS locations are randomly distance-proportionally located referenced to the maximum cell radius R_{max}. The second assumption is to assume that the TS locations are randomly area-proportionally located. In this latter case, approximately 50 % of TS locations would be expected to be located at greater than $0.75R_{max}$. Only the area proportional assumption will be subsequently examined.

To account for the assumption that there is no operator co-ordination, the relative boresight alignment of the two CS antennas is considered to be unknown. A simulation run is configured to spin the relative sector alignment in 5 degree increments. A complete simulation run thus consists of $360/5*N_t$ interference estimates (N_t = 64, resulting in 4608 interference estimates).

In the rural environment, only LOS transmission is considered. Thus, the only fading mechanism considered to be applicable is that of atmospheric Rayleigh multipath. Generally speaking, it is not statistically appropriate to mix spatial link availability with time varying availability. However, we will examine this situation, with the caveat that <u>it only applies during the time intervals when Rayleigh fading occurs</u>.

Due to the distance differentials associated with the victim and interference paths, uncorrelated Rayleigh fading is ensured. To account for Rayleigh fading, it is necessary to generate random Rayleigh deviates that are created from the uniform random deviates available with computational machine programs. The procedure is based on the Acceptance-Rejection method as detailed in [3] and is summarised in Appendix A to Annex 2.

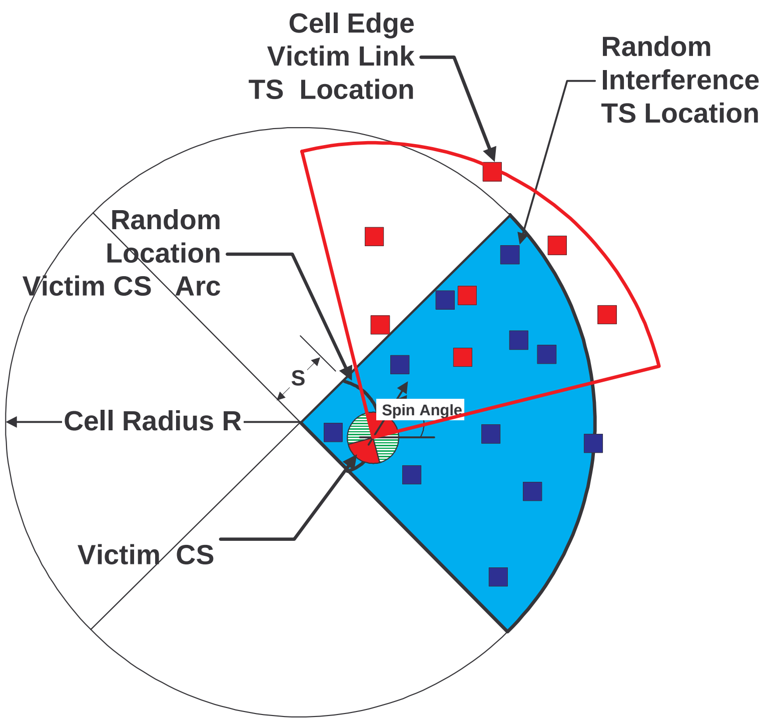

Figure 23: Simulation Model

The inclusion of Rayleigh fading adds considerable complexity to the simulation model. It is best described by reference to Figure 24. It is no longer valid to assign the victim TS to be at distance R_{max}. Only one victim TS is active during a given TDMA time block. As the magnitude of Rayleigh fading is distance related, we should now place the victim TS at some random distance R_v from it's serving CS. To establish link loss, we must now do the following:

- Compute FSL based on the distance R_v.
- Adjust the FSL signal level PT_v so that it is reduced to be ATPC distance proportional, i.e., by $20\log(R_v/R_{max})$.
- Determine the Rayleigh fading adjustment as discussed above. Modify the value of PT_v accordingly.
- Adjust the victim TX signal level via ATPC so that it adjusts to the FSL margin level set at R_{max}. If the Rayleigh fade impairment exceeds this adjustment, then set the victim TX power to be at its maximum level.

This sets the TX power level of the victim link transmitter. However, we now have to examine the TX power of the interference link. Given that we have a local meteorological environment that induces Rayleigh fading on the victim link, it is quite valid to assume that the same conditions apply to the interference link. But we now have two transmission paths to consider. Referenced to Figure 24, the first of these is the link between the interference TS and it's serving CS. For any one of the N_t interference TS's, located at some random distance R0, the uncorrelated Rayleigh fading signal level adjustment is described as above. This fixes the TX power level PT_i of any single interference link.

However, the interference coupling path is a different uncorrelated Rayleigh path at a distance R_i. Employing the same methodology as previously described, a new Rayleigh fading adjustment is determined for this path. Given that both the uncorrelated Rayleigh faded victim signal level (C) and the interference signal (I) can now be computed, the C/I of each interference estimate can be determined.

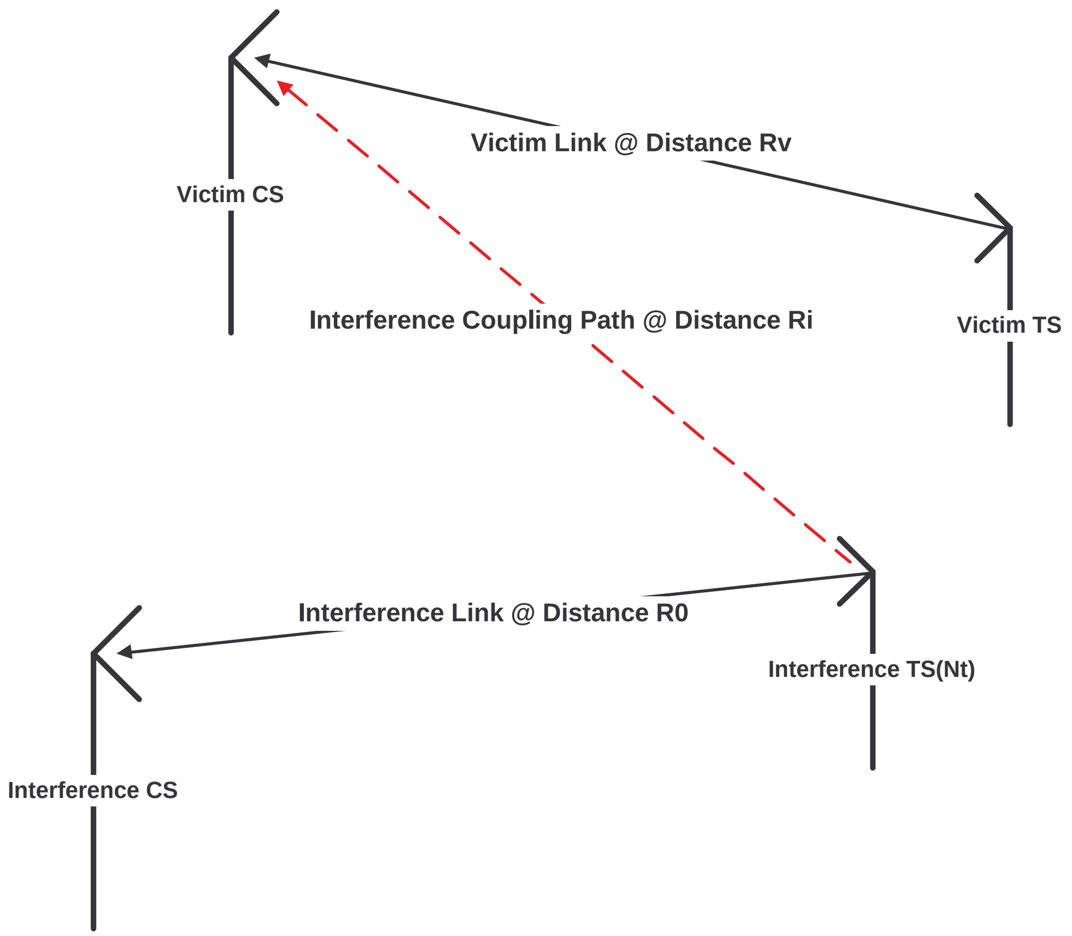

Figure 24: Rayleigh Faded Interference Model

A2.1.2 Unfaded Simulation Results

For a cell size of Rmax = 8.9 km, Figure 25 trough Figure 28 illustrate the Monte Carlo simulation results (unfaded) with antenna classes TS2 to TS3 (i.e. with typical RPE derived from ITU-R F.1336 TS antenna using Gain = 16, 18 and 20 dBi).

In each figure a value of NFD has been selected, identifying the minimum NFD requirement to “hit” the ~ 1% CDF at the C/I critical threshold for the system types reported in Table 1.

Figure 25 applies to S being between 3 to 6 km while Figure 26 applies to a CS separation distance S from 0.1 to 2 km. A comparative examination of Figure 25 and Figure 26 indicates that the poorest CDF results occur when S is large. These differences can be explained as follows:

- When S is small, and both the interference and victim CS antennas are partially aligned, a high percentage of the interference TS links are illuminated by the victim CS antenna. Also, when S is small, FSL is comparable on both links and TS Antenna RPE is modest. With ATPC, both interference and victim link signals would be expected to arrive at the victim CS at comparable levels. Hence, the major difference in signal level is that of NFD and, as shown on Figure 26, there is a resultant sharp "knee" in the C/I in the vicinity of the NFD value.
- As S increases, conflicting geometrical results occur. Some interference TS locations are essentially eliminated as they are behind the victim CS antenna. As well, as interference TS distance from victim CS decreases, angles increase, and the RPE rejection of the interference TS increases, thus further reducing the number of serious interference exposures. Countering this, is relative distance proportional ATPC. It now becomes modest on the interference links, thus setting up an increase in signal level differentials. The C/I "knee" is thus diminished while the percentage of C/I exposures above the knee is reduced. However the level, and percentage of worst case C/I exposures, will increase, as shown on Figure 25.

Hence in the subsequent simulations (Figure 27 and Figure 28), we will only present the S > 3 km case, which controls the NFD requirement.

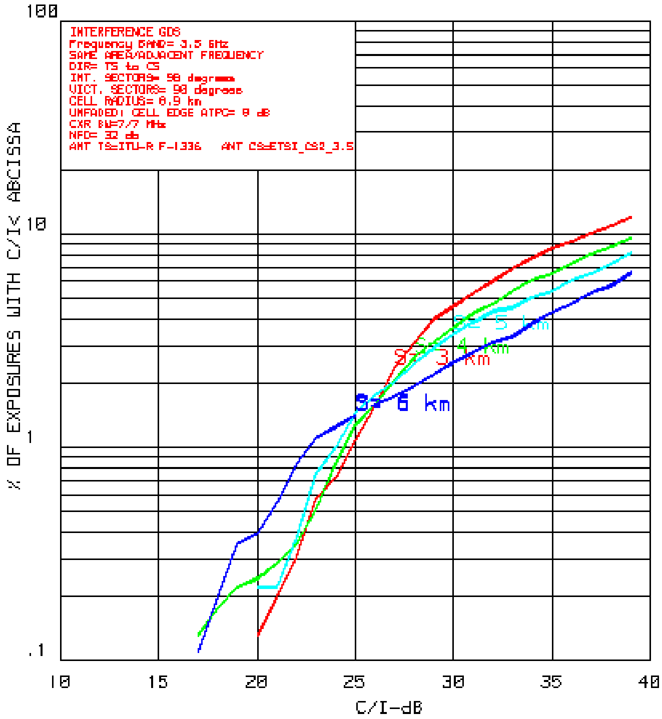

Figure 25 . Unfaded CDF (S > 3 km, NFD = 32 dB)
(TS 2 antenna class ***(ITU-R RPE G=16 dBi)*****)**

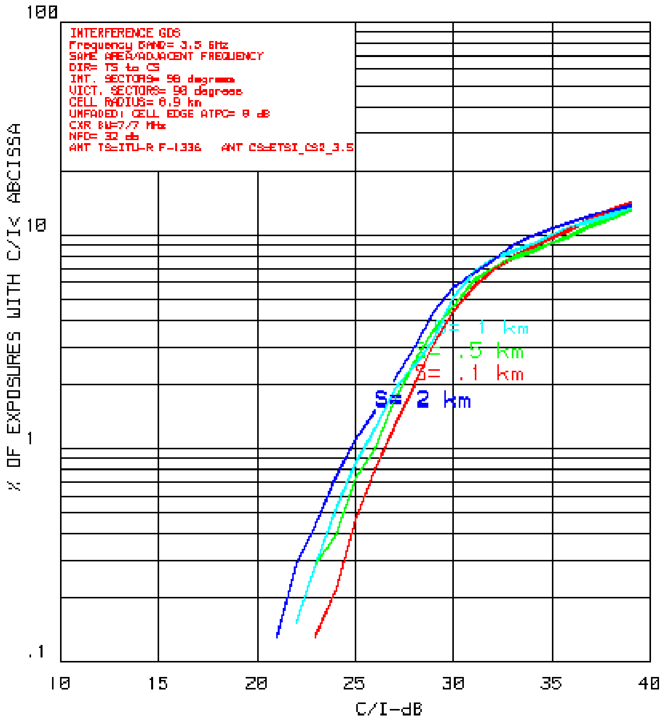

Figure 26: Unfaded CDF S < 2 km, NFD = 32 dB)
(TS 2 antenna class ***(ITU-R RPE G=16 dBi)*****)**

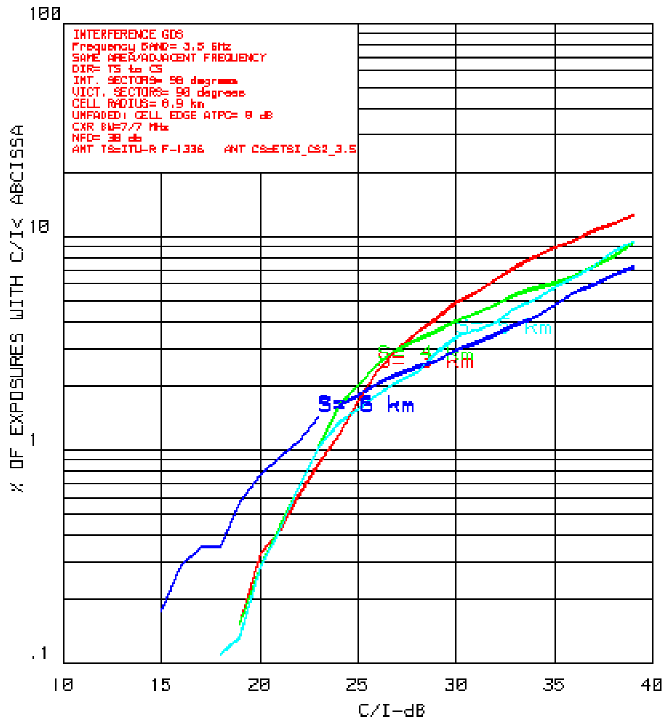

Figure 27: Unfaded CDF (S > 3 km, NFD = 30 dB)
(TS2/TS3 intermediate RPE *(ITU-R RPE G= +18 dBi)*)

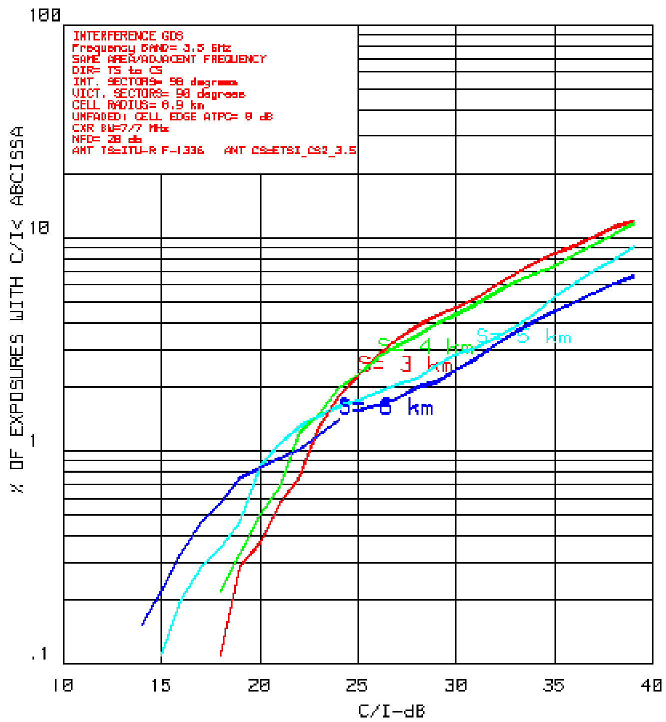

Figure 28: Unfaded CDF (S > 3 km, NFD = 28 dB)
(TS 3 antenna class *(ITU-R RPE G=20 dBi)*)

A2.1.3 Rayleigh Faded Simulation Results

Figure 29through Figure 32 illustrate the results for the case where the Rayleigh fading distance probability coefficient d_{coeff} is set to 3.. As compared to the unfaded case, the CDF impairments resulting from uncorrelated Rayleigh fading are quite modest.

To explain this somewhat surprising result, we first note that the median level p.d.f. crossover for Rayleigh occurs at 63%. But this also means that 37% of the links will be in excess of the median level. For the interference links, these TS transmitters are ATPC adjusted to be lower in power. They thus transmit at a lower power than in the unfaded coexistence scenario.

For the victim links, a statistical examination of the ATPC adjusted signal level was performed. Here, it was found that 24% of the victim links were required to operate at maximum power. For the remainder, the distance proportional ATPC range was sufficient to restore the signal level to its unfaded margin level. However, 50% of these maximum power links were within 3 dB of the unfaded signal margin. Thus, a high percentage of victim links arrive at close to the same signal level as that for the unfaded scenario.

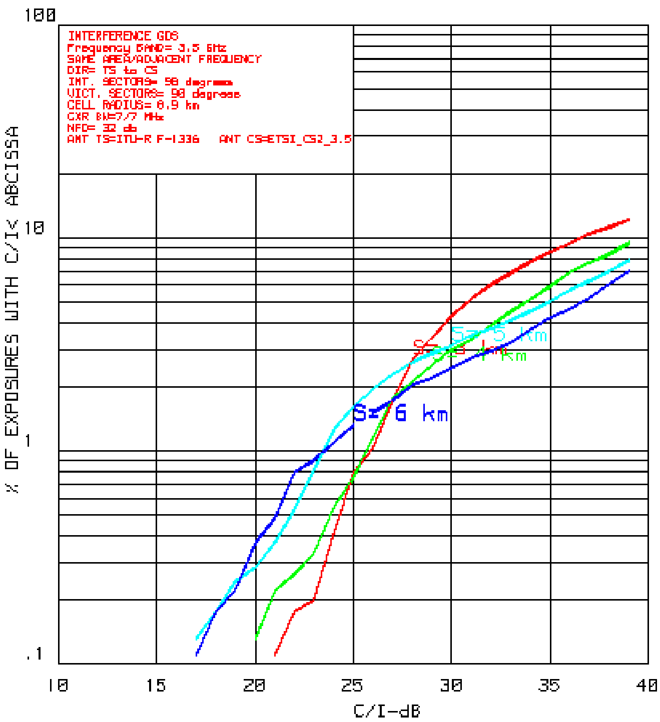

Figure 29: Rayleigh Faded CDF (S > 3 km, NFD = 32 dB)
(TS 2 antenna class *(ITU-R RPE G=16 dBi)*)

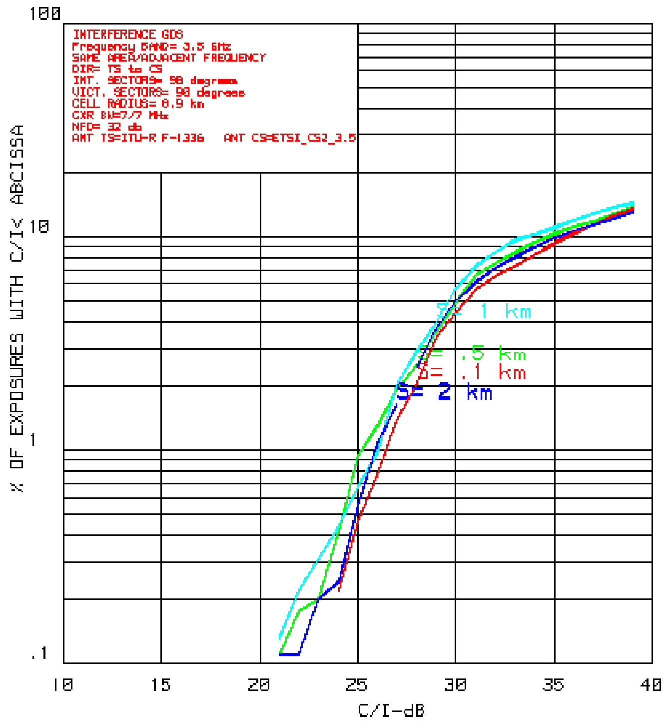

Figure 30: Rayleigh Faded CDF (S < 2 km, NFD = 32 dB)
(TS 2 antenna class *(ITU-R RPE G=16 dBi)*)

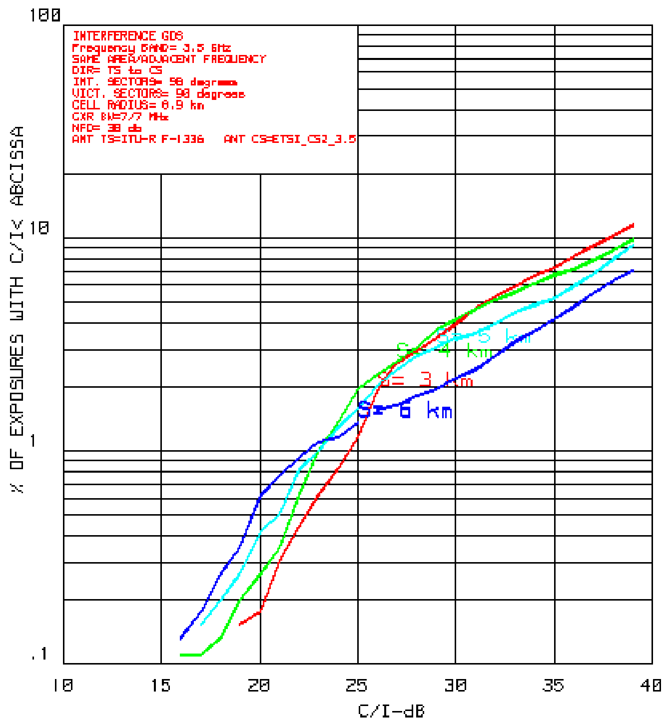

Figure 31: Rayleigh Faded CDF (S > 3 km, NFD = 30 dB)
(TS2/TS3 intermediate RPE *(ITU-R RPE G= +18 dBi)*)

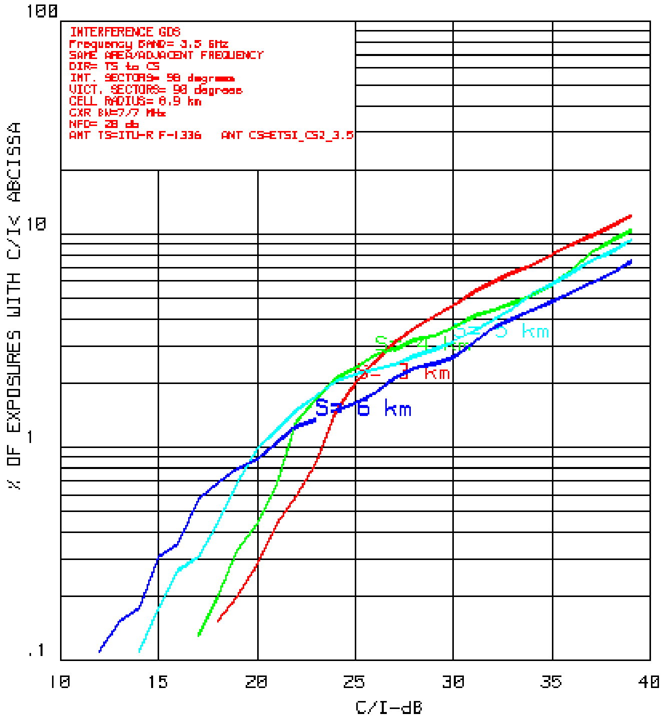

Figure 32: Rayleigh Faded CDF (S > 3 km, NFD = 28 dB)
(TS 3 antenna class *(ITU-R RPE G=20 dBi)*)

A2.1.4 Conclusions

It is concluded that the NFD values summarised in the following Table 23 are acceptable values for the TS emissions associated with TS to CS interference couplings in the rural scenario.

TS antenna class	**TS antenna class TS 2** *(ITU-R RPE G=16 dBi)*	**TS2/TS3 intermediate RPE** *(ITU-R RPE G= +18 dBi)*	**TS antenna class TS 3** *(ITU-R RPE with G=20 dBi)*
Minimum NFD required for Type B System (dB)	32	30	28

Table 23: Minimum NFD required for Type B Systems Rural scenario

A2.2 Urban Scenario

A2.2.1 Simulation Methodology

The simulation model is comparable to that described in section A2.1 and Figure 24 for the rural scenario. Again, there are three transmission paths to consider. These are the victim link at distance R_v, the interference link at distance R_0 and the interference-coupling path at distance R_i. For each interference computation it is necessary to set the TX power of the TS for the first two links. The procedure is as follows:

- Compute FSL based on the distance R_x equal to R_v or R_0.
- Adjust the FSL signal level so that it is reduced to be distance proportional, i.e., $20\log(R_x/R_{max})$.
- Compute the mean excess path loss based on the distance R_x.
- Compute the mean value of Rician K based on distance R_x and relative to the SUI value for K, as specified for the cell edge at R_{max}.
- Determine the Rician fading adjustment by the random deviate method.
- Adjust the RX signal level to account for both mean excess loss and Rician fading.
- Readjust the TX signal levels via ATPC so that some signal margin above the threshold level is restored. This would typically be somewhere between 6 dB and 15 dB. As subsequently discussed, the simulations found some degree of C/I performance sensitivity referenced to the margin value selected.
- Set the TS - TX Power level accordingly. If the ATPC range is insufficient to achieve the specified margin, then set the TX power to P_{max}.

The TX power of both the interference and victim links is now set. The signal level of the interference-coupling path at distance R_i is now determined based on the procedure for computation of excess loss and Rician fading described. The C/I for each interference estimate can now be determined.

A2.2.2 Simulation Results

A2.2.2.1 Unfaded

Figure 33 through Figure 44 in this section illustrate the CDF vs. C/I results for:

- Rice factor K = 30 dB. For this K value, the probability of a deep fade is extremely low. Hence, this is essentially the case without fading.
- R_{max} = 2.7 km. and R_{max} = 2.0 km
- Different TS antenna heights (15 and 20 m)
- Different TS antenna classes TS2 to TS3 (i.e. with typical RPE derived from ITU-R F.1336 TS antenna using Gain = 16, 18 and 20 dBi, still with fixed 16 dBi boresight gain).

Each time, in the presented simulations the NFD used correspond to the minimum required to “hit” the ~ 1% of cases with C/I over the critical C/I threshold for the system type as reported in **Table 1**.

Performance degrades noticeably as CS separation distance S increases. This is a result of the excess loss differential and can be explained as follows:

- When S is small, a large number of interference and victim links are at a comparable distance from their serving CS sites. Consequently, excess loss is comparable on both interference and victim links.
- When S is large, there are fewer interference links that can illuminate the victim CS. But for those that do so, the interference distance is small; thus setting up an excess loss differential that strongly favours the interference link.

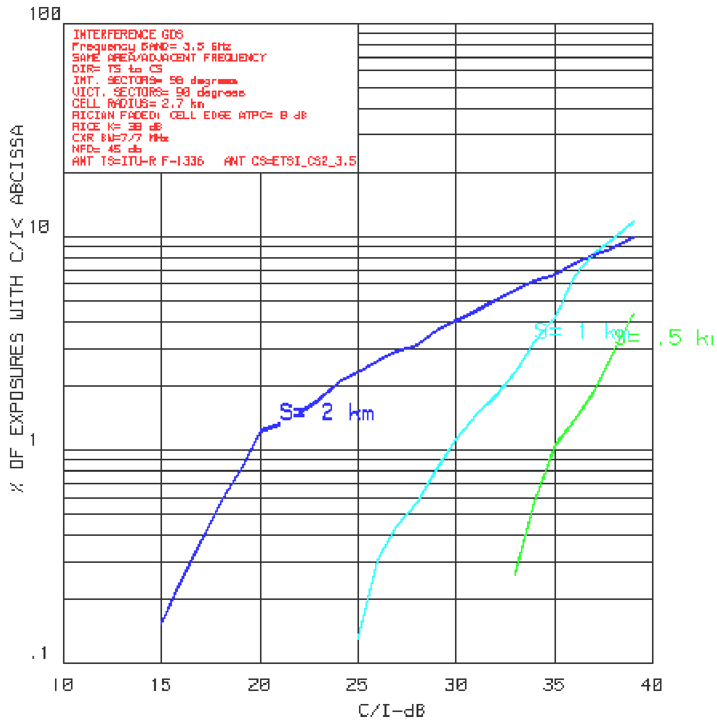

Figure 33: Mean Excess Loss-based CDF R_{max} = 2.7 km, TS Ant Elev = 15 m, NFD = 45 (TS 2 antenna class ***(ITU-R RPE G=16 dBi)*****)**

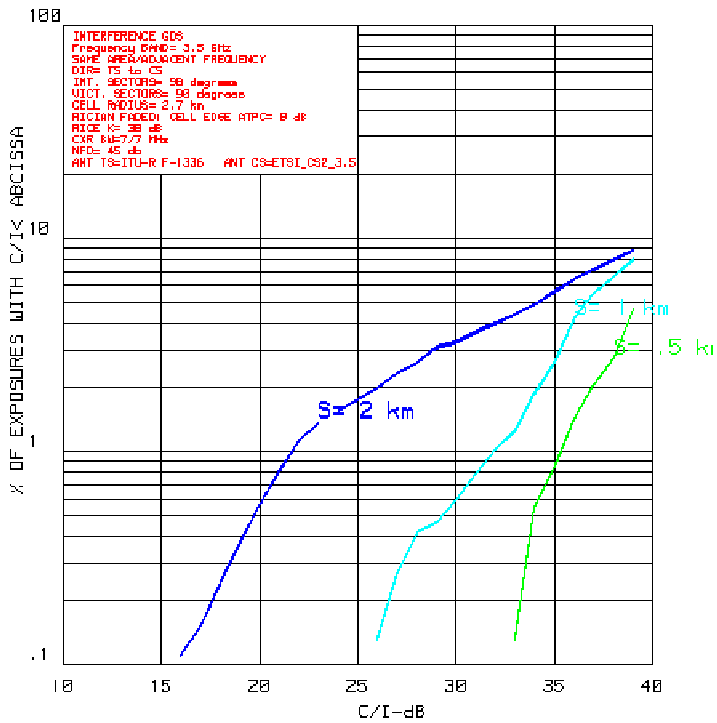

Figure 34: Mean Excess Loss-based CDF R_{max} = 2.7 km, TS Ant Elev = 15 m, NFD = 45 dB (TS2/TS3 intermediate RPE ***(ITU-R RPE G= +18 dBi)*****)**

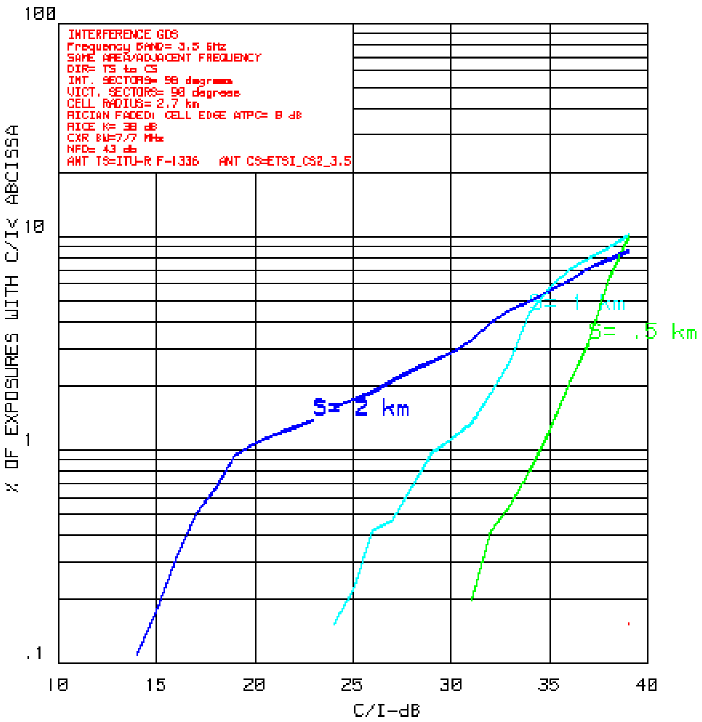

Figure 35: Mean Excess Loss-based CDF R_{max} = 2.7 km, TS Ant Elev = 15 m, NFD = 43 dB (TS 3 antenna class *(ITU-R RPE G=20 dBi)*)

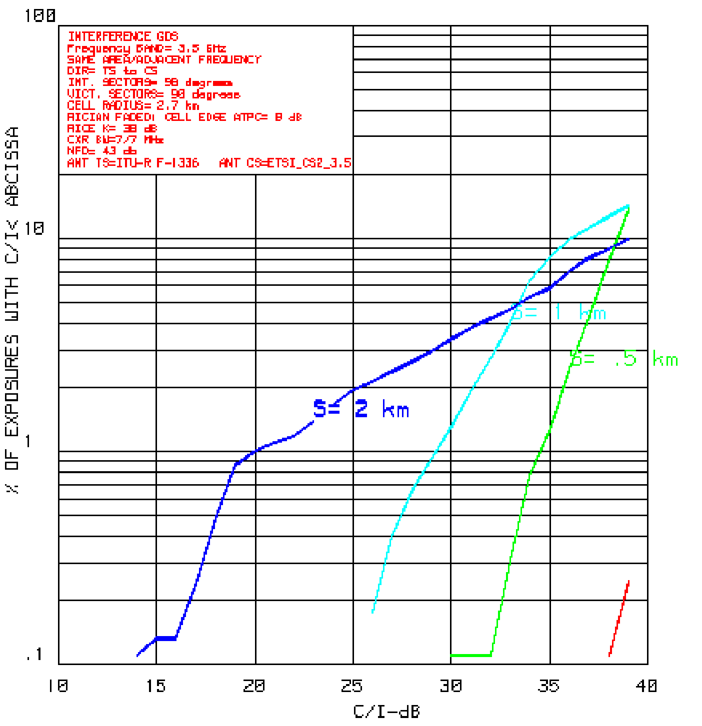

Figure 36: Mean Excess Loss based CDF R_{max} = 2.7 km, TS Ant Elev = 20 m, NFD = 43 dB (TS 2 antenna class *(ITU-R RPE G=16 dBi)*)

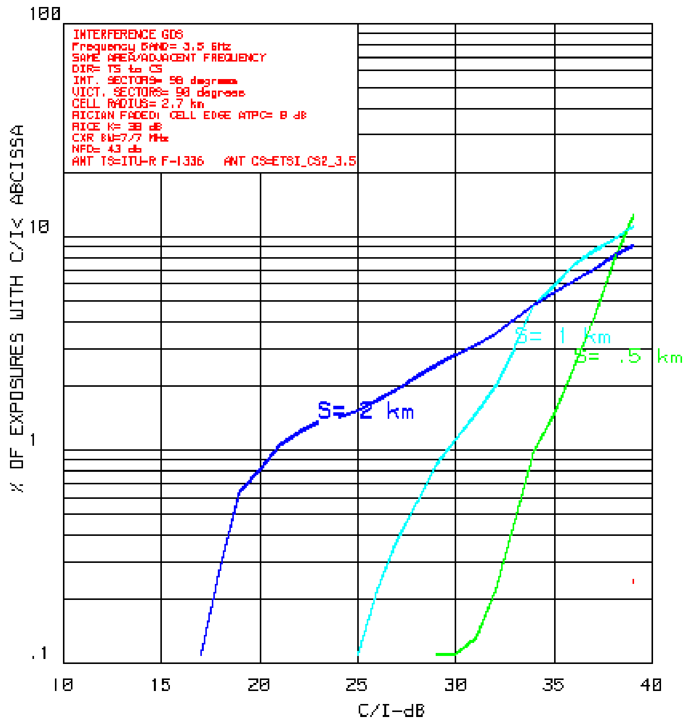

Figure 37: Mean Excess Loss based CDF R_{max} = 2.7 km, TS Ant Elev = 20 m, NFD = 43 dB (TS2/TS3 intermediate RPE *(ITU-R RPE G= +18 dBi)*)

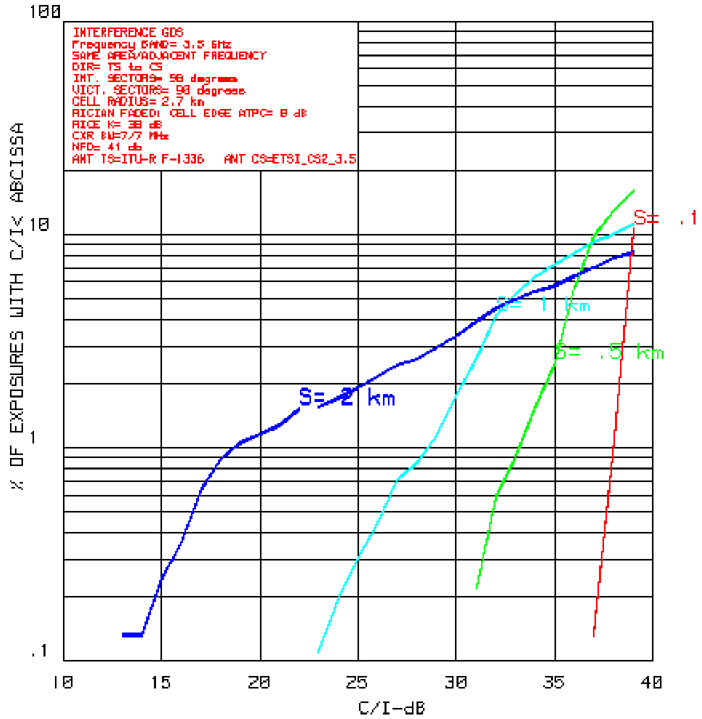

Figure 38: Mean Excess Loss based CDF R_{max} = 2.7 km, TS Ant Elev = 20 m, NFD = 41 dB (TS 3 antenna class *(ITU-R RPE G=20 dBi)*)

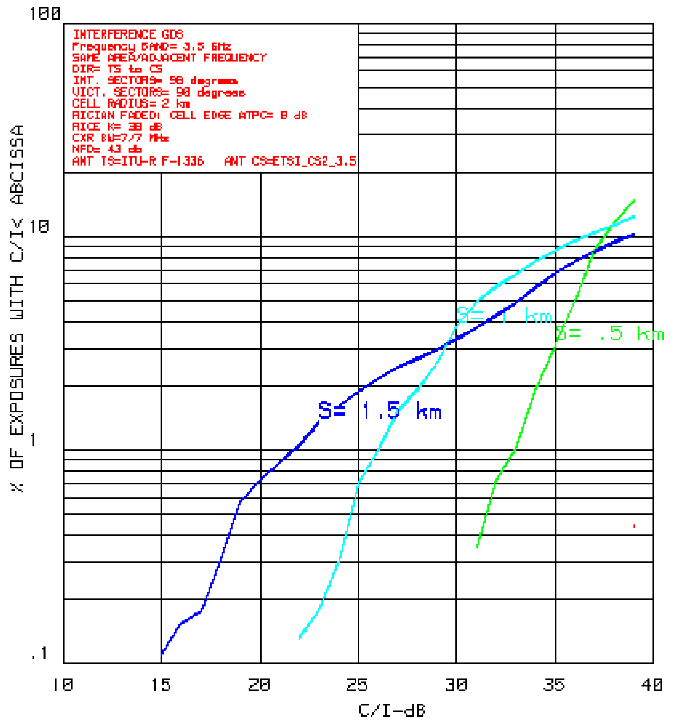

Figure 39: Mean Excess Loss based CDF R_{max} = 2.0 km, TS Ant Elev = 15 m, NFD = 43 dB (TS 2 antenna class *(ITU-R RPE G=16 dBi)*)

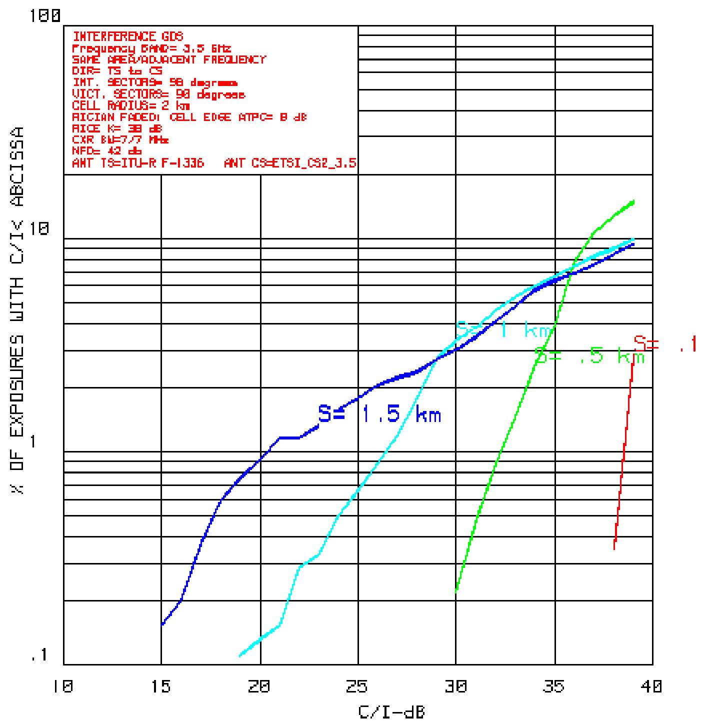

Figure 40: Mean Excess Loss based CDF R_{max} = 2.0 km, TS Ant Elev = 15 m, NFD = 42 dB (TS2/TS3 intermediate RPE *(ITU-R RPE G= +18 dBi)*)

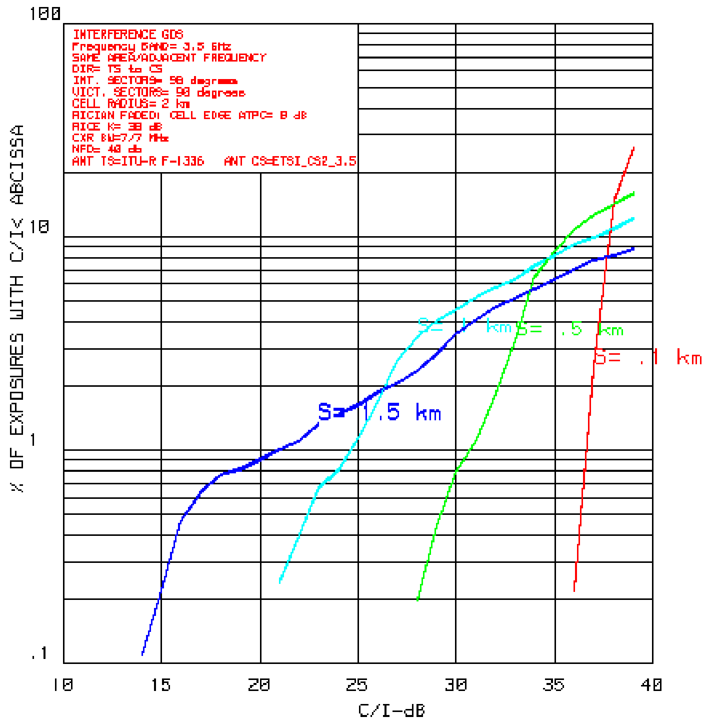

Figure 41: Mean Excess Loss based CDF R_{max} = 2.0 km, TS Ant Elev = 15 m, NFD = 40 dB (TS 3 antenna class *(ITU-R RPE G=20 dBi)*)

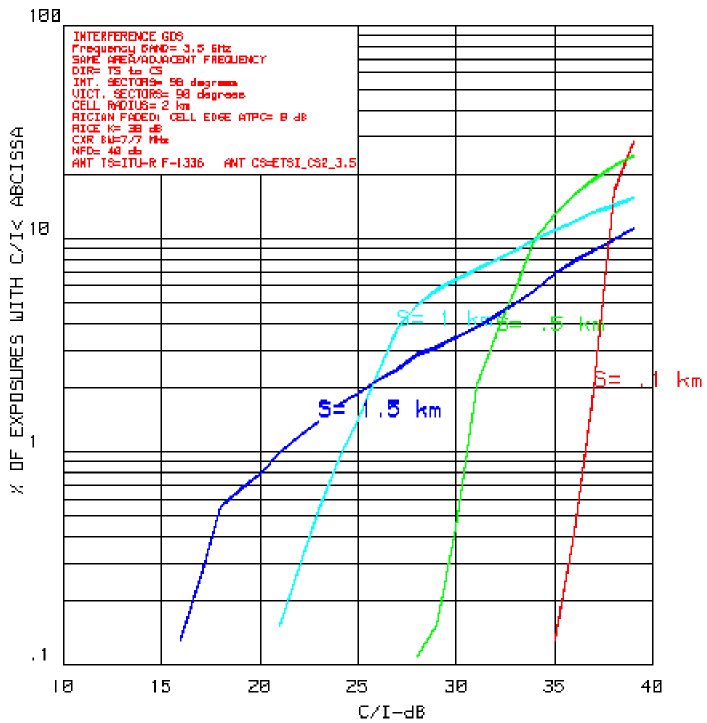

Figure 42: Mean Excess Loss based CDF R_{max} = 2.0 km, TS Ant Elev = 20 m, NFD = 40 dB (TS 2 antenna class *(ITU-R RPE G=16 dBi)*)

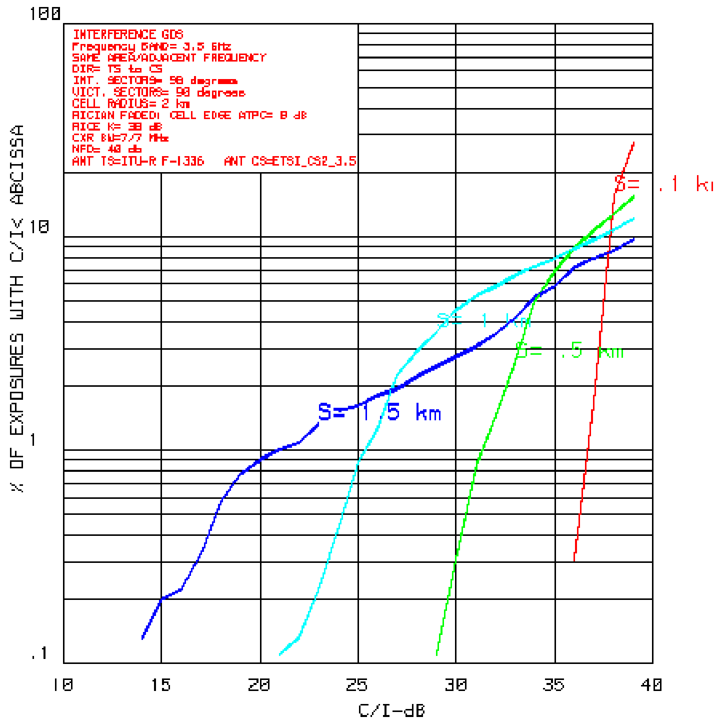

Figure 43: Mean Excess Loss based CDF R_{max} = 2.0 km, TS Ant Elev = 20 m, NFD = 40 dB (TS2/TS3 intermediate RPE *(ITU-R RPE G= +18 dBi)*)

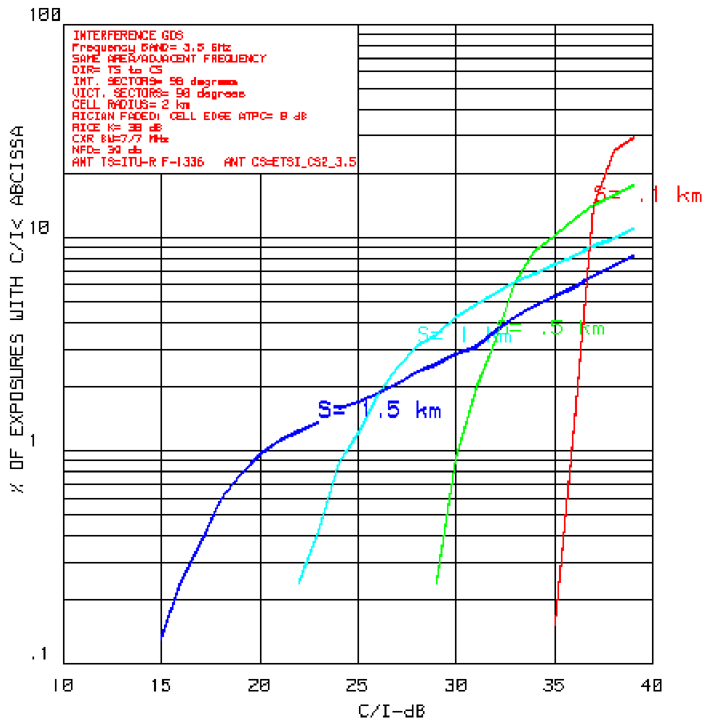

Figure 44: Mean Excess Loss based CDF R_{max} = 2.0 km, TS Ant Elev = 20 m, NFD = 39 dB (TS 3 antenna class *(ITU-R RPE G=20 dBi)*)

The following Table 24 summarizes, for the most critical system type B, the main findings, in terms of minimum required NFD value, for the various configurations in the urban scenario:

	TS Antenna Height (m) ⇩	TS Antenna class		
		TS antenna class TS 2 *(ITU-R RPE G=16 dBi)*	**TS2/TS3 intermediate RPE** *(ITU-R RPE G= +18 dBi)*	**TS antenna class TS 3** *(ITU-R RPE with G=20 dBi)*
		Minimum NFD value required (dB) ⇩		
System Type B (Cell size 2.7 km)	**15**	45	45	43
	20	43	43	41
System Type B (Cell size 2.0 km)	**15**	43	42	40
	20	40	40	39

Table 24: Minimum NFD required for Type B Systems Urban scenario

In case of 4-QAM system (system type A), there is an 8 dB increase in system gain. Thus, the critical receiver levels drop to 14.2 dB and 20.2 dB and the CDFs values improve.

A2.2.2.2 Rician Faded

If we run simulations for the SUI-1 channel model with cell edge Rice K = 12 dB, with cell radius R_{max} = 2.7 km, except for differences in detail, there will be very little difference between the previous unfaded results and the Rician faded case. This result is expected, Rician fading is modest for K = 12 dB. As well, the uncorrelated fading relationship results in an "averaging out" of fading differentials between the interference and victim paths. Coexistence performance criteria are thus dominated by the excess loss differential associated with near-NLoS transmission.

For simulation for a cell radius of R_{max} = 2 km, a SUI-2 channel is assumed with a mean value of Rice K equal to 9 dB at cell edge. Note that the maximum value for S has to be reduced to 1.5 km, reflecting the smaller value of R_{max}.

In spite of the reduced value of K, the results will be little changed from those of the previous SUI-1 case. Due to the smaller cell size, excess path loss at cell edge is reduced, resulting in a larger fade margin. As the excess loss differential was previously concluded to control CDF vs. C/I performance, this loss differential reduction is sufficient to offset the increased probability of deep fades.

A2.2.3 Conclusions

From the preceding analysis and simulations, the following may be concluted:

1. The system gain set for the asumed transmission model constrains near-NLoS operation to be within the SUI-1 and SUI-2 transmission environment. To operate in more severe near-NLoS environments, additional system gain is required. While means exist to provide some increase in system gain, they are outside the scope of this Report.
2. With the use of ITU-R F.1336 TS antenna RPE, representative of reasonably designed ETSI antennas, a NFD between 40 dB and 45 dB looks adequate for acceptable percentages of interference impairment, depending both on antenna gain and TS antenna heights.

APPENDIX A TO ANNEX 2: ACCEPTANCE-REJECTION METHOD

i. Generate three uniform random deviates U1, U2, U3. U3 is a spare deviate to be subsequently described.
ii. Let F_{max} be the maximum value of a normalized Rayleigh distribution.
iii. Compute a probability point $P_r(3U2)$ based on the Rayleigh probability equation and within a finite truncated range for U2. Setting the range for U2 to be within (0, 3) allows Rayleigh fades to span the range from $-\infty$ to +10 dB.
iv. Examine the ratio u = $P_r(3U2)/ F_{max}$. If the ratio u is less than U1, then accept U2 as the random deviate. If not, then reject the triplet and start again.
v. Once accepted as a valid Rayleigh deviate, the adjustment to the FSL signal level is 20log(U2).

Random deviate U3 was not required in the preceding. However, once U1 and U2 are accepted, the associated U3 value is employed to identify the probability of Rayleigh fading at some transmission distance R_x. For Rayleigh fading, the probability of it's occurrence is known to vary as the 3^{rd} power of the distance [4], [5]. The simulation assumptions are as follows:

a) Under Rayleigh fading conditions, set the probability of a Rayleigh fade at maximum distance R_{max} to be $\rho(R_{max}) = 1$. For some lesser distance, say R_x, set the probability to be $\rho(R_x) = (R_x / R_{max})^{d_{coeff}}$, where $d_{coeff} = 3$.
b) Compare the value of $\rho(R_x)$ with that of U3. If U3 > $\rho(R_x)$, then conclude that there is no Rayleigh fading on the link. If U3 < $\rho(R_x)$, then set the Rayleigh fading adjustment to be that given by step v. above.

ANNEX 3: EXAMPLES FOR MANAGING A BLOCK-EDGE MASK

In the following graphs the proposed block-edge mask is provided against the FDMA type A equipment for 7 MHz channels.

As an example, simple Tchebyschef channel filters with 3 to 6 cavities have been applied to the spectrum mask (assumed un-filtered in ETSI EN). The result in terms of the maximum EIRP allowed by the mask is shown in Figure 45. Without extra filtering system it could be placed only at 10.5 MHz from the edge and transmit -20 dBW/MHz (i.e. ~+18 dBm EIRP only). With the simplest 3 cavity extra filtering at the same distance from edge, the EIRP might increase up to + 2 dBW/MHz and with only 4 cavity the full proposed + 14 dBW/MHz could be reached.

As a second example, in Figure 46 systems at maximum proposed EIRP are allowed to be placed nearer to block-edge as far as the filter complexity increases (e.g. from 10.5 to 5.5 MHz).

RF filters up to 6 cavities are considered common technology in these frequency bands; cheap and relatively low loss could be achieved within small dimension (important for TS applications).

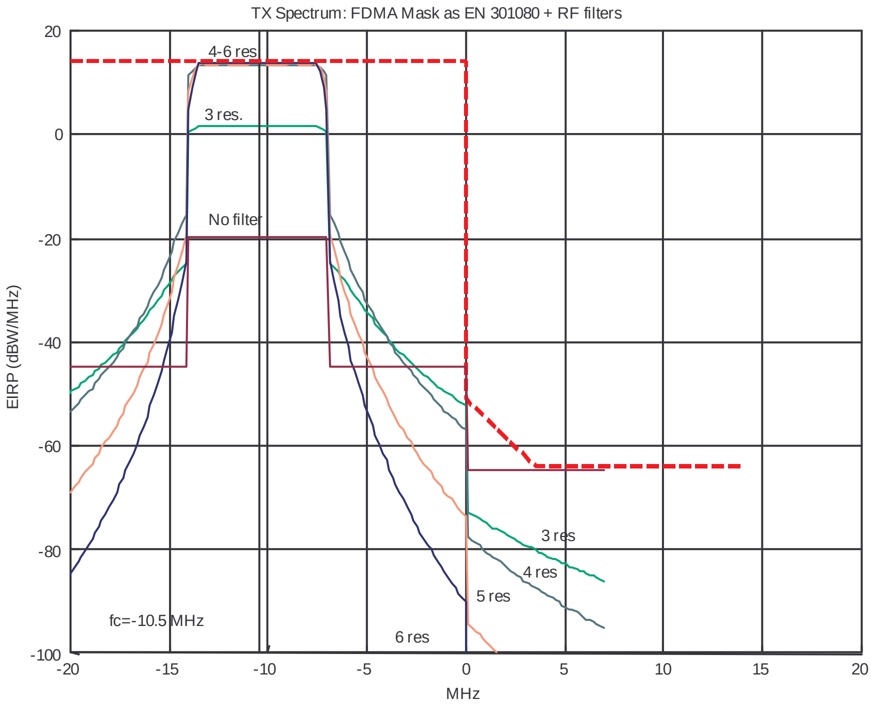

Figure 45: Example of increasing EIRP with RF filtering at same edge distance

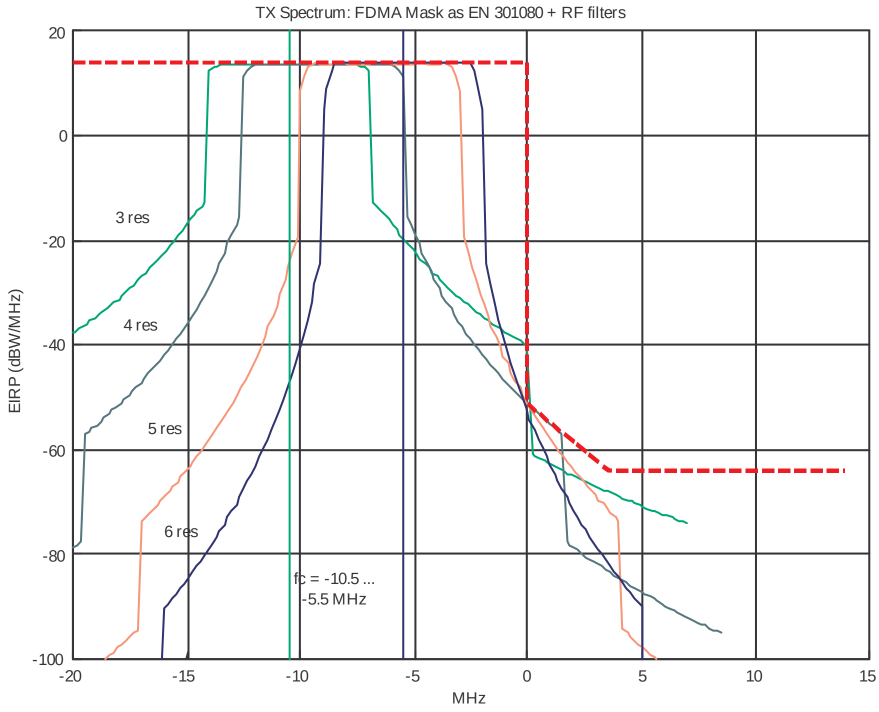

Figure 46: Example of decreasing edge distance with RF filtering at same max EIRP

REFERENCES:

[1] Y. Okumura, E. Ohmori, T. Kawano, K. Fukuda "Field Strength and its Variability in VHF and UHF land-Mobile Radio Service" (in "Communication Channels: Characterization and Behaviour", Editor B. Goldberg, IEEE Press 1976).

[2] J.D. Parsons "The Mobile Radio Propagation Channel" Pentech Press, London.

[3] S. R. Saunders "Antennas and Propagation for Wireless Communication Systems" J. Wiley & Sons.

[4] IEEE 802.16.3c-01/29r4, Channel Models for Fixed Wireless Applications, 2001-07-17.

[5] SE19(02)107 Rural Area TS to CS Coexistence Requirements at 3.5 GHz.

[6] ETSI EN 302 085 v1.1.2,(2001-02) Fixed Radio Systems; Point-to-Multipoint Antennas; Antennas for point-to-multipoint fixed radio systems in the 3 GHz to 11 GHz band.

[7] Coexistence Same Area Simulations at 3.5 GHz (Inbound), C802.16.2a-02/08,02/03/16.

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Anlage H

ECC/REC/(04)05 (Guidelines for Accomodation and Assignment of Multipoint Fixed Wireless Systems in Frequency Bands 3.4-3.6 GHz and 3.6- 3.8 GHz)

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

ECC RECOMMENDATION (04)05

GUIDELINES FOR ACCOMMODATION AND ASSIGNMENT OF MULTIPOINT FIXED WIRELESS SYSTEMS IN FREQUENCY BANDS 3.4-3.6 GHz AND 3.6-3.8 GHz

Recommendation adopted by the Working Group "Spectrum Engineering" (SE)

INTRODUCTION

Multipoint Fixed Wireless Systems (FWS) are deployed in several bands; the lowest frequency band, among preferential bands for Fixed Wireless Access (FWA), identified CEPT/ERC REC13-04, is the band 3.4-3.6 GHz.

In that band, CEPT/ERC REC14-03 recommends channel arrangements that, for Point-to-Multipoint (PMP) systems, are primarily based on multiple slots of 0.25 MHz with possible duplex spacing of 50 and 100 MHz, but also other rasters (multiple of 1.75 MHz) are provided in the recommendation.

In addition, CEPT/ERC REC12-08 recommends the optional use of the band 3.6-3.8 GHz, providing, for PMP systems, the same channel arrangement, frequency assignment criteria and duplex spacing as in REC 14-03; this band is therefore used by some administrations as an extension of, or an alternative to, the 3.4–3.6 GHz band. It is also recognised that both bands are also used by Point-to-Point (PP) systems in the Fixed Service, FSS systems and ENG/OB users, along with a secondary allocation to the Radio Location Service.

However, none of the above mentioned recommendations gives any further guidance on the assignment rules among different operators, or different service types, in either co-ordinated or uncoordinated deployment, leaving to administrations to decide on any further limitations (e.g. in term of EIRP limitation, guard-bands, co-ordination distance for frequency re-use, etc.). Also no guidance is given within the referenced documents on how sharing should be managed between PMP FWS that use spectrum adjacent to non-MP services.

Those bands, even if being of limited size, are valuable because they provide for quite wide cell coverage when Line-of-Sight (LOS) rural conventional deployment is considered, as well as connections with partially obstructed (Non-LOS, NLOS) paths and even with simple self-deployable indoor terminals, which is important feature for deployments where simple and cost-effective radio-access connections are desirable. Therefore the bands around 3.5 GHz are potentially interesting for a quick growth of domestic/small business access connectivity of moderate capacity, typically for ensuring the policy goals of proliferation of broadband Internet (IP) connections (e.g. in accordance with EU e-Europe action plan).

For such purpose a wide variety of Multipoint FWS technologies are already available on the market; they span from different system capacities, modulation formats (e.g. 4 or 16 states using Single Carrier or OFDM) access methods (e.g. TDMA, FDMA, CDMA and OFDM/OFDMA), system architectures (PMP and MP-MP), duplex arrangements (TDD and FDD) and asymmetry (different up-stream/down-stream traffic as typically needed for IP-based access). Each technology offers to operators specific benefits for specific market segments/characteristics; in addition, the continuous extensive evolution of the market and of the related technologies could imply that operators might be willing to change the system deployed with others, which better fit the changing needs; and this switch-over should not impact other operators, irrespective of the newly selected system. Some of these technologies would enlarge the field of possible applications, for instance to nomadic applications for indoor terminals.

PMP FWS technologies, whenever the local conditions and the administrative (license) policies permit, may be used also for provisioning of mobile network infrastructure, in particular for traffic collection from mobile base stations serving rural low density and urban pico-cells. In addition, as envisaged in CEPT/ERC Recommendation 14-03, FWA operators have interests in deploying point to point links within their own blocks (e.g., for their infrastructure or to connect remote stations).

Consequence of the above considerations is the need for a technology-neutral assignment methodology, possibly harmonised among CEPT administrations for reducing the market fragmentation. This recommendation is addressing elements for a harmonised assignment methodology, based on studies reported in ECC Report 33.

Given the latest trends for the development of FWA in this band, it is currently expected that most of new deployments will utilise the broadband systems, which means that broader frequency blocks would be needed. Thus, this assumption was taken into consideration in this recommendation.

It has to be finally noted that Multipoint-to-Multipoint (MP-MP), also known as "Mesh", network architectures were not specifically addressed by ECC Report 33, and consequently by this Recommendation, due to lack of sufficient supportive contributions.

BACKGROUND TO RECOMMENDED ARRANGEMENTS

In order to cater for the mix of technologies and services to be delivered it is most appropriate that a block (or blocks) of spectrum should be made available to a potential operator in a manner consistent with the technology and market that the operator may wish to address.

Medium-to-large size blocks (most likely of similar size between different operators) are anticipated and their size will depend, up to certain extent, on the applications foreseen. Administrations should be aware of the spectrum engineering measures proposed in the annexes of this recommendation and their relationship to the assigned block size. A key principle of the assignment guidelines is that even though a technology specific channelisation scheme is expected to operate within an assigned block, this channelisation is not the basis for the assignment process.

It is a requirement of the block assignment process, detailed in this recommendation, that systems supporting both symmetric and asymmetric traffic are accommodated as well as systems that employ FDD and TDD techniques. However, it should be taken into account that the guidance in this Recommendation would not completely eliminate any possible interference; in particular, if very different technologies were deployed in frequency adjacent blocks in the same geographic area without coordination, the probability of interference may increase. Therefore, while maintaining the neutrality of assignments, any "common-practice" measure and available information on systems to be deployed should be used in conjunction with the provisions of this Recommendation; furthermore, also inter-operator coordination should be encouraged and favoured for reducing the interference potential among operators directly or via the administrative licensing regime.

On the opposite, such inter-operator coordination, in conjunction with these "common-practice" measures, would in some situations allow the possibility to exceed the limits provided in this Recommendation while maintaining inter-systems interference at acceptable level.

Actually, different methodologies for the assignment of those blocks might be envisaged; namely, either block-edge regulations or guard bands between assigned blocks might be enforced depending on the required protection between adjacent assignments. However the amount of protection depends on equipment technology and characteristics that, in these bands, are consistently varying from system to system due to the large number of different market needs addressed. On this basis, this recommendation proposes as a preferred option to assign blocks contiguously with associated "block-edge mask" requirement, which is considered the most simple and "spectral efficient" among "technology neutral" methods.

Measures are recommended for dealing with the issue of inter-operator coexistence both between frequency blocks and between neighbouring geographic areas. The basis for these measures is to allow deployment with the minimum co-ordination, although more detailed co-ordination is encouraged as an inter-operator issue.

It is also noted that ETSI ENs for PMP FWS in these bands (see references below) have not been historically designed for a technology neutral deployment (this is done only in the 40 GHz MWS EN 301 997); therefore, they do not contain system controlling parameters, in terms of EIRP or absolute power densities, useful for the desired "technology neutral" and "uncoordinated" deployment. Not having any previous ECC harmonised guidance for such deployment, ETSI ENs are still bound to a cell-by-cell "co-ordinated deployment" concept actually not used in most of the licensing regimes. It is therefore assumed, that this recommendation would eventually generate feedback actions in revising also ETSI ENs accordingly.

Aspects that relate to sharing issues with P-P FS links, FSS, radiolocation (in adjacent band) and ENG/OB are not considered in this Recommendation, but are being dealt with in other ECC deliverables.

The applicability of this Recommendation is based on the following aspects:

- The presented guidelines should be independent from the access methods described in the ETSI EN 302 326-2 and EN 301 753.

- MP-MP (Mesh) architectures have not been considered. In order to include Mesh architectures, within the same assignment framework, a number of assumptions on "typical" application in these bands (e.g. on the use of omni-directional/directional antennas) still need to be defined in order to devise a typical set of intra-operator, mixed MP-MP/PMP interference scenarios and any necessary simulations should be carried out in order of define, if needed, specific requirements for that.

- This recommendation considered both outdoor and indoor deployment of user terminals, assuming respectively directional and omni-directional antennas;

- Performance and availability requirements for indoor terminals applications, for their nature, are assumed to be less stringent than conventional outdoor applications with directional antennas;

- Also channel sizes and modulation schemes were not specifically considered unless for defining "typical" system parameters;

- Use of either FDD/TDD, symmetric/asymmetric deployments was considered.

- Additionally, system independent, absolute power density limits at the edge of deployed region (pfd boundary conditions), as well as at the edge of assigned spectrum (block edge boundary conditions) are considered as licensing conditions for "generic" co-existence between neighbouring operators (similarly to the principles in ECC/REC 01-04 for the 40 GHz band); however, it should be taken into account that there might be few "worst cases" on the territory where site-by-site co-ordination may be needed. Being provided as guidelines for licensing conditions only, these limits shall not be used for the purpose of presuming conformity of equipment for access to the market.

Presently, the spectrum blocks assigned per operator vary widely from country to country; examples of assigned blocks ranging from ~10 MHz up to ~28MHz (single or duplex) have been reported. However current assumptions of broadband services, required by the market drive, suggest the need for wider system channel bandwidths (e.g. up to ~14/28 MHz) and therefore correspondingly wider spectrum blocks assignment in the future.

"The European conference of Postal and Telecommunications Administrations,

considering

a) that within CEPT the band 3.4-3.6 GHz has been identified as a preferred frequency band for Fixed Wireless Access (FWA), ERC/REC13-04, ERC/REC14-03 refer;

b) that the band 3.6-3.8 GHz is also used or might be used in the future in several CEPT countries for Point-to-Multipoint Fixed Wireless Systems (PMP FWS) in accordance with provisions of ERC/REC 12-08;

c) that the Fixed Satellite Service is also allocated with primary status in these bands and in some locations appropriate measures will be needed in the planning and deployment of FWS around earth stations installations to ensure sharing with the Fixed Satellite Service;

d) that other radiocommunications services also operate in the bands 3.41 – 3.6 GHz and 3.6 – 3.8 GHz;

e) that the EU "e-Europe" program states that "affordable, high speed Internet access, available over a variety of technology platforms, is crucial to ensuring that everybody has access to the benefits of the Information Society";

f) that harmonisation of the frequency assignment regulation will greatly enhance the penetration of such access through appropriate FWS technologies;

g) that FWS in the bands 3.41–3.6 GHz and 3.6–3.8 GHz are expected to provide broadband services with enhanced availability for fast Internet connections, including telephony, video, media streaming and data services to both residential and business customers (see examples of standardised technologies in annex 5);

h) that national licensing policies may also allow deployment of various other FWS applications in these bands, such as PMP FWS used for mobile networks infrastructure (e.g. linking low-traffic base stations) and point-to-point links (e.g. for FWS infrastructure or connections to single remote stations) within the allocated FWS spectrum blocks;

i) that it is desirable to achieve a flexible frequency assignment plan that can accommodate both symmetrical and asymmetrical MP FWS traffic requirements, whilst remaining consistent with good spectrum management principles, including provision for co-existence of PMP FWS systems and overall spectrum efficiency;

j) that both time division duplex (TDD) systems and frequency division duplex (FDD) systems should be allowed inside assigned frequency blocks, provided that appropriate co-existence criteria can be met;

k) that sufficient capacity and flexibility for deployment of multiple systems within a desired service area can be achieved by the aggregation of a variable number of contiguous frequency slots from a homogeneous pattern to form a block assignment;

l) that in order to enhance the efficient use of the assigned block(s) according present and future available technology, operators should be able to freely define and modify suitable channel arrangement(s) within the block(s);

m) that the frequency assignment methodology for FWS should consider the need for necessary traffic capacity as well as provisions for inter-operator coexistence within contiguously assigned blocks;

n) that in PMP applications, particularly when also NLOS propagation situations are considered, intra and inter system coexistence studies may be carried out only on statistical basis; therefore interference forecast could only be given in terms of a certain occurrence probability of worse cases;

o) that it is desirable to provide suitable harmonised CEPT guidelines for implementation of PMP systems using both conventional fixed terminals with outdoor directional antennas, as well as terminals with omni-directional or low directivity antennas, flexibly deployed by the users, typically in indoor scenarios;

p) that self-deployed terminal stations with omni-directional or low directivity antennas, by their nature more sensitive to interference, may also have less demanding objectives in term of error performance and availability; therefore over-regulating limitations of all base stations emissions, in the attempt of providing these indoor terminals with the protection objectives similar to those of conventional terminals with outdoor directional antennas, might adversely and unnecessarily affect the market;

q) that administrations should encourage and facilitate the co-operation among operators to maximise the efficient use of assigned blocks and for resolving worst cases of interference that might occur beyond the assumptions and objectives of this recommendation;

r) that guidance material, on which this recommendation is based, is available in ECC Report 33 to assist administrations with co-existence considerations for deployment of FWS systems in multiple operators scenario;

s) that in some countries interference to FWS operations was noted from radars operating below 3.4 GHz, therefore administrations should take this potential problem into account when assigning frequencies to FWS in lower parts of 3.4 GHz band;

t) that the national implementation of measures recommended in this recommendation should take due account of any prior bi- or multi-lateral international coordination agreements in the subject band;

u) that the provisions of block edge mask given in this recommendation are based on limitation of transmitter emissions only. Although it was recognised that receiver selectivity also may have impact on co-existence, it was not taken into account in these studies because of the technology neutrality assumption;

v) that the ECC Report 33 could not consider multipoint-to-multipoint (MP-MP or Mesh) architectures. Therefore further studies might be necessary in order to verify the applicability of this recommendation for Mesh systems;

recommends

1) that administrations wishing to apply block assignment of frequencies to PMP FWS in bands subject of this recommendation, should assign frequency blocks contiguously, following the guidance in Annex 1 for defining the preferred block arrangement and size, including some spectrum allowance for internal guard bands;

2) that administrations should consider the guidance given in Annex 2 when deciding on maximum EIRP levels to be established in FWS licences, to provide reference to assess the interference level between adjacent blocks and adjacent service areas and the interference to other services or systems;

3) that the Block Edge Mask measures given in Annex 3 may be used to limit interference between frequency-adjacent blocks within the same geographic area. Operators of the adjacent blocks might be allowed to deviate from the Block Edge Mask requirements, subject to their mutual agreement (e.g. involving co-ordinated deployment, mitigation techniques, etc);

4) those administrations who do not wish to follow the approach of contiguous block assignment as given in Recommends 1, should still find appropriate guidance for inter-block coexistence in annexes 1 and 3 when defining the size of external guard bands;

5) that administrations should consider the measures given in Annex 4 to limit interference between the same blocks assigned in geographically adjacent service areas;

6) that blocks should be assigned without further regulatory requirements on the actual channel arrangements and centre frequencies inside the blocks;

7) that administrations encourage inter-operator co-operation on co-existence issues to maximise utilisation of the assigned blocks, e.g. by requesting advance notification of technical and geographical deployment characteristics of base stations and making such data base available to all operators;

8) that due consideration should be given to ensure sharing/compatibility of PMP FWS with other radiocommunications systems/services, which may require alternative protection criteria, not addressed in this recommendation;

9) that care should be taken when licensing systems using MP-MP (mesh) architectures, due to the not yet proven applicability of this recommendation to them.

Note:

Please check the Office web site (http://www.ero.dk) for the up to date position on the implementation of this and other ECC and ERC recommendations.

ANNEX 1

FREQUENCY ASSIGNMENT IN BLOCKS

Point-to-Multipoint Fixed Wireless Systems (PMP FWS) may be provided by a number of different access technologies. The following recommended approach includes steps addressing the situation whereby no decision is taken beforehand by an administration regarding the technology anticipated. It provides the most flexibility and freedom for operators to choose how to make best use of the spectrum:

1. Consider the amount of spectrum available for PMP FWS applications and its distribution over the bands 3.4-3.6 GHz and/or 3.6-3.8 GHz (e.g. how many suitably sized blocks could be possibly accommodated adjacent each other);

2. Consider the geographic extent of licences: local/regional vs. nation-wide service areas;

3. Consider any constraints brought about by the need to share with other services;

4. The blocks should be made from aggregation of a number of basic 0.25 MHz slots. It is then also possible to form blocks according to existing channel plans (e.g. 3.5 MHz raster). Reference is made to relevant provisions in CEPT ERC/RECs 14-03 and 12-08;

5. Co-existence between frequency-adjacent blocks and most efficient use of spectrum should be preferably addressed by assigning blocks contiguously, by advocating inter-operator co-ordination and/or applying the block edge mask as given in Annex 3. For the block edge mask to be effective, the blocks must include spectrum required to facilitate internal guard bands at the block edges. Alternatively, it should be also possible to use external guard bands for additional protection and as a reserve for possible future expansion of blocks; the size of external guard bands should be approximately equal to 25% of block size (of the largest block, if assigning of equal blocks is not possible);

6. Consider that assigned blocks within the same geographical areas should be as far as possible of equal or very similar size, subject to market demand, so that the necessary co-existence measures can be balanced between the operators of adjacent blocks.

7. Consider the requirement for duplex spacing in the band. Unless there is a clear *a priori* preference from operators for TDD deployment, the assigned blocks should be paired, as shown in Fig. A1.1, as this would, in principle, allow operators choosing either FDD or TDD deployment[1]. In case of having explicit *a priori* knowledge of required proportion of planned FDD and TDD deployments, the available band could be more efficiently divided for paired vs un-paired blocks, e.g. as shown in Fig. A1.2.

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[1] Whilst contiguous frequency blocks for TDD would have been most advantageous in terms of equipment cost and spectrum efficiency, TDD systems do not necessarily require contiguous frequency blocks; therefore, in view of balancing flexibility and complexity within the assignment criteria, their use may be fitted in the general policy of paired symmetric block assignment. However, in this case the necessary guard-bands may reduce the overall spectrum utilization factor.

8. Consider the appropriate block size (B, MHz) for assignment. Although it is difficult to determine an absolute value for the optimum block size, typical values for contiguously assigned blocks are suggested in the Table below:

Recommended block sizes, MHz Paired deployment	**Recommended block sizes, MHz Un-paired deployment**
17.5 x 2	35
21 x 2	42
35 x 2	70
42 x 2	84

Note 1: If administration decides to have external guard bands, then the necessary minimum size of the blocks may be reduced by some 20%, which is then dedicated to external guard bands.

Note 2: The block sizes given in the above table are suitable for typical channel sizes of up to 7 MHz, if the requirement for broader channels would be envisaged, this may require block sizes of up to 50/60 MHz x2 paired or 100/120 MHz unpaired).

9. Taking due account of the technology choices and the constraints on spectrum access brought about by the need to share the band, consider the following guidelines in order to develop an appropriate frequency block assignment plan:

- Paired equal blocks should be normally offset by 100 MHz[2], unless the amount of available band dictates differently[3]. Only if the available frequency band is limited, the offset of 50 MHz[2] may be used as alternative.

- In cases when two operators would both wish to operate TDD systems, while having been initially assigned adjacent paired blocks, such operators should be allowed to swap the blocks so that they could themselves achieve formation of contiguous blocks optimised for TDD operation, as shown in Fig. A1.2, with due respect of national regulations and international cross-border agreements. This may bring increased efficiencies to these assignments.

- For a generic co-existence enhancement and for harmonisation of the CEPT market, in absence of any different legacy or other constraints (e.g. existing bi- or multi-lateral co-ordination agreements at country-borders), the following should be considered:

  A. Symmetric FDD PMP systems should use the lower sub-band for the transmission from the terminals to the central station and the upper sub-band for the transmission from the central station to the terminals;

  B. Use of geographic and frequency separation might provide a useful tool for improving co-existence of different systems (e.g. TDD vs. FDD).

- Without prejudice to any requirements stemming from bi- or multi-national cross-border coordination agreements, an operator should have the flexibility to choose its own system channel arrangement within its block. Consequently, an assigned block may contain a number of actual channels, as defined by the operator independently from the original raster used for creating the block, as well as variable in-block guard bands to meet the inter-block co-existence requirements for the case of contiguously allocated blocks.

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2 Depending on the band allocation in each country, these are the offset options provided by CEPT ERC/REC 14-03 and 12-08.

3 In the band 3.41 to 3.5 GHz or 3.41 to 3.6 GHz, the missing band 3.4 to 3.41 GHz will create unpaired corresponding band, 3.45 to 3.46 GHz or 3.5 to 3.51 GHz, respectively. This un-paired sub-band should either constitute a guard band, a single unpaired assignment or be attached to one or both adjacent blocks forming an asymmetric paired assignment, see Figure A1.1.

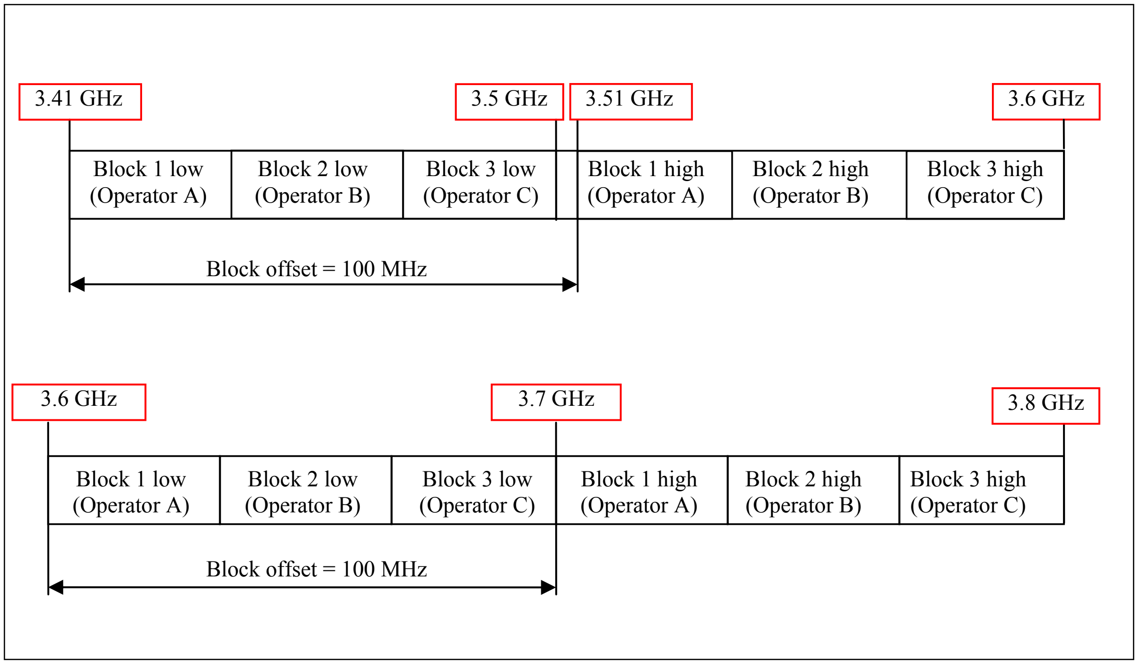


Figure A1.1: Example scheme for the concept of paired equal blocks only in 3.4-3.6 GHz and 3.6-3.8 GHz bands

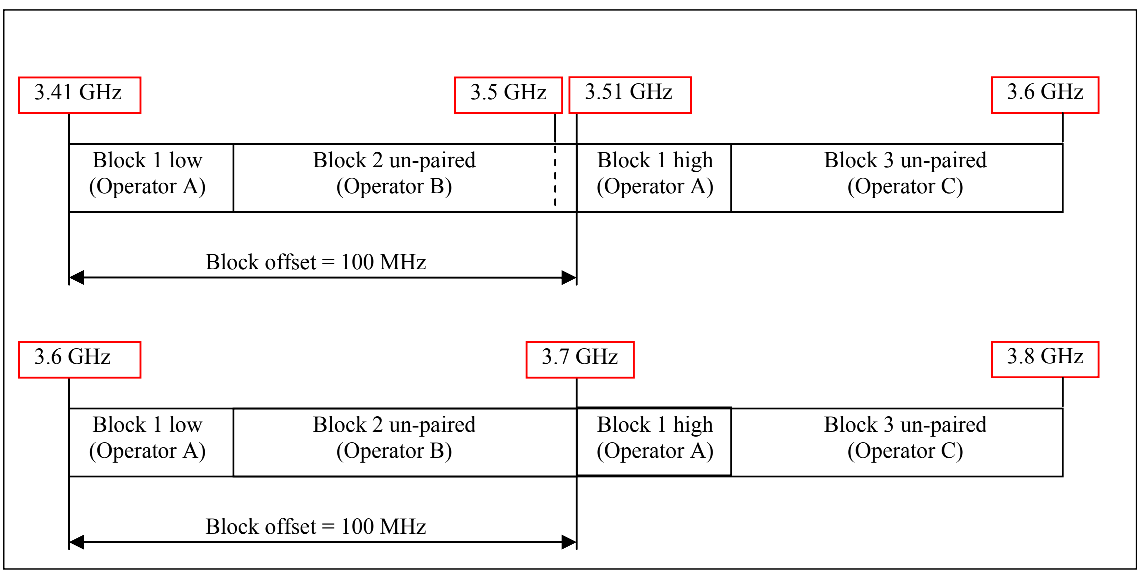


Figure A1.2: Example scheme for combining paired and un-paired blocks in 3.4-3.6 GHz and 3.6-3.8 GHz bands

Background for choosing the block size for considered PMP FWS applications

For the examples of PMP FWS applications referred in Annex 5, it appears that most of them are designed for a cell coverage methodology of "reuse four", using four frequency channels with separation (ChS) of typically 3.5/7 MHz.

In other ERC/ECC recommendations for higher bands, where the channel size of system on the market is in practice constant at 28 MHz, the recommended assignment methodology provides for blocks composed by 2/4 x 28 MHz channels, keeping, for mixed TDD and FDD licensing, one or two further 28 MHz channels as guard band.

Therefore:

a) for contiguously adjacent, technology neutral blocks that may need to contain also suitable guard bands inside those blocks, this would require block sizes that would exceed the 4 x ChS by an amount of one to two additional channels. Therefore in such cases of contiguously assigned blocks, typically required block sizes might be in the order of:

- System channel raster 3.5 MHz: Block size B=~17.5÷21 MHz
- System channel raster 7 MHz: Block size B=~35÷42 MHz

b) if external guard bands are employed between the assigned blocks, then the suitable size of assigned blocks should be equivalent just to the sum of 4 reference channel bandwidths.

Studies carried out by industry, based on assessing the balance between the coverage data density requirements and the economics of system deployment conclude that total paired block sizes ranging from about 2x17.5 MHz up to 2x35 MHz (including allowance for internal guard bands) can accommodate a reasonable capacity to meet the demands of a currently anticipated service set. However these block sizes might be considered only a starting point if higher data rate demands are expected, therefore total paired block size of about 2x42 MHz to 2x50 MHz, when available, would be more desirable, easily satisfying current needs whilst providing capacity for future expansion and growth as well as spectrum for dealing with interference issues.

In addition, whenever operators in contiguously assigned adjacent blocks would use the same standardised systems, the potential for closer coordination and cooperation is maximised, increasing efficiency of spectrum use.

ANNEX 2

MAXIMUM EIRP

1. Introduction

Maximum EIRP density limits are set by administrations in their national licensing conditions in order to define pfd levels for co-ordination distances between different geographical areas or for cross-border agreements or sharing with other services. Transmit output power and EIRP levels for Multipoint FWS systems are more driven by trade-offs between the required service coverage and other operational considerations. EIRP density depends also on the system bandwidth that in modern PMP FWS might be flexibly changed.

2. Maximum EIRP within a block

The following table A2 gives guidance for Administrations on setting possible maximum EIRP limits or to arbitrate interference cases between operators.

Station Type	**Max EIRP spectral density (dBW/MHz)** (Including tolerances and ATPC range, Note 1)
Central Station (CS) (and Repeater Station(RS) down-links)	+23 Note 2
Terminal Station (TS) outdoor (and RS up-links)	+ 20 Note 3
TS (indoor)	+ 12

Note 1: the total power delivered by a transmitter to the antenna of a station should not exceed 13 dBW, ITU RR S21.5 refers

Note 2: CS EIRP density value given in the table is considered suitable for conventional 90 deg sectorial antennas. Administrations may consider to adjust this value if other type of antennas are used (e.g. decrease the limit for omni-directional antennas, or increase when narrow-sector or adaptive antennas are used)

Note 3: If Administrations wish to consider higher EIRP limits (e.g. for improving coverage in remote rural areas), this should be achieved by using the high gain directional antennas, not by increasing output power, however the higher interference potential of EIRP increase should be carefully considered

Table A2: EIRP density limits for CS and TS stations of PMP FWS

For further enhancing the efficiency, administrations may allow operators to apply mutual co-ordination at the block edge and at the service border edge for potential further relaxation of the above EIRP limits, depending on requirements for protecting other services or systems, such as PP FS. This could be reached, for instance, by taking advantage of mitigation techniques such as the shielding effect, limiting the height of Central Stations, or for stations that are located far from the service area boundary.

It should be noted that in some CEPT countries certain legacy systems in this band (e.g. WLL) were licensed with lower EIRP limits than shown on Table A2 (e.g. 6.5-7.5 dBW/MHz). If in such cases administrations consider introduction of new systems with power limits given in Table A2, the means to ensure mutual co-existence of new and legacy systems should be considered.

ANNEX 3

REFERENCE BLOCK EDGE MASK

1. Introduction

The block edge mask given in this annex was developed to ensure co-existence between PMP FWS applications only; different considerations would be required where the adjacent system is not a PMP FWS system, but for example ENG/OB or other.

The floor level in the mask provided in this annex has been based on co-existence studies reported in ECC Report 33; where the PMP FWS co-existence studies were mostly made with statistical tools and assumptions of typical radio systems, their deployment and service performance objectives. The reference points of the transition slope were chosen based on consideration of practical filters and various modulation envelopes. These studies and considerations may be subject to refinement as operational experience and system characteristics evolve. Therefore the block edge mask based upon these studies may also be subject to refinement.

Emissions from one operator's frequency block into another operator's frequency-adjacent block will need to be controlled. This was done in few other frequency bands by establishing fixed guard bands between the assignments. However, taking due account of the possible variety of broadband systems considered in this recommendation, different network and service requirements, and considering the expected broadening of the required bandwidth, it would be impossible to uniquely and efficiently set such guard bands and it is recommended that coordination and interference mitigation techniques be implemented between operators.

Alternatively, in this recommendation, a so-called Block Edge Mask (BEM) is established to achieve limitation of emissions into an adjacent frequency block, by enabling the operators to place the outermost radio channels with suitable guard-bands inside their assigned block, in order to reduce the interference potential with the operator of adjacent frequency blocks. Transmitter power and outermost channel's centre frequency could be traded-off in order to fulfil the block edge requirement.

BEM is generally designed on the basis of a small level of degradation in an assumed interference scenario with a low occurrence probability of a worst case (e.g. low probability of two directional antennas pointing exactly at each other). It is not therefore excluded that in a limited number of cases specific mitigation techniques might be necessary.

In particular when Central Stations (CS) are co-located on the same building, the statistical approach is not applicable and it is assumed that common practice of site engineering (e.g. vertical decoupling) is implemented for improving antenna decoupling as much as possible.

Also adjacent block receiver rejection concurs to a reduced interference scenario, however the study in Report 33 did not consider the effect of receiver selectivity since the technology neutrality assumption did not allow deciding on its typical parameters. Therefore it is not in the scope of this recommendation to set limits for it; nevertheless it is expected that ETSI standards will adequately cover the issue.

The BEMs given below were developed as a trade-off between the need to ensure co-existence between PMP FWS systems with technology neutral assumptions and practical feasibility of transmitter filters to match the recommended masks, while maintaining suitable frequency agility inside the assigned block.

The CS mask recommended in this Annex provides adjacent blocks (assumed to be sized from 4 typical system channels plus an internal guard band as recommended in Annex 1) with increasingly protected frequency areas:

- Internal guard bands' areas where protection is not offered unless the interested operators would practice active coordination;
- Outermost system channels' areas where protection is given with high probability, but in few worst cases coordination between CSs might be needed, preferably between the involved operators themselves, considering that in most cases the need for coordination may be avoided by operators choosing the innermost systems channels of the block that are more protected;
- Innermost system channels' areas where protection is given with very high probability.

2. Block edge mask for CS

In cases where the amount of spectrum available for PMP FWS applications allows licensing of multiple frequency blocks in the same geographical area, maximising spectral efficiency would require establishing some general rules for co-existence of adjacent frequency blocks. These would require either coordination and/or mitigation techniques or the application of a block edge mask. No such rules are necessary if only one block is made available for PMP FWS operations in a given frequency band/geographic area.

It should be also noted that when TDD or mixed FDD/TDD systems are placed in immediately adjacent blocks, the probability of occurrence of worst cases of interference between CSs is quite higher than in situations where only FDD are deployed. Therefore, even if the mask proposed in this annex would offer a suitably low probability of interference for such cases, when TDD systems are concerned additional mitigation techniques (geographic separation of stations, natural/physical shielding, etc) and/or additional co-ordination (including networks synchronisation) between operators should be implemented as far as possible.

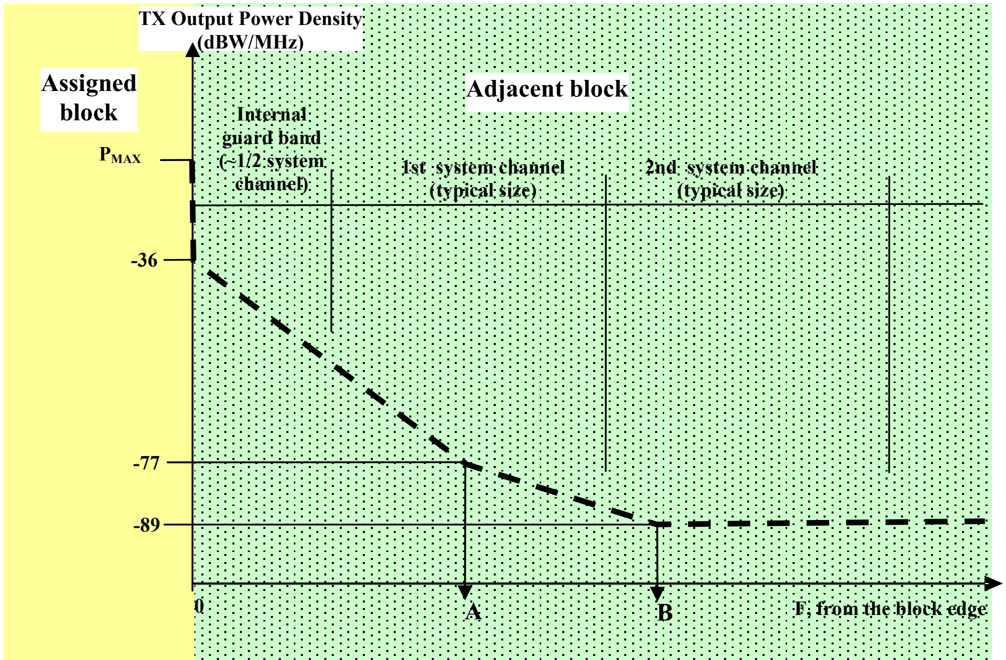
Figure A3 shows the recommended block edge mask limits for the CS of PMP FWA; the limits shown are the absolute maximum transmitter output power density values and intended to include tolerances and any ATPC range. The figures are supplemented by tabular description of mask curve in Table A3.

ECC Report 33 has shown that when no co-ordination or interference mitigation is applied, the less directional antennas (either CS or TS) generally produce more probability of interference; therefore out-of-block emissions in terms of EIRP should be more stringent for lower directivity (and consequently with lower gain) antennas. That is why the recommended block edge mask limits outside the block are described in this annex in terms of transmitter output power, allowing operators to make practical use of this phenomenon by obtaining higher EIRP when using highly directional hence less interfering antennas, while EIRP would be automatically lowered when low gain (e.g. omni-directional antennas) are employed.

The reference frequency $\Delta F=0$ of the mask should be understood as the central division line between adjacent frequency blocks. If the blocks are immediately adjacent, then the mask reference frequency is precisely the border between the two assigned blocks and respecting the mask limits may require operators to employ appropriate guard band inside the assigned blocks. However, if an administration decides to introduce between neighbouring blocks external guard band of ~25% of the assigned blocks (see Annex 1), then the reference frequency $\Delta F=0$ of the mask should be understood to be at the centre of guard band between neighbouring blocks.

It should be noted, that the occupied bandwidth of the channel carriers should always lie within the assigned block limits, regardless of its absolute power. In other words, the occupied bandwidth of all individual carrier emissions are required to fall within the spectrum block limit indicated by “0” in Figure A3. Only the out-of-band emissions of that transmitted carrier should be present within the portion indicated between the “0” and “20%” markers.

After the block assignment procedure, if operators of adjacent blocks agree to co-ordinate between themselves, then administration should not be enforcing the block edge mask requirement at the common border between those blocks. This would allow fully optimising the utilisation of outermost parts of the blocks and achieving maximal spectral efficiency.



Frequency offset break points for the CS mask	Definition (% of the size of the assigned block, Note)
A	20%
B	35%

Note: X% of the smaller of adjacent blocks, if blocks are of unequal size

Figure A3: Central Station Block Edge Spectral Density Mask

Frequency offset	CS Transmitter Output Power Density Limits (dBW/MHz)
In-band (within assigned block)	See Annex 2
ΔF=0	-36
0<ΔF<A	-36 - 41·(ΔF/A)
A	-77
A<ΔF<B	-77 - 12·((ΔF-A)/(B-A))
ΔF≥B	-89

Table A3: Tabular description of Central Station Block Edge Spectral Density Mask

3. Out-of-block emission limits for TS

It was considered that the block edge mask for Terminal Stations was not required since Report 33 has shown that the protection requirements would be sufficiently covered by applying current harmonised ETSI standards.

However, the applicability of the latter conclusion for TS limits with low gain non-directional antennas was verified for scenarios with predominant use of such terminals in indoor environment. If it is intended that the majority of a consistent population of TS with non-directional antennas will be used outdoors (e.g. on vehicles or for fixed outdoor installations), then administrations may wish to establish special radio interface requirements setting out-of-block power limits for non-directional outdoor TS, which would be up to 15 dB more stringent than noise floor limits given in ETSI EN 302 326-2, or, alternatively, limit the maximum allowed EIRP for these applications, according to the expected proportion of outdoor use.

4. Assessment of the block edge masks

The BEM presented in this Annex is intended as "normalised" to 1MHz; however, for assessment purpose, the resolution bandwidth (RBW), in particular in the out-of-band domain (which is likely related to the outermost transition zone), should be appropriate for the system under test (ref. ITU-R SM.1541).

Therefore, in case a 1 MHz RBW, which will give conservative results, might not be appropriate for frequencies up to B+1MHz (or −B−1MHz) from the block edges, the same RBW, recommended in ETSI EN 302 326−2 for spectrum density masks (for the actual channel bandwidth of system under test) may be used, provided that the BEM limits are re-normalised (tightened) by a factor:

$$10 \log(1 / RBW|_{MHz}) \cdot$$

In this latter case, discrete CW spectral lines may exceed the new re-normalised BEM by a factor:

$$10 \log(1 / RBW|_{MHz}) - 10 \log N \cdot$$

where N = number of actual discrete lines falling within ±0.5 MHz centred on each line.

Note: The above BEM limits shall not imply any relaxation of the limits for transmitter unwanted emissions in the spurious domain that are referenced to actual carrier centre frequency, for these the equipment should still meet the requirements according to ERC/REC74–01.

ANNEX 4

GUIDANCE FOR INTERFERENCE AVOIDANCE BETWEEN CO-FREQUENCY ADJACENT-AREA ASSIGNMENTS

1 Introduction

In order to assign frequencies to a number of competing FWA operators in any given area or territory, certain guidelines are needed in order to ensure that interference probability between these operators is minimised. These operators may be deploying differing technologies requiring co-existence guidelines at the top level to be as generic as possible.

In addition, the inter-operator co-ordination burden should be minimised and flexibility provided to cater for specific scenarios in order to help minimising any deployment constraints.

The same concept may be used for developing international agreements on utilisation of subject bands between neighbouring countries. However, the procedure recommended in this annex may be not suitable for co-ordination in the country border regions when different provisions are agreed via bi- or multi-lateral international agreements, e.g. based on the concepts of preferential frequency blocks.

For detailed description of the proposed methodology, see section 3 in ECC Report 33.

2 Main principle behind the proposed procedure

For a balanced use of the assigned blocks at the service area boundary, without overestimating the coordination areas, it is assumed that operators assigned with the same block, in adjacent areas, have to share the burden of co-existence the by increasing the PFD limit at the boundary to that equivalent to half the required separation distance based on calculations derived from the acceptable I/N at the receiver. This fully protects receivers located in the victim operator's licensed area at a distance equivalent to half the separation distance, but increases the chance that the victim will receive unacceptable interference at distances less than this. This reduces the co-ordination burden within a reduced area and minimises "over-protection". Careful choice of distances and PFD triggers can minimise the chance of unacceptable interference.

The concept is illustrated in the figure A4.1 where equal systems and antenna height are assumed. However, the impact of spherical diffraction attenuation makes the antenna height to play a role in the evaluation of D_{min} (the lower are the antennas the lower is the separation distance); when different antenna height are assumed, ECC Report 33 shows that, even if the two operators might evaluate $D_{min}/2$ differently, due to different antenna heights, their sum is still producing the required total D_{min} required as shown in Figure A4.2.

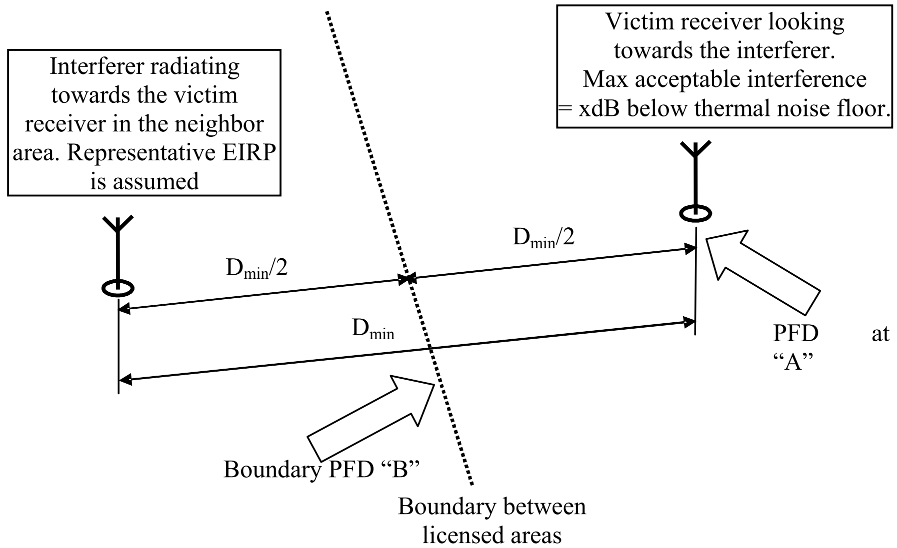


Figure A4.1: Defining PFD limit at geographical block assignment boundary (equal systems with same antenna heights)

In Figure A4.2 $(D_{min}/2)_A$ (evaluated on the base of PFD at the boundary by operator A without knowing different antenna height of operator B) is compensated by the fact that operator B, using higher antenna, would require a larger distance from the border for matching PFD at the boundary.

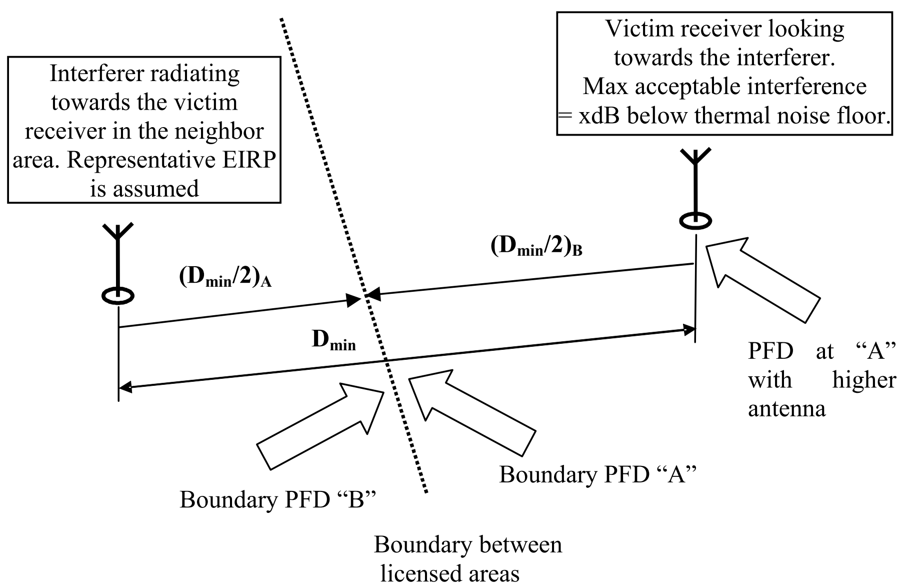


Figure A4.2: Defining PFD limit at geographical block assignment boundary (equal systems, different antenna heights)

No compensation is present for different EIRP, therefore the evaluation of PFD should be made assuming a common minimum value; operator wishing to go closer, could reduce EIRP beyond that value at risk of having interference or asking for co-ordination.

3 Proposed procedure

Administrations are recommended to request operators to apply the following process before installing a Central Station (CS):

a. The operator is considering the antenna height and EIRP of the proposed CS;

b. The operator is calculating the suitable value for the boundary PFD from Figure A4.3 (reprinted from Report 33) based on the characteristics of proposed CS: actual antenna height and on the actual eirp or some agreed for co-ordination purposed minimum EIRP value, whichever is the greatest;

c. The operator is determining using terrain-data propagation model whether he would meet such PFD at the licensed area boundary;

d. In case, the PFD level is exceeded at the licensed area boundary, the operator need to reach an agreement from the adjacent area operator.

It has to be noted that the lower is the antenna height, the higher are the diffraction attenuation and all other attenuation due to obstacles such as building, trees etc. generally reducing the probability of worst case occurrence; and operators are encouraged to use low antenna heights at the boundary.

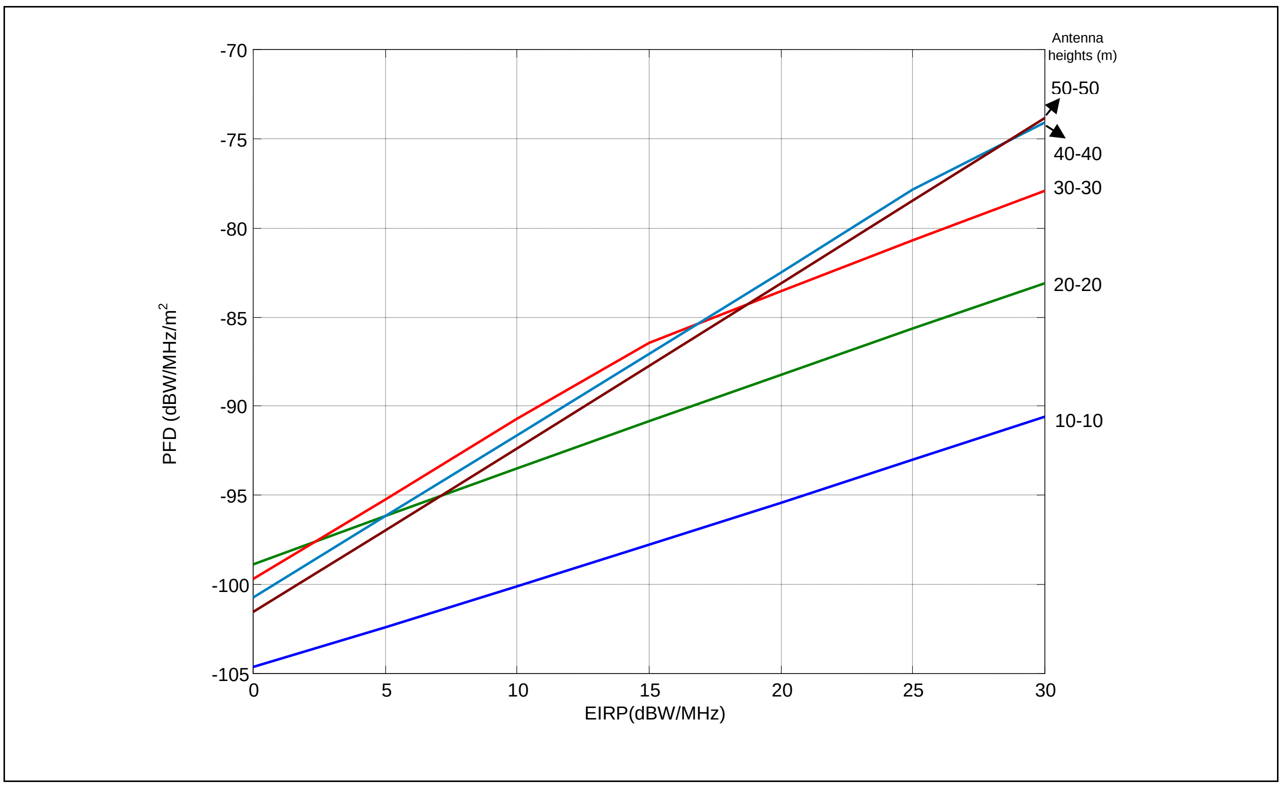


Figure A4.3: PFD at $D_{min}/2$ (half the minimum CS separation distance) vs. $EIRP_{tx}$

Note: the graphs in Fig. A4.3 were developed on the assumption of average case with propagation over flat land. Therefore, these curves will be over-conservative in cases of propagation over obstructed paths (e.g. mountains, hills), and over-optimistic for cases where spherical diffraction attenuation may be lower (e.g. broad river valleys, etc).

ANNEX 5

SOME EXAMPLES OF STANDARDISED PMP FWS TECHNOLOGIES

1 Introduction

A number of ETSI Standards have been developed defining the "minimum requirements" (i.e. the basic radio-frequency interface parameters and receiver sensitivity and interference robustness).

The ETSI EN 302 326-2 foresees system characteristics suitable for various basic access technologies (e.g. FDMA, TDMA, CDMA and any mixture of those) defining the parameters relevant to R&TTE Directive's Article 3.2 on essential requirements.

A number of new mixed technologies are also present on the market (e.g. TDMA/OFDMA) and more are expected to be designed for covering the increasing demand for new wide- and broadband services.

This annex notes some possibilities and their key characteristics based upon known (at the time of writing) standardisation activities. These key characteristics were kept in mind whilst developing the assignment plans detailed in the previous annexes. Their inclusion is not intended as a statement regarding their suitability, nor to grant them any "preferred" status, but merely serves to illustrate the degree of flexibility that needs to be included in the frequency planning for PMP FWS.

2 EP ETSI BRAN HIPERMAN (HM) and IEEE 802.16

ETSI EP TC BRAN has drafted the TS 102 177 "*HIPERMAN; Physical (PHY) layer HIPERMAN PHY*" and TS 102 178 "*HIPERMAN; Data Link Control (DLC) layer HIPERMAN DLC*", defining the basics for a standardized "multi-vendor" radio interface in bands below 11 GHz. The revision 1.3.1 of the HiperMAN standard defines the PHY and DLC for supporting Fixed/Nomadic applications.

TS 102 210 "*HIPERMAN; System profiles*" defines the interoperability profiles, the last available version at the publication of this document being 1.2.1.

The main characteristics of HIPERMAN standards, v. 1.3.1, which is harmonized with IEEE 802.16-2004 and the 802.16e amendment (see technical details below), include:

- All the PHY improvements related to OFDM and OFDMA modes, including MIMO for the OFDMA mode
- Adaptive modulation and coding
- Flexible channelisation, including the 3.5MHz, the 7MHz and 10MHz raster (up to 28MHz)
- Scalable OFDMA, including FFT sizes of 512, 1024 and 2048 points, to be used in function of the channel width, such that the sub-carrier spacing remains constant
- Up-link and down-link OFDMA (sub-channelisation) for both OFDM and OFDMA modes
- Adaptive antenna support for both OFDM and OFDMA modes
- MIMO support for OFDMA mode
- PMP system architecture is supported
- Improvements related to low power consumption and hand-over for load-balancing or best C/(I+N)– carrier over interference + noise – applicable also for fixed STs
- Capable to operate in paired spectrum allocations employing FDD and/or TDD; FDD terminal stations can operate in either full or half-duplex.

These standards provide for many new features, calling for different deployment scenarios, in particular with indoor terminals with omni-directional antennas, which have also been considered in a revision of ECC Report 33.

F 1/09

Anlage I

Kommissionsentscheidung vom 21. 5 .2008 zur Harmonisierung des Frequenzbands 3400 – 3800 MHz für terrestrische Systeme, die elektronische Kommunikationsdienste in der Gemeinschaft erbringen können (2008/411/EG)

ENTSCHEIDUNG DER KOMMISSION

vom 21. Mai 2008

zur Harmonisierung des Frequenzbands 3 400—3 800 MHz für terrestrische Systeme, die elektronische Kommunikationsdienste in der Gemeinschaft erbringen können

(Bekannt gegeben unter Aktenzeichen K(2008) 1873)

(Text von Bedeutung für den EWR)

(2008/411/EG)

DIE KOMMISSION DER EUROPÄISCHEN GEMEINSCHAFTEN —

gestützt auf den Vertrag zur Gründung der Europäischen Gemeinschaft,

gestützt auf die Entscheidung Nr. 676/2002/EG des Europäischen Parlaments und des Rates vom 7. März 2002 über einen Rechtsrahmen für die Funkfrequenzpolitik in der Europäischen Gemeinschaft (Frequenzentscheidung) ([1]), insbesondere auf Artikel 4 Absatz 3,

in Erwägung nachstehender Gründe:

(1) Die Kommission hat in ihrer Mitteilung „Zügiger Zugang zu Frequenzen für drahtlose elektronische Kommunikationsdienste durch mehr Flexibilität“ ([2]), in der sie sich u. a. auch auf das Frequenzband 3 400—3 800 MHz bezieht, eine flexiblere Frequenznutzung befürwortet. Technologieneutralität und Dienstneutralität sind von den Mitgliedstaaten im Rahmen der Gruppe für Frequenzpolitik (RSPG) in ihrer Stellungnahme vom 23. November 2005 zur Politik für den Drahtloszugang zu elektronischen Kommunikationsdiensten (WAPECS) als wichtige politische Ziele zur Erreichung einer flexibleren Frequenznutzung hervorgehoben worden. In dieser Stellungnahme vertritt die Gruppe für Frequenzpolitik ferner die Auffassung, dass diese Ziele nicht unvermittelt, sondern schrittweise verwirklicht werden sollten, um Marktstörungen zu vermeiden.

(2) Die Zuweisung des Frequenzbands 3 400—3 800 MHz für feste, ortsungebundene und mobile Anwendungen ist ein wichtiger Schritt zur Bewältigung der Konvergenz des Mobilfunk-, Festnetz- und Rundfunksektors, der auch der technischen Innovation gerecht wird. Die in diesem Frequenzband erbrachten Dienstleistungen sollten hauptsächlich den Zugang der Endnutzer zur Breitbandkommunikation ermöglichen.

(3) Es wird erwartet, dass die drahtlosen elektronischen Kommunikationsdienste, denen das Frequenzband 3 400—3 800 MHz zugewiesen werden soll, weitgehend europaweite Dienste insofern sein werden, als die Nutzer solcher Kommunikationsdienste in einem Mitgliedstaat auch Zugang zu gleichwertigen Diensten in jedem anderen Mitgliedstaat erhalten.

(4) Gemäß Artikel 4 Absatz 2 der Entscheidung Nr. 676/2002/EG erteilte die Kommission der Europäischen Konferenz der Verwaltungen für Post und Fernmeldewesen (nachfolgend „CEPT“ genannt) am 4. Januar 2006 ein Mandat zur Feststellung der Bedingungen für die Bereitstellung harmonisierter Funkfrequenzbänder in der EU für Anwendungen des drahtlosen Breitbandzugangs (BWA).

(5) In ihrem aufgrund dieses Mandats vorgelegten Bericht zum drahtlosen Breitbandzugang (CEPT-Bericht 15) kommt die CEPT zu dem Schluss, dass der Aufbau von Festnetzen, ortsungebundenen Netzen und Mobilfunknetzen im Frequenzband 3 400—3 800 MHz unter den technischen Bedingungen, die in der Entscheidung ECC/DEC/(07)02 und in der Empfehlung ECC/REC/(04)05 des Ausschusses für elektronische Kommunikation festgelegt sind, technisch durchführbar ist.

(6) Angesichts der großen Marktnachfrage nach terrestrischen elektronischen Kommunikationsdiensten für den Breitbandzugang in diesen Frequenzbändern sollten die Ergebnisse des der CEPT erteilten Mandats in der Gemeinschaft Anwendung finden und von den Mitgliedstaaten unverzüglich umgesetzt werden. In Anbetracht der Unterschiede, die derzeit auf nationaler Ebene bei der Nutzung und der Marktnachfrage in den Teilbändern 3 400—3 600 MHz und 3 600—3 800 MHz bestehen, sollten für die Zuweisung und Bereitstellung der beiden Teilbänder unterschiedliche Termine festgesetzt werden.

(7) Die Zuweisung und Bereitstellung des Frequenzbands 3 400—3 800 MHz im Einklang mit den Ergebnissen des BWA-Mandats trägt der Tatsache Rechnung, dass es in diesen Frequenzbändern bereits andere Anwendungen gibt und auch nicht ausgeschlossen ist, dass diese Bänder künftig von anderen Systemen oder Diensten genutzt werden, denen sie im Einklang mit der ITU-Vollzugsordnung für den Funkdienst zugewiesen sind (nicht-ausschließliche Zuweisung). Geeignete Kriterien für eine gemeinsame Frequenznutzung, die ein Nebeneinander mit anderen Systemen und Diensten in denselben oder in benachbarten Frequenzbändern ermöglichen, sind im ECC-Bericht 100 enthalten. Darin wird u. a. bestätigt, dass eine gemeinsame Frequenznutzung mit Satellitendiensten angesichts des Ausbaus solcher Dienste in Europa und der geografischen Trennungserfordernisse nach einer Einzelfallprüfung der tatsächlichen topografischen Bedingungen oft möglich ist.

([1]) ABl. L 108 vom 24.4.2002, S. 1.
([2]) KOM(2007) 50.

(8) Frequenzblock-Entkopplungsmasken (Block Edge Masks, BEM) sind technische Parameter, die für den gesamten Frequenzblock eines bestimmten Frequenznutzers gelten, und zwar unabhängig von der Anzahl der Kanäle, welche die von ihm gewählte Technik belegt. Diese Masken sollen Bestandteil des Genehmigungssystems für die Frequenznutzung sein. Sie gelten sowohl für Aussendungen innerhalb eines Frequenzblocks (blockinterne Sendeleistung) als auch die Aussendungen außerhalb des Blocks (Außerblockaussendungen). Sie stellen regulatorische Anforderungen dar, die dem Management des Risikos funktechnischer Störungen zwischen benachbarten Netzen dienen und unbeschadet der Grenzwerte gelten, die in den gemäß der Richtlinie 1999/5/EG des Europäischen Parlaments und des Rates vom 9. März 1999 über Funkanlagen und Telekommunikationsendeinrichtungen und die gegenseitige Anerkennung ihrer Konformität (FuTEE-Richtlinie) ([1]) aufgestellten Gerätenormen festgelegt sind.

(9) Die Harmonisierung der technischen Bedingungen für die Verfügbarkeit und effiziente Nutzung der Funkfrequenzen umfasst weder Fragen der Zuteilung, Genehmigungsverfahren oder Befristung, noch die Frage der Anwendung wettbewerbsorientierter Auswahlverfahren zur Frequenzzuteilung; diese Aufgaben werden von den Mitgliedstaaten im Einklang mit dem Gemeinschaftsrecht wahrgenommen.

(10) Unterschiedliche Ausgangssituationen in den Mitgliedstaaten könnten zu Wettbewerbsverzerrungen führen. Der geltende Rechtsrahmen sieht jedoch Instrumente vor, mit denen die Mitgliedstaaten solche Probleme in angemessener, nicht diskriminierender und objektiver Weise sowie unter Beachtung des Gemeinschaftsrechts bewältigen können, vor allem im Einklang mit der Richtlinie 2002/20/EG des Europäischen Parlaments und des Rates vom 7. März 2002 über die Genehmigung elektronischer Kommunikationsnetze und -dienste (Genehmigungsrichtlinie) ([2]) und der Richtlinie 2002/21/EG des Europäischen Parlaments und des Rates vom 7. März 2002 über einen gemeinsamen Rechtsrahmen für elektronische Kommunikationsnetze und -dienste (Rahmenrichtlinie) ([3]).

(11) Aus der Nutzung des Frequenzbands 3 400-3 800 MHz durch andere bestehende Anwendungen in Drittländern können sich in mehreren Mitgliedstaaten Beschränkungen bei der Einführung und Nutzung dieser Bänder für elektronische Kommunikationsnetze ergeben. Informationen über solche Beschränkungen sollten der Kommission gemäß Artikel 7 und Artikel 6 Absatz 2 der Entscheidung 676/2002/EG übermittelt und gemäß Artikel 5 der Entscheidung 676/2002/EG veröffentlicht werden.

(12) Um eine effektive Nutzung des Frequenzbands 3 400—3 800 MHz auch langfristig sicherzustellen, sollten die Behörden weiterhin Studien zur Steigerung der Effizienz und zu innovativen Nutzungsarten, z. B. vermaschten Netzarchitekturen, durchführen. Solche Studien sollten bei Überlegungen zur Überprüfung dieser Entscheidung berücksichtigt werden.

(13) Die in dieser Entscheidung vorgesehenen Maßnahmen stimmen mit der Stellungnahme des Funkfrequenzausschusses überein —

HAT FOLGENDE ENTSCHEIDUNG ERLASSEN:

Artikel 1

Diese Entscheidung dient der Harmonisierung der Bedingungen für die Verfügbarkeit und die effiziente Nutzung des Frequenzbands 3 400—3 800 MHz für terrestrische Systeme, die elektronische Kommunikationsdienste erbringen können, unbeschadet des Schutzes und weiteren Betriebs anderer bestehender Nutzungsarten in diesem Band.

Artikel 2

(1) Spätestens sechs Monate nach Inkrafttreten dieser Entscheidung sorgen die Mitgliedstaaten für die nicht-ausschließliche Zuweisung und Bereitstellung des Frequenzbands 3 400—3 600 MHz für terrestrische elektronische Kommunikationsnetze in Übereinstimmung mit den Parametern im Anhang dieser Entscheidung.

(2) Zum 1. Januar 2012 sorgen die Mitgliedstaaten für die nicht-ausschließliche Zuweisung und die anschließende Bereitstellung des Frequenzbands 3 600—3 800 MHz für terrestrische elektronische Kommunikationsnetze in Übereinstimmung mit den Parametern im Anhang dieser Entscheidung.

(3) Die Mitgliedstaaten stellen sicher, dass die in Absatz 1 und 2 genannten Netze einen ausreichenden Schutz der Systeme in benachbarten Frequenzbändern gewährleisten.

(4) In geografischen Gebieten, in denen die Koordinierung mit Drittländern ein Abweichen von den Parametern im Anhang dieser Entscheidung erforderlich macht, sind die Mitgliedstaaten nicht gehalten, die Verpflichtungen aus dieser Entscheidung zu erfüllen.

Die Mitgliedstaaten unternehmen alle möglichen Anstrengungen zur Behebung solcher Abweichungen, die sie der Kommission unter Angabe des betroffenen Gebiets mitteilen, und veröffentlichen die diesbezüglichen Informationen gemäß der Entscheidung Nr. 676/2002/EG.

Artikel 3

Die Mitgliedstaaten gestatten die Nutzung des Frequenzbands 3 400—3 800 MHz in Übereinstimmung mit Artikel 2 für feste, ortsungebundene und mobile elektronische Kommunikationsnetze.

([1]) ABl. L 91 vom 7.4.1999, S. 10. Richtlinie geändert durch die Verordnung (EG) Nr. 1882/2003 (ABl. L 284 vom 31.10.2003, S. 1).
([2]) ABl. L 108 vom 24.4.2002, S. 21.
([3]) ABl. L 108 vom 24.4.2002, S. 33. Richtlinie geändert durch die Verordnung (EG) Nr. 717/2007 (ABl. L 171 vom 29.6.2007, S. 32).

Artikel 4

Die Mitgliedstaaten beobachten die Nutzung des Frequenzbands 3 400—3 800 MHz und teilen der Kommission ihre Erkenntnisse mit, um eine regelmäßige und rechtzeitige Überprüfung dieser Entscheidung zu ermöglichen.

Artikel 5

Diese Entscheidung ist an die Mitgliedstaaten gerichtet.

Brüssel, den 21. Mai 2008

Für die Kommission
Viviane REDING
Mitglied der Kommission

ANHANG

PARAMETER GEMÄß ARTIKEL 2

Die folgenden technischen Parameter werden als Frequenzblock-Entkopplungsmaske (Block Edge Mask, BEM) bezeichnet und sind ein wesentlicher Teil der notwendigen Bedingungen für ein Nebeneinander benachbarter Netze bei Fehlen bilateraler oder multilateraler Abkommen. Weniger strenge technische Parameter können angewandt werden, sofern diese zwischen den Betreibern solcher Netze vereinbart worden sind. In diesem Frequenzband betriebene Geräte können auch anderen als den folgenden EIRP-Höchstwerten ([1]) entsprechen, sofern geeignete Störungsminderungstechniken eingesetzt werden, die den Anforderungen der Richtlinie 1999/5/EG genügen und mindestens einen gleichwertigen Störungsschutz bieten wie diese technischen Parameter ([2]).

A. HÖCHSTWERTE FÜR BLOCKINTERNE AUSSENDUNGEN

Tabelle 1

Höchstwerte der spektralen EIRP-Dichte für feste oder ortsungebundene Anwendungen zwischen 3 400—3 800 MHz

Stationsart	Maximale spektrale EIRP-Dichte (dBm/MHz) (dBm/MHz) (einschließlich Toleranzen und des Bereichs der automatischen Sendeleistungsregelung (ATPC))
Zentralstation (und Verstärkerstation auf der Abwärtsstrecke)	+ 53 Anmerkung 1
Endstelle (im Außenbereich) (und Verstärkerstation auf der Aufwärtsstrecke)	+ 50
Endstelle (im Innenbereich)	+ 42

Anmerkung 1: Der in der Tabelle für die Zentralstation angegebene Wert der spektralen EIRP-Dichte wird als geeignet für konventionelle 90°-Sektorantennen angesehen.

Tabelle 2

Höchstwerte der spektralen EIRP-Dichte für Mobilfunkanwendungen zwischen 3 400—3 800 MHz

Stationsart	Maximale spektrale EIRP-Dichte (dBm/MHz) (Mindestbereich der automatischen Sendeleistungsregelung (ATPC): 15 dB)
Zentralstation	+ 53 Anmerkung 1
Endstelle	+ 25

Anmerkung 1: Der in der Tabelle für die Zentralstation angegebene Wert der spektralen EIRP-Dichte wird als geeignet für konventionelle 90°-Sektorantennen angesehen.

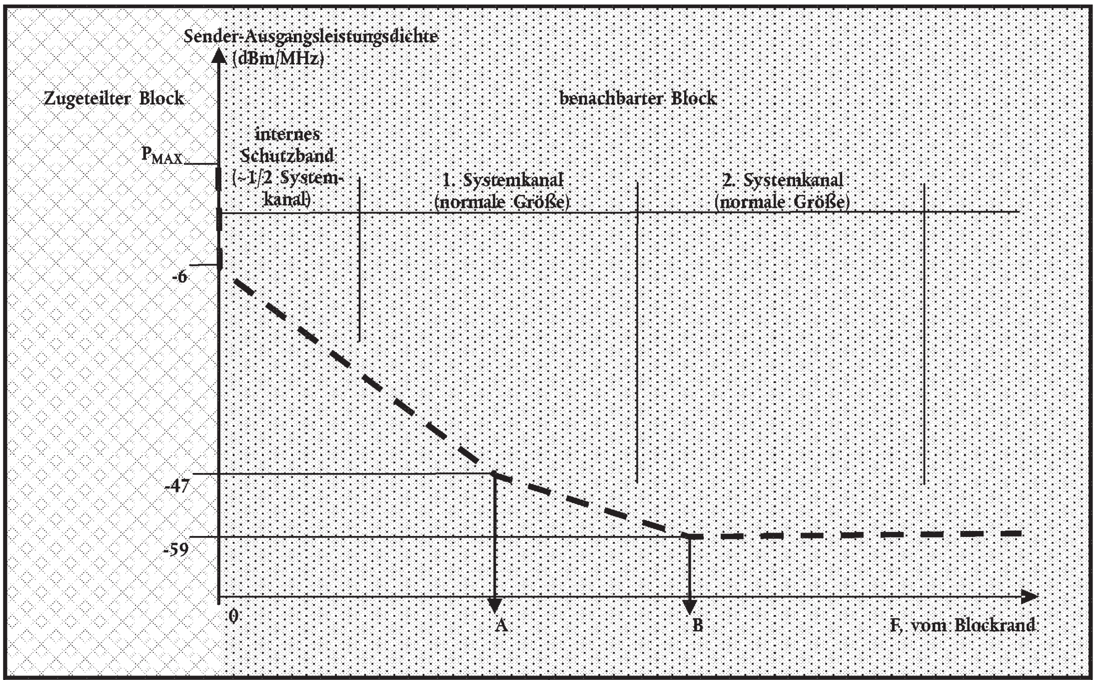
([1]) EIRP bedeutet *äquivalente isotrope Strahlungsleistung* (Equivalent Isotropic Radiated Power).

([2]) Die allgemeinen technischen Bedingungen für feste und ortsungebundene Netze sind in den harmonisierten Normen EN 302 326-2 und EN 302 326-3 beschrieben, die auch Begriffsbestimmungen für Zentralstation und Endstelle enthalten. Der Begriff Zentralstation entspricht dem Begriff Basisstation, der im Zusammenhang mit zellularen Mobilfunknetzen verwendet wird.

B. HÖCHSTWERTE FÜR AUSSERBLOCKAUSSENDUNGEN (FREQUENZBLOCK-ENTKOPPLUNGSMASKE FÜR ZENTRALSTATIONEN)

Abbildung

Außerblockaussendungen der Zentralstation



Frequenzabstand	Definition (% der Größe des zugeteilten Frequenzblocks)
A	20 %
B	35 %
Anmerkung: Bei unterschiedlich großen Frequenzblöcken beziehen sich die unter „Definition" angegebenen Prozentsätze auf den kleineren der benachbarten Blöcke.	

Tabelle

Tabellarische Beschreibung der Frequenzblock-Entkopplungsmaske für die Zentralstation

Frequenzabstand	Höchstwerte für die Sender-Ausgangsleistungsdichte der Zentralstation (dBm/MHz)
Innerhalb des Bands (innerhalb des zugeteilten Blocks)	Siehe Tabellen 1 und 2
$\Delta F = 0$	-6
$0 < \Delta F < A$	$-6 - 41 \cdot (\Delta F/A)$
A	-47
$A < \Delta F < B$	$-47 - 12 \cdot ((\Delta F - A)/(B - A))$
$\Delta F \geq B$	-59

F 1/09

Anlage J

Gliederung des Businessplans

Businessplan

	PLAN G&V	2010	2011	2012
		in Tsd EUR	in Tsd EUR	in Tsd EUR
	Dienste			
	Vorleistungen			
	Sonstige			
Erträge	**Gesamt**	**0**	**0**	**0**
	Personal eigenes			
	Leasingpersonal und freie Mitarbeiter			
	technischer Aufwand durch Dritte			
	Miete, Leasing von technischem Anlagevermögen			
	Mietleitungsaufwand			
	Vorleistungen			
	Abschreibung auf technisches Anlagevermögen Funknetz			
	Abschreibung auf sonstiges technisches Anlagevermögen			
	sonstige Abschreibung			
	sonstiger Aufwand			
Aufwand	**Gesamt**	**0**	**0**	**0**
	Betriebsergebnis	**0**	**0**	**0**
	Cash Flow	**0**	**0**	**0**

Investitionen	techn. Ausstattung Funknetz			
	sonstige techn. Ausstattung			
	sonstige Investitionen			
	Gesamt	**0**	**0**	**0**
Finanzierung	Eigenmittel			
	Fremdmittel verbundene Unternehmen kurzfristig (bis ca. 3 Jahre)			
	Fremdmittel verbundene Unternehmen langfristig			
	Fremdmittel sonstige kurzfristig (bis ca. 3 Jahre)			
	Fremdmittel sonstige langfristig			
	Gesamt	**0**	**0**	**0**

Personal	Anzahl Mitarbeiter (in GTK)[1] techn. Personal			
	Anzahl Mitarbeiter (in GTK)[1] sonstiges Personal			
	Leasingpersonal und freie Mitarbeiter			
	Gesamt	**0**	**0**	**0**

	PLANBILANZ	2010	2011	2012
		in Tsd EUR	in Tsd EUR	in Tsd EUR
	technisches AV Funknetz			
	sonstiges technisches AV			
	sonstiges AV			
	Anlagevermögen Gesamt	0	0	0
	Sonstige Aktiva			
Aktiva	**Gesamt**	**0**	**0**	**0**
	Eigenkapital			
	Verbindlichkeiten verbundene Unternehmen kurzfristig (bis ca. 3 Jahre)			
	Verbindlichkeiten verbundene Unternehmen langfristig			
	Verbindlichkeiten sonstige kurzfristig (bis ca. 3 Jahre)			
	Verbindlichkeiten sonstige langfristig			
	Sonstige Passiva			
Passiva	**Gesamt**	**0**	**0**	**0**

1) **G**anz-**T**ages-**K**räfte (GTK): Umrechnung des teilbeschäftigten Personals auf vollbeschäftigtes:
Eine Teilzeitkraft mit 10 Wochenstunden entspricht 0,25 GTK (wenn die Regelarbeitszeit bei Vollbeschäftigung 40 Wochenstunden beträgt).

F 1/09

Anlage K

Abtretungserklärung Sparbuch

Abtretungserklärung

An

Telekom-Control-Kommission

Mariahilferstrasse 77-79

A-1060 Wien

Österreich

____

Name und Anschrift des Antragstellers

Betr.: **Antrag zu F 1/09**

Der Antragsteller erklärt die unwiderrufliche Abtretung (siehe Kapitel 2.4 der Ausschreibungsunterlage) folgenden Sparbuches

Name ______________________________________

Kontonummer _________________________________

Bank _______________________________________

Bankleitzahl _________________________________

Losungswort _________________________________

Betrag ______________________________________

Datum:

____________________ ____________________

(firmenmäßige Zeichnung)

F 1/09

Telekom-Control-Kommission

TKK

Anlage L

Vorlage Bankgarantie

Vorlage für Bankgarantie

Bankbezeichnung

Adresse

Republik Österreich

c/o Telekom-Control-Kommission

Mariahilferstraße 77-79

A-1060 Wien

Garantie Nummer 1234567890

Die Bank XX gibt hiermit der Republik Österreich die nachstehend umschriebene unwiderrufliche Garantieerklärung ab:

Der Bank ist bekannt, dass sich die Firma XX, Adresse, im Rahmen des derzeit laufenden Ausschreibungsverfahrens um die Frequenzzuteilungen im Frequenzbereich 3,5 GHz (F 1/09) bewirbt. Gemäß Kapitel 2.4 der Ausschreibungsunterlage vom XX.XX.2009 der Telekom-Control-Kommission muss die Firma XX zusammen mit ihrem Antrag eine abstrakte Bankgarantie einer Bank mit guter Bonität zur Besicherung der beantragten Bietberechtigung erbringen.

Die Bank XX garantiert hiermit gegenüber der Republik Österreich, ohne Prüfung des zugrundeliegenden Rechtsverhältnisses und unter Verzicht auf jede Einwendung daraus, eine Zahlung bis zu einer Gesamtsumme von

Euro XX

(in Worten XX Euro)

Auf Ihre erste schriftliche Aufforderung auf das von Ihnen bezeichnete Bankkonto zu leisten, unter der Bedingung, dass die Zuteilung der Frequenzen nach dieser Ausschreibung an die Firma XX erfolgt ist. Der Eintritt dieser Bedingung gilt uns als nachgewiesen, wenn Sie uns dies in Ihrer schriftlichen Aufforderung bestätigen.

Diese Garantie kann nicht vor dem XX.XX.2009 in Anspruch genommen werden.

Diese Garantie erlischt automatisch, sobald wir diese Urkunde zurückerhalten haben, spätestens jedoch am XX.XX.2009, selbst bei Nichtrückgabe dieser Urkunde, es sei denn, dass sich von Ihnen mittels Brief (per eingeschriebener Post oder Kurierdienst) spätestens an diesem Tag bei uns eintreffend, in Anspruch genommen wurde.

Ansprüche aus der gegenständlichen Garantie können nur mit ausdrücklicher Zustimmung zugunsten Dritter abgetreten, verpfändet bzw. vinkuliert werden.

______________________ ______________________

(firmenmäßige Zeichnung)

F 1/09

Anlage M

ECC/DEC/(07)02 (Availability of frequency bands between 3400-3800 MHz for the harmonised implementation of Broadband Wireless Access systems (BWA))

ELECTRONIC COMMUNICATIONS COMMITTEE

ECC Decision
of 30 March 2007
on availability of frequency bands between 3400-3800 MHz
for the harmonised implementation of
Broadband Wireless Access systems (BWA)

(ECC/DEC/(07)02)

EXPLANATORY MEMORANDUM

1 INTRODUCTION

This CEPT/ECC Decision addresses the availability of frequency bands between 3400-3800 MHz for the harmonised implementation of Broadband Wireless Access (BWA) systems.

BWA is a descriptive term for radiocommunications systems providing wireless delivery (mainly to an end user but not exclusively) of broadband traffic that can encompass fixed, nomadic and mobile applications. It is also considered that BWA systems might include backhauling services for the same or a second operator.

Results of CEPT/ECC studies clearly identify the band 3400-3600 MHz as the widest available choice for current and future BWA deployment in CEPT. The band 3600-3800 MHz has been identified as a possible additional or alternative frequency band. On the basis of a survey undertaken by ERO in 2005, updated in 2006, a clear majority of European countries indicated that they already use the 3400-3600 MHz band for Fixed Wireless Access (FWA). In addition, it was also indicated in the survey that the use of the 3600-3800 MHz band for wireless access systems was at that time limited to a few European countries.

To prepare the harmonisation of the frequency bands 3400-3600 MHz and 3600-3800 MHz for BWA, the following sharing considerations have been carried out:

- The intra-service sharing (i.e. co-existence rules for two BWA systems/cells of different operators) was originally addressed in ECC Report 33 (February 2006) for FWA/NWA deployment. The subsequent studies of mobile usage mode, i.e. Mobile Wireless Access (MWA) systems, were based on certain assumptions that included un-coordinated deployment as well as possible concentration of users (with active user density representative of BWA scenarios) in indoor environment. These studies indicated that a guard band of around one channel might be needed for MWA Terminal Station (TS) to TS compatibility scenario, which is understood to be implicitly provided by Central Station (CS) Block Edge Mask requirements.

- The inter-service sharing of BWA vs. other systems and/or services across entire 3400–3800 MHz range. The other systems and/or services considered in this study were Electronic News Gathering and Outside Broadcasting (ENG/OB), Fixed Point-to-Point links, Fixed-Satellite Service (Space-to-Earth) and Radiolocation Service (primary allocation below 3400 MHz and secondary allocation above 3400 MHz). The results of these studies are contained in ECC Report 100. This Report provides guidance for Administrations on co-ordination between BWA and other systems/services in the band, the details of the coordination depending upon the characteristics of other systems/services and the BWA as well as BWA usage mode. This includes guidance for co-channel sharing scenarios as well as for some adjacent compatibility cases, such as the impact from BWA operation in the 3400-3600 MHz band into FSS earth station receivers operating above 3600 MHz.

2 BACKGROUND

In 1998 the band 3400-3600 MHz was identified as a preferred frequency band for FWA (ERC/REC13-04, ERC/REC14-03, ERC Report 25 refer). The band 3600-3800 MHz is also used in some CEPT countries for multipoint FWA systems in accordance with provisions of ERC/REC 12-08. Consequently, many CEPT administrations have already delivered FWA licences to operators in order to provide FWA services. These authorisations are more often technologically neutral and provide flexibility and freedom for operators to choose the best use of the spectrum for fixed applications. Any modification of the use of the spectrum, especially on the usage mode, shall be analysed in terms of compatibility and general policy for the licensed band.

During recent years the broadband connectivity has been increasing in Europe dramatically, boosted by the demand for high speed access to the Internet, large volume e-mailing, video and audio streaming and file sharing and further innovative multimedia services. The prospects of BWA take-up have been changing recently after the consolidated industry efforts resulted in development of open inter-operability standards and new modulation technologies, allowing to overcome the former line-of-sight requirements for links in subject bands, hence allowing deployment of easy-to-install indoor user terminals. Recognising this ever increasing demand for broadband connectivity and the improved prospects of radiocommunications systems in satisfying these demands in a most universal way, the ECC has studied the advantages and disadvantages of the development of a regulatory framework for BWA in the frequency band 3400-3800 MHz.

BWA systems are expected to be mainly deployed in all usage modes i.e. FWA, Nomadic Wireless Access (NWA) and MWA, where the CS will be at a fixed location, while TS will be deployed in a ubiquitous way. This Decision did not consider wireless access systems using Multipoint-to-Multipoint (MP-MP, also known as Mesh) architectures. Therefore further studies might be necessary in order to verify the applicability of this Decision for MP-MP (Mesh) systems subject to market availability of such systems.

It should be noted that BWA TSs may use either directional or omni-directional antennas. It is assumed that, for FWA/NWA use, the vast majority of TSs using omni-directional antennas will be operated indoors, but this may not necessarily be the case for MWA use.

The more traditional authorisation approach required the regulator to make decisions between the service definitions identified for each particular frequency band within an allocation table (e.g. European Common Allocations table in ERC Report 25). This then required the regulator to define specific operating conditions. These conditions were required to manage the interference potential for the specific usage mode (e.g. fixed and mobile). Therefore, this may have meant that not all of the usage modes would be permitted. In some CEPT countries there has already been a move towards spectrum authorisations that allow operators flexibility in the manner in which networks are deployed and configured. These are spectrum block geographical area authorisations. This is where the operator is given authorisation to use a particular frequency block for a defined geographic area, rather than defining the operating conditions (e.g. specific location of transmitters, specific bandwidth etc.). In this regime it could be possible, depending on the national situation, to give to the operators the flexibility to determine the usage mode. However it has to be acknowledged, that the need for managing the different interference potential related to the specific usage mode might result in limiting this additional flexibility, or in different constraints for the use of some modes.

3 REQUIREMENT FOR AN ECC DECISION

The allocation or designation of frequency bands for use by a service or system under specified conditions in CEPT administrations is laid down by law, regulation or administrative action. ECC Decisions are required to deal with the radio spectrum related matters and for the carriage and use of equipment throughout Europe. The harmonisation on an European basis supports the *Directive 1999/5/EC of the European Parliament and of the Council of 9 March 1999 on radio equipment and telecommunications terminal equipment and the mutual recognition of their conformity.* A commitment by CEPT administrations to implement an ECC Decision will provide a clear indication that the required frequency bands will be made available on time and on a European-wide basis.

ECC Decision
of 30 March 2007

on availability of frequency bands between 3400-3800 MHz
for the harmonised implementation of
Broadband Wireless Access systems (BWA)

(ECC/DEC/(07)02)

"The European Conference of Postal and Telecommunications Administrations,

considering

a) that the frequency bands 3400-3600 MHz and 3600-3800 MHz are allocated to the Fixed Service and to the Fixed-Satellite Service (space-to-Earth) on a primary basis in ITU Region 1;

b) that the bands in considering “a” are allocated to the Mobile Service on a secondary basis and the band 3400-3600 MHz is also allocated to the Radiolocation Service on a secondary basis in ITU Region 1;

c) that definitions of Broadband Wireless Access (BWA) applications encompassing Fixed Wireless Access (FWA), Nomadic Wireless Access (NWA), and Mobile Wireless Access (MWA) can be found in Recommendation ITU-R F.1399;

d) that the European Common Allocation Table (ECA) specified in ERC Report 25 foresees an allocation in the frequency band 3400-3800 MHz on a primary basis to the Mobile Service, recognising that in some countries the status of the Mobile Service may be secondary;

e) that the ECA indicates the major co-primary utilisation of the band 3400-3600 MHz for BWA applications and coordinated SAP/SAB applications for occasional use;

f) that the ECA indicates the major co-primary utilisation of the band 3600-3800 MHz for BWA, medium/high capacity Fixed Service links and FSS applications;

g) that the band 3400-3600 MHz has been identified as a preferred frequency band for FWA (ERC/REC 13-04, ERC/REC 14-03 refer);

h) that the band 3600-3800 MHz has been also used in some CEPT countries for multipoint FWA systems in accordance with provisions of ERC/REC 12-08;

i) that in some countries the band 3400 MHz to 3410 MHz is used by land, airborne and naval military radars;

j) that FSS earth stations are operated in the bands 3400-3600 MHz and 3600-3800 MHz, especially above 3700 MHz;

k) that Radio Amateur Services are authorised in the frequency band 3400-3410 MHz on a secondary basis;

l) that spectrum authorisations for BWA in the bands in considering “a”, based on assignment/allotment of spectrum blocks over a defined geographical area, may allow one or more of the applications of BWA referred to in considering “c”;

m) that for spectrum authorisations for BWA in the bands in considering “a” that are given by Administrations to individual equipment, i.e. Central Stations (CS), the conditions of use may need to be qualified to manage the technical arrangements between a number of different operators;

n) that for an efficient introduction of BWA in the frequency bands identified in considering “a”, administrations will have to consider an appropriate co-ordination regime, e.g. licensing on a regional, local area or on an individual equipment basis, that takes in to account the extent of the use of these bands by other systems or services (e.g. FSS, Point-to-Point FS, etc);

o) that in general, if suitable separation distance is set up between BWA CS and other systems the impact of BWA Terminal Stations (TS) is not significant. Therefore registration of CSs alone may be sufficient for managing sharing issues;

p) that within the two frequency bands defined in considering “a”, if both bands completely available for BWA, pairing of sub-bands 3400-3500/3500-3600 MHz and 3600-3700/3700-3800 provide suitable frame conditions for Frequency Division Duplex (FDD) and Time Division Duplex (TDD) systems or their combination;

q) that ECC Report 33 on "The analysis of the coexistence of point-to-multipoint Fixed Wireless Systems cells in the 3.4-3.8 GHz band" (February 2006) provides guidelines for efficient, technology independent deployment of 3.5 GHz and 3.7 GHz point-to-multipoint FWA systems;

r) that ECC Report 76 on "Cross-border coordination of multipoint fixed wireless systems in frequency bands from 3.4-33.4 GHz" (February 2006) addresses the issue of finding a most suitable method and criteria for cross-border coordination between point-to-point systems and multipoint FWA systems located on different sides of a national border;

s) that ECC Recommendation (04)05 (adopted in February 2006) provides “Guidelines for accommodation and assignment of multipoint fixed wireless systems in frequency bands 3400-3600 MHz and 3600-3800 MHz”;

t) that ECC Report 100 on ”Compatibility studies in the band 3400-3800 MHz between Broadband Wireless Access Systems (BWA) and other services” addresses the inter-service sharing and adjacent band compatibility of BWA vs. other existing services/systems (point-to-point, ENG/OB, fixed-satellite service (space-to-Earth) and radiolocation service);

u) that taking into account the availability of spectrum on a national basis, some CEPT administrations have already released spectrum within the 3400-3600 MHz band and may also consider providing spectrum to BWA within the 3600-3800 MHz band as far as compatible operation with earth stations in the fixed-satellite service (s-E) as well as with existing Point-to-point links in the fixed service is possible;

v) that it is important to make spectrum available for BWA in order to meet an overall demand for broadband connectivity;

w) that the identification of the bands defined in considering “a” for BWA does not preclude the future use of these bands by other systems and services to which these bands are allocated or designated;

x) that the frequency assignment/allotment for BWA should also take into account the existing bi- or multi-lateral international agreements and general cross-border co-ordination procedures as given in ITU Radio Regulations to ensure suitable protection of similar or different systems and services in neighbouring countries;

y) that in EU/EFTA countries the radio equipment that is under the scope of this Decision shall comply with the R&TTE Directive. Conformity with the essential requirements of the R&TTE Directive may be demonstrated by compliance with the applicable harmonised European standard(s) or by using the other conformity assessment procedures set out in the R&TTE Directive;

DECIDES

1. that spectrum shall be designated for BWA deployment within the band 3400-3600 MHz and/or 3600-3800 MHz, subject to market demand and with due consideration of other services deployed in these bands;

2. that administrations shall consider allowing flexible usage modes within authorised BWA deployments in the frequency bands identified in Decides 1, taking into account the considerations as described in the Annex;

3. that for the deployment of BWA networks in the frequency bands identified in Decides 1, administrations shall take into account the in-band and adjacent band compatibility with other services/systems (e.g. FS, FSS, ENG/OB, etc) and as a result, coordination of the BWA CS with existing services/systems may be required in the concerned area;

4. that this Decision enters into force on 30 March 2007;

5. that the preferred date for implementation of this Decision shall be 01 July 2007;

6. that CEPT administrations shall communicate the national measures implementing this Decision to the ECC chairman and the Office when the Decision is nationally implemented."

Note:

1 The following Members have a derogation to implement this Decision:
Spain until 31 December 2012

2 Please check the Office web site (http://www.ero.dk) for the up to date position on the implementation of this and other ECC Decisions.

Annex

Considerations for Implementation of Flexible Usage Mode for BWA in 3400-3600 MHz and/or in 3600-3800 MHz

1. Definitions

The reference to “flexible usage mode” means regulatory provisions (e.g. licence conditions), which would allow BWA licence holder to deploy various types of TSs: fixed (Fixed Wireless Access - FWA), nomadic (Nomadic Wireless Access - NWA) or mobile (Mobile Wireless Access - MWA).

The detailed definitions of FWA, NWA and MWA are given in Recommendation ITU-R F.1399.

A typical example of FWA TS could be a stationary roof-top user equipment. An example of NWA TS could be a desk-top portable user equipment or laptop PC equipped with the internal BWA access card. An example of MWA TS could be a handheld user terminal.

2. General considerations

When deciding on granting flexible usage mode rights to BWA licence(s), administrations shall consider following issues:

- Compliance with relevant provisions of legal instruments governing the field of radiocommunications, such as the ITU Radio Regulations, EU legislation and corresponding national telecommunications laws (i.e. national acts transposing ITU and EU acts, as well as any further sovereign regulations in the field);
- Legacy situation, e.g. consider the regulatory limitations and conditions of existing (previously issued) authorisations in the frequency bands subject to this Decision;
- Technical provisions established by existing international frequency co-ordination agreements.

3. Technical considerations

As a starting point, the guidance given in ECC Recommendation (04)05 on technical conditions for implementation of flexible usage mode, to be set in the technology neutral BWA licence process, shall be considered.

Furthermore, the introduction of MWA usage mode will be subject to following additional requirements for deployment of mobileTS:

a. Maximum radiated power density of 25 dBm/MHz;
b. Minimum ATPC range of 15 dB;
c. When blocks are assigned contiguously (without external guard bands) care should be taken not to allow a TS transmit centre frequency closer than one channel width from the block edge unless co-ordination between operators is undertaken. Co-ordination may include the application of other specific interference mitigation measures. However it is understood that such a “virtual guard channel” is implicit, under normal circumstances, through application of the CS Block Edge Mask as recommended in ECC/REC(04)05.