CEPT Report 40

Report from CEPT to the European Commission in response to Task 2 of the Mandate to CEPT on the 900/1800 MHz bands

"Compatibility study for LTE and WiMAX operating within the bands 880-915 MHz / 925-960 MHz and 1710-1785 MHz / 1805-1880 MHz (900/1800 MHz bands)"

Final Report on 12 November 2010 by the

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

0 EXECUTIVE SUMMARY

A Commission Decision of 16 October 2009 (2009/766/EC) and a Directive of the European Parliament and of the Council of 16 September 2009 (2009/114/EC) have been approved as measures to enable the introduction of new technologies into the 900/1800 MHz bands. The annex to the EC Decision contains essential technical parameters for systems for which studies have demonstrated the ability to coexist with GSM. In addition to UMTS, which is already included in this annex, there is confirmation from Industry that other technologies are envisaged for deployment in the 900/1800 MHz bands. Before further technologies can be included in this annex, coexistence analysis would need to be conducted.

The European Commission has issued a mandate to CEPT on the technical conditions for allowing LTE and possibly other technologies within the bands 880-915 MHz / 925-960 MHz and 1710-1785 MHz / 1805-1880 MHz (900/1800 MHz bands).

This EC Mandate encompasses the following tasks:

- Task 1: on whether there are other technologies besides LTE developing equipment for 900/1800 MHz that would need to be studied,
- Task 2: to study the technical conditions under which LTE technology (and other technology identified in task1) can be deployed in the 900/1800 MHz bands
- Task 3: Investigate compatibility between UMTS and adjacent band systems above 960MHz.

Under Task 1 CEPT has verified that WiMAX is another technology besides LTE showing interest for 900/1800 MHz bands that would need to be studied within the scope of this mandate.

Concerning Task 2, ECC PT1 decided to draft two CEPT Reports:

- This CEPT Report 40 ("in band") on compatibility study for LTE and WiMAX operating within the bands 880-915 MHz / 925-960 MHz and 1710-1785 MHz / 1805-1880 MHz (900/1800 MHz bands)
- Another CEPT Report 41 ("adjacent band") on compatibility study between LTE and WiMAX operating within the bands 880-915 MHz / 925-960 MHz and 1710-1785 MHz / 1805-1880 MHz (900/1800 MHz bands) and systems operating in adjacent bands

Based on the analysis of the simulation results of the interference between LTE/WiMAX and GSM, the frequency separation between the LTE/WiMAX channel edge and the nearest GSM carrier's channel edge is derived as follows:

1) When LTE/WiMAX networks in 900/1800 MHz band and GSM900/1800 networks are in uncoordinated operation, the recommended frequency separation between the LTE/WiMAX channel edge and the nearest GSM carrier's channel edge is 200 kHz or more.
2) When LTE/WiMAX networks in 900/1800 MHz band and GSM900/1800 networks are in coordinated operation (co-located sites), no frequency separation is required between the LTE/WiMAX channel edge and the nearest GSM carrier's channel edge.

The recommended frequency separation of 200 kHz or more for the uncoordinated operation can be reduced based on agreement between network operators, bearing in mind that the LTE/WiMAX wideband system may suffer some interference from GSM due to LTE/WiMAX BS/UE receiver narrow band blocking effect.

Based on the analysis of the simulation results of the interference between LTE/WiMAX and UMTS, there is no frequency separation required between the LTE/WiMAX channel edge and the UMTS carrier's channel edge.

Based on the analysis of the simulation results of the interference between LTE systems with different channel bandwidths, there is no requirement on frequency separation between LTE channel edges for the different channel bandwidths.

Based on the analysis of the simulation results of the interference between WiMAX systems with different channel bandwidths, there is no requirement on frequency separation between WiMAX channel edges for the different channel bandwidths.

Based on a simple analysis of the system parameters, CEPT concluded that the downlink interference from LTE to WiMAX and from WiMAX to LTE does not require frequency separation between channel edges. It is noted that the ACLR figures for LTE and WiMAX are similar. Although these figures are not directly applicable to the interference scenario between LTE and WiMAX since they refer to interference from LTE to LTE and WiMAX to WiMAX respectively (assumed difference in channel occupation between LTE and WiMAX), this gives an indication that interference between LTE and WiMAX and vice versa will be limited.

The uplink interference between LTE and WiMAX has not been analysed through simulations.
As a result of these studies, to ensure coexistence between LTE/WiMAX and GSM/UMTS in the 900/1800 MHz bands, the following parameters shall be respected:

Systems	Technical Parameters	Date
LTE complying with LTE Standards, as published by ETSI, in particular EN301908-1, EN301 908-13, EN301908-14, and EN301908-11	1) A frequency separation of 200 kHz or more between LTE channel edge and the GSM carrier's channel edge between a neighbouring LTE network and a GSM network 2) No frequency separation required between LTE channel edge and the UMTS carrier's channel edge between a neighbouring LTE network and a UMTS network 3) No frequency separation required between LTE channel edges between two neighbouring LTE networks These recommended technical conditions could be relaxed at national level based on agreement between operators.	
WiMAX complying with harmonised standards EN301908-21 and EN301908-22 under development in ETSI	1) A frequency separation of 200 kHz or more between WiMAX channel edge and the GSM carrier's channel edge between a neighbouring WiMAX network and a GSM network 2) No frequency separation required between WiMAX channel edge and the UMTS carrier's channel edge between a neighbouring WiMAX network and a UMTS network 3) No frequency separation required between WiMAX channel edges between two neighbouring WiMAX networks These recommended technical conditions could be relaxed at national level based on agreement between operators.	

Note:
It should be noted that EC Decision 2009/766/EC and ECC Decision (06)01 define the required frequency separation as the separation between the two carriers' centre frequencies. This approach is straight-forward for both GSM and UMTS as those technologies have fixed carrier separations of 200 kHz and 5 MHz respectively.
Since both LTE and WiMAX have multiple possible channel bandwidths, the required frequency separation for those technologies is defined in a generic way based on the separation between the channel edges of the respective carriers. This generic edge-to-edge separation can then be converted into the appropriate separation of the carriers' centre frequencies taking into account the relevant channel bandwidths.
For example, for a 5 MHz LTE/WiMAX system, the generic edge-to-edge separation (uncoordinated) of 200 kHz results in a separation between the LTE and GSM carriers' centre frequencies of 2.8 MHz, whereas for a 10 MHz LTE/WiMAX system the generic edge-to-edge separation (uncoordinated) of 200 kHz results in a separation between the LTE/WiMAX and GSM carriers' centre frequencies of 5.3 MHz.

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LIST OF ABBREVIATIONS

Abbreviation	Explanation
3GPP	3rd Generation Partnership Project
ACIR	Adjacent Channel Interference Ratio
ACLR	Adjacent Channel Leakage Ratio
ACS	Adjacent Channel Selectivity
BER	Bit Error Rate
BS	Base Station
CEPT	Conférence Européenne des Administrations des Postes et des Télécommunications
DL	Down Link
EIRP or e.i.r.p.	Equivalent isotropically radiated power
EC	European Commission
ECC	Electronic Communications Committee
ETSI	European Telecommunications Standards Institute
FDD	Frequency Division Duplex
GSM	Global System for Mobile communication
IEEE	Institute of Electrical and Electronics Engineers
LTE	Long Term Evolution (IMT technology developed by 3GPP)
MCBTS	Multi Carrier Base Transceiver Station
MCL	Minimum Coupling Loss
MCS	Modulation Coding Scheme
MS	Mobile Station
OOB	Out Of Band
RF	Radio Frequency
SEM	Spectrum Emission Mask
SINR	Signal to Interference plus Noise Ratio
SNR	Signal to Noise Ratio
UE	User Equipment
UL	Up Link
UMTS	Universal Mobile Telecommunications System

Compatibility study for LTE and WiMAX operating within the bands 880-915 MHz / 925-960 MHz and 1710-1785 MHz / 1805-1880 MHz (900/1800 MHz bands)

1 INTRODUCTION

A Commission Decision of 16 October 2009 (2009/766/EC) and a Directive of the European Parliament and of the Council of 16 September 2009 (2009/114/EC) have been approved as measures to enable the introduction of new technologies into the 900/1800 MHz bands. The annex to the EC Decision contains essential technical parameters for systems for which studies have demonstrated the ability to coexist with GSM. In addition to UMTS, which is already included in this annex, there is confirmation from Industry that other technologies are envisaged for deployment in the 900/1800 MHz bands. Before further technologies can be included in this annex, coexistence analysis would need to be conducted. The European Commission has issued a mandate to CEPT on the technical conditions for allowing LTE and possibly other technologies within the bands 880-915 MHz / 925-960 MHz and 1710-1785 MHz / 1805-1880 MHz (900/1800 MHz bands).

The mandate comprises the following elements for study:

(1) Verify whether there are other technologies besides LTE developing equipment for 900/1800 MHz that would need to be studied concerning their coexistence with GSM at this stage.

(2) Study the technical conditions under which LTE technology can be deployed in the 900/1800 MHz bands: With the aim of adding LTE and possibly other technologies (identified in Task 1) to the list in the annex of the draft decision on 900/1800 MHz frequency bands (see Footnote 6), technical coexistence parameters should be developed. A Block Edge Mask is not requested at this stage, noting that common and minimal (least restrictive) parameters would be appropriate after strategic decisions concerning the role of GSM as the reference technology for coexistence have been taken.

(3) Investigate compatibility between UMTS and adjacent band systems above 960 MHz: Noting that compatibility with systems outside of the 900/1800 MHz bands will be studied for LTE and any other identified technology at all band edges under Task 2, the aim of this task is to review the risk of interference between UMTS and existing and planned aeronautical systems above 960 MHz, in order to enable the development of all systems below and above 960 MHz without taking a risk relating to aeronautical safety.

This Report deals with the reply to Task 2 of the EC Mandate, in particular the technical co-existence within the 900/1800 MHz bands ("in band" studies). A separate CEPT Report (CEPT Report 41) addresses technical co-existence with adjacent bands ("adjacent band" studies) defined in Task 2. The compatibility study between UMTS and adjacent band systems above 960 MHz is described in another CEPT Report (CEPT Report 42).

The following co-existence scenarios are covered in this report:

Co-existence scenarios covered in this report				
To **From**	**GSM**	**UMTS**	**LTE**	**WiMAX**
GSM	No	No (Already covered by ECC Report 082)	Yes, Section 9.2	Yes, Section 13.2
UMTS	No (Already covered by ECC Report 082)	No. (Already covered by ECC Report 082)	Yes, Section 10.2	Yes, Section 14.3
LTE	Yes, Section 9.1	Yes, Section 10.1	Yes, Section 11	Yes, Section 16
WiMAX	Yes, Section 13.1	Yes, Section 14.2	Yes, Section 16	Yes, Section 15

2 CHANNEL ARRANGEMENTS IN THE 900 MHZ AND 1800 MHZ BANDS

2.1 900 MHz

- 2 x 25 MHz are allocated as Standard or primary GSM 900 Band, P-GSM:
  - Uplink: 890 MHz to 915 MHz: mobile transmit, base receive;
  - Downlink: 935 MHz to 960 MHz: base transmit, mobile receive.
- Another 2 x 10 MHz are allocated as Extended GSM 900 Band, E-GSM:
  - Uplink: 880 MHz to 915 MHz: mobile transmit, base receive;
  - Downlink: 925 MHz to 960 MHz: base transmit, mobile receive.

In total there are thus 2 x 35 MHz used by GSM900 (Standard GSM and Extended GSM).

Figure 1: 900 MHz band plan

2.2 1800 MHz

2 x 75 MHz of the 1800 MHz frequency band are totally or partially allocated to and used by GSM (DCS), see Figure 2:
- Uplink: 1 710 MHz to 1 785 MHz: mobile transmit, base receive;
- Downlink: 1 805 MHz to 1 880 MHz: base transmit, mobile receive.

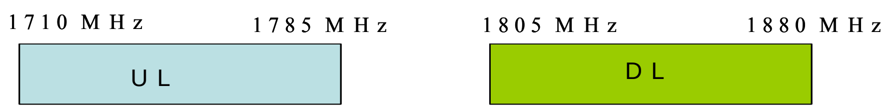

Figure 2: 1800 MHz frequency band plan

It should be pointed out that both GSM900 and GSM1800 have channel raster of 200 kHz, as described in ETSI EN301 502[7], the carrier frequency is the multiple of 200 kHz.

Fl(n) and Fu(n) for all other ARFCNs:

P-GSM 900	Fl(n) = 890 + 0.2*n	$1 \leq n \leq 124$	Fu(n) = Fl(n) + 45
E-GSM 900	Fl(n) = 890 + 0.2*n Fl(n) = 890 + 0.2*(n-1024)	$0 \leq n \leq 124$ $975 \leq n \leq 1\ 023$	Fu(n) = Fl(n) + 45
DCS 1 800	Fl(n) = 1710.2 + 0.2*(n-512)	$512 \leq n \leq 885$	Fu(n) = Fl(n) + 95

Where Fl(n) and Fu(n) are the downlink and uplink carrier frequencies in MHz, ARFCN is the absolute radio frequency channel number.

UMTS (UTRA-FDD) has also a channel raster of 200 kHz, as described in ECC Report 082 [5].

GSM900/1800 and UMTS900/1800 system characteristics and parameters can be found in the ECC Report 082 [5].

3 LTE900 AND LTE1800 SYSTEM CHARACTERISTICS

The LTE900 and LTE1800 system parameters are summarized in Table 1. Further details on LTE system parameters are described in Annex 1.

	LTE900		**LTE1800**	
Downlink band (MHz)	925 – 960		1805-1880	
Uplink band (MHz)	880 – 915		1710 – 1785	
Carrier separation (MHz)/ carrier bandwidth/ resource blocks	1.4/1.08/6 3/2.7/15 5/4.5/25 10/9/50 15/13.5/75 20/18/100		1.4/1.08/6 3/2.7/15 5/4.5/25 10/9/50 15/13.5/75 20/18/100	
Channel raster (kHz)	100		100	
	BS	**UE**	**BS**	**UE**
Tx Power (Maximum) (dBm)	43	23	43	23
Antenna gain (dBi)	18 (rural) 15 (urban)	0	18	0
Feeder loss (dB)	3	0	3	0
Antenna height (m)	45 (Rural) 30 (Urban)	1.5	45 (Rural) 30 (Urban)	1.5
Antenna down-tilt (°)	3 (Urban) 3 (Rural)	-	3 (Urban) 3 (Rural)	-
BS-UE MCL (dB)	80 (Rural) 70 Urban)	-	80 (Rural) 70 (Urban)	-
Spectrum mask	Section A1.1 (Ref. TS36.104/ EN301908-14)	Section A1.2 (Ref. TS36.101/ EN301908-13)	Section A1.1 (Ref. TS36.104/ EN301908-14)	Section A1.2 (Ref. TS36.101/ EN301908-13)
ACLR_1 (First adjacent channel) (dB)	45 (LTE & UMTS channel BWs) Section A1.3 (Ref. TS36.104/ EN301908-14)	30 (LTE channel BWs) 33 (3.84 MHz) Section A1.4 (Ref. TS36.101/ EN301908-13)	45 (LTE & UMTS channel BWs) Section A1.3 (Ref. TS36.104/ EN301908-14)	30 (LTE channel BWs) 33 (3.84 MHz) Section A1.4 (Ref. TS36.101/ EN301908-13)
ACLR_2 (Second adjacent channel (dB)	45 dB (LTE & UMTS channel BWs) Section A1.3 (Ref. TS36.104/ EN301908-14)	36 (LTE channel BWs) 36 (3.84 MHz) Section A1.4 (Ref. TS36.101/ EN301908-13)	45 dB (LTE & UMTS channel BWs) Section A1.3 (Ref. TS36.104/ EN301908-14)	36 (LTE channel BWs) 36 (3.84 MHz) Section A1.4 (Ref. TS36.101/ EN301908-13)
Spurious emissions	Section A1.5 (Ref. TS36.104/ EN301908-14)	Section A1.6 (Ref. TS36.104/ EN301908-14)	Section A1.5 (Ref. TS36.104/ EN301908-14)	Section A1.6 (Ref.TS36.101/E N301908-13)

	LTE900		LTE1800	
	BS	**UE**	**BS**	**UE**
Receiver Bandwidth (MHz)	1.08 2.7 4.5 9 13.5 18	1.08 2.7 4.5 9 13.5 18	1.08 2.7 4.5 9 13.5 18	1.08 2.7 4.5 9 13.5 18
Receiver Temperature (kBT) (dBm)	-113.6 -109.7 -107.4 -104.4 -102.7 -101.4	-113.6 -109.7 -107.4 -104.4 -102.7 -101.4	-113.6 -109.7 -107.4 -104.4 -102.7 -101.4	-113.6 -109.7 -107.4 -104.4 -102.7 -101.4
Receiver noise Figure (dB)	5	12	5	12
Receiver Thermal Noise Level (dBm)	-108.6 -104.7 -102.4 -99.4 -97.7 -96.4	-101.6 -97.7 -95.4 -92.4 -90.7 -89.4	-108.6 -104.7 -102.4 -99.4 -97.7 -96.4	-101.6 -97.7 -95.4 -92.4 -90.7 -89.4
Receiver reference sensitivity	Section A1.7 (Ref. TS36.104/ EN301908-14)	Section A1.8 (Ref. TS36.101/ EN301908-13)	Section A1.7 (Ref. TS36.104/ EN301908-14)	Section A1.8 (Ref. TS36.101/ EN301908-13)
Receiver ACS (dB)	Section A1.9 (Ref. TS36.104/ EN301908-14)	Section A1.10 (Ref. TS36.101/ EN301908-13)	Section A1.9 (Ref. TS36.104/ EN301908-14)	Section A1.10 (Ref. TS36.101/ EN301908-13)
Receiver in-band locking	-43 Section A1.11 (Ref. TS36.104/ EN301908-14)	Section A1.12 (Ref. TS36.101/ EN301908-13)	-43 Section A1.11 (Ref. TS36.104/ EN301908-14)	Section A1.12 (Ref. TS36.101/ EN301908-13)
Receiver out-of-band blocking	-15 Section A1.11 (Ref. TS36.104/ EN301908-14)	Section A1.12 (Ref. TS36.101/ EN301908-13)	-15 Section A1.11 (Ref. TS36.104/ EN301908-14)	Section A1.12 (Ref. TS36.101/ EN301908-13)
Receiver Narrow band blocking	Section A1.13 (Ref. TS36.104/ EN301908-14)	Section A1.14 (Ref. TS36.101/ EN301908-13)	Section A1.13 (Ref. TS36.104/ EN301908-14)	Section A1.14 (Ref. TS36.101/ EN301908-13)

Table 1: LTE900/1800 system parameters

4 WIMAX SYSTEM CHARACTERISTICS

The WiMAX900 and WiMAX1800 system parameters are summarized in Table 2. Further details on WiMAX system (IMT technology developed by IEEE) parameters are described in Annex 2. The WiMAX system characteristics contained in this report were provided by WiMAX Forum [8, 11, 15], the Mobile WiMAX-FDD harmonised standards EN301908-21 and EN301908-22 are under development in ETSI.

	WiMAX 900		**WiMAX 1800**	
Downlink band (MHz)	925-960		1805-1880	
Uplink band (MHz)	880-915		1710-1785	
Carrier separation (MHz)	5. 10		5. 10	
Channel raster (kHz)	100		100	
	BS	**UE**	**BS**	**UE**
Tx Power (Maximum) (dBm)	43	23	43	23
Antenna gain (dBi)	15 to 17	0	15 to 17	0
Feeder loss (dB)	3	1	3	1
Antenna height (m)	45 (Rural) 30 (Urban)	1.5	45 (Rural) 30 (Urban)	1.5
Antenna down-tilt (°)	3	-	3	-
BS-UE MCL (dB)	80 (Rural) 70 (Urban)	-	80 (Rural) 70 (Urban)	-
Spectrum mask	Table 48 Table 50	Table 47 Table 49	Table 48 Table 50	Table 47 Table 49
ACLR_1 (dB) (±5MHz for 5 MHz channel) (±10MHz for 10 MHz channel) ACLR_1 (dB) (UTRA BW 3.84 MHz)	45 45	30 33	45 45	30 33
ACLR_2 (dB) (±10 MHz for 5 MHz channel) (±20 MHz for 10 MHz channel)	50	44	50	44
Spurious emissions	Table 55 Table 57	Table 51 Table 53	Table 56 Table 57 Table 58	Table 52 Table 54
Receiver Bandwidth (MHz)	4.75 for WiMAX 5 MHz channel 9.5 for 10 MHz channel	4.75 for WiMAX 5 MHz channel 9.5 for 10 MHz channel	4.75 for WiMAX 5 MHz channel 9.5 for 10 MHz channel	4.75 for WiMAX 5 MHz channel 9.5 for 10 MHz channel
Receiver Thermal Noise Level (dBm)	-102.2 for 5 MHz channel -99.2 for 10 MHz channel	-99.2 for 5 MHz channel -96.2 for 10 MHz channel	-102.2 for 5 MHz channel -99.2 for 10 MHz channel	-99.2 for 5 MHz channel -96.2 for 10 MHz channel
Receiver reference sensitivity (dBm)	-101.3 for 5 MHz channel -98.3 for 10 MHz channel	-97.8 for 5 MHz channel -94.8 for 10 MHz channel	-101.3 for 5 MHz channel -98.3 for 10 MHz channel	-97.8 for 5 MHz channel -94.8 for 10 MHz channel

	WiMAX 900		WiMAX 1800	
	BS	**UE**	**BS**	**UE**
Receiver ACS (dB)	Table 60	Table 59	Table 60	Table 59
Receiver in-band blocking	Table 67 Table 68	Table 61 Table 62	Table 69 Table 70	Table 63 Table 64
Receiver out-of-band blocking	Table 67 Table 68	Table 65	Table 69 Table 70	Table 66
Receiver narrow band blocking	Table 75 Table 76	Table 71 Table 72	Table 77 Table 78	Table 73 Table 74

Table 2: WiMAX900/1800 system parameters

5 CALCULATIONS OF ACIR VALUES FOR INTERFERENCE FROM LTE/WIMAX TO GSM AND UMTS

5.1 Downlink ACIR from UMTS/LTE/WiMAX to GSM/UMTS

UMTS, LTE, and WiMAX ACLR/200 kHz at 300 kHz frequency separation from the channel edge are calculated from the BS spectrum mask, the results are given in Table 3. The calculation of GSM ACS values at different frequency offsets is described in Annex 3.

Then ACIR is calculated with the formula below

$$ACIR = 1/\{1/ACLR + 1/ACS\} \quad (5\text{-}1)$$

	BS ACLR (dB/200 kHz)	GSM MS ACSn (dB)	ACIR (dB)
UMTS (5 MHz)	50	68.7	49.9
LTE (1,4 MHz)	50	58.7	49.5
LTE (3 MHz)	50	68.7	49.9
LTE (5 MHz)	50	68.7	49.9
LTE (10 MHz)	50	78.7	50.0
LTE (15 MHz)	50	78.7	50.0
LTE (20 MHz)	50	78.7	50.0
WiMAX(5 MHz)	50	68.7	49.9
WiMAX(10 MHz)	50	78.7	50.0

Table 3: BS ACLR/200 kHz at 300 kHz frequency separation from channel edge

It can be seen from Table 3 that the ACIR from LTE/WiMAX BS to GSM DL is dominated by LTE/WiMAX BS ACLR, the contribution from GSM ACS to ACIR is negligible.

	BS ACLR (dB/3.84 MHz)	UMTS UE ACS (dB/3.84 MHz)	ACIR (dB/3.84 MHz)
UMTS (5 MHz)	48.6	33	32.9
LTE (1,4 MHz)	48.6	33	32.9
LTE (3 MHz)	48.6	33	32.9
LTE (5 MHz)	48.6	33	32.9
LTE (10 MHz)	48.6	33	32.9
LTE (15 MHz)	48.6	33	32.9
LTE (20 MHz)	48.6	33	32.9
WiMAX(5 MHz)	48.6	33	32.9
WiMAX(10 MHz)	48.6	33	32.9

Table 4: BS ACLR/3.84 MHz at 2.5 MHz frequency separation from channel edge

The ACLR of UMTS/LTE/WiMAX BS have been calculated from the spectrum mask, ACS of UMTS UE was taken from 3GPP TS25.101 & ETSI EN301908. The derived ACIR values are given in Table 4. The same ACIR is obtained for LTE & WiMAX to UMTS DL since LTE and WiMAX BS have the same spectrum mask as UMTS BS.

It can be seen that the ACIR from the BS of LTE and WiMAX to UMTS UE is 32.9 dB/3.84 MHz at 2.5 MHz frequency offset from the channel edge of LTE/WiMAX downlink, it is dominated by the UMTS UE ACS.

5.2 Uplink ACIR from UMTS/LTE/WiMAX to GSM/UMTS

The UE ACLR/200 kHz at 300 kHz frequency offset from the channel edge for UMTS, LTE, and WiMAX are provided in Table 5. It can be seen that LTE 1.4 MHz channel and 3 MHz channel have the smaller ACLR, the ACLR of LTE 1.4 MHz channel is 6 dB smaller compared to that of UMTS UE at 300 kHz frequency offset.

	UE ACLR (dB/200 kHz)	GSM BS ACS (dB)*	ACIR (dB)
UMTS (5 MHz)	31.2	83.7	31.2
LTE (1.4 MHz)	24.8	83.7	24.8
LTE (3 MHz)	27.8	83.7	27.8
LTE (5 MHz)	29.8	83.7	29.8
LTE (10 MHz)	32.8	83.7	32.8
LTE (15 MHz)	34.8	83.7	34.8
LTE (20 MHz)	35.8	83.7	35.8
WiMAX(5 MHz)	30	83.7	30.0
WiMAX(10 MHz)	30	83.7	30.0

Table 5: UE ACLR/200 kHz at 300 kHz frequency separation from channel edge

- Note: in this Table the GSM1800 BS ACS is used, for GSM900 BS ACS, it is several dB more than GSM1800 BS, as shown in Annex 3.

Table 5 shows that the ACIR from UMTS/LTE/WiMAX UE to GSM BS is dominated by UE ACLR, since GSM BS ACS is too high to contribute to the ACIR.

UMTS, LTE, and WiMAX UE ACLR/3.84 MHz at 2.5 MHz frequency offset are calculated with the UE spectrum mask given in Annex 1 and 2, the associated ACIR values with UMTS BS ACS of 46.4 dB are also calculated and given in Table 5.4.

	UE ACLR (dB/3.84 MHz)	UMTS BS ACS (dB/3.84 MHz)	ACIR (dB/3.84 MHz)
UMTS (5 MHz)	33	46.4	32.8
LTE (1.4 MHz)	33	46.4	32.8
LTE (3 MHz)	33	46.4	32.8
LTE (5 MHz)	33	46.4	32.8
LTE (10 MHz)	33	46.4	32.8
LTE (15 MHz)	33	46.4	32.8
LTE (20 MHz)	33	46.4	32.8
WiMAX(5 MHz)	33	46.4	32.8
WiMAX(10 MHz)	33	46.4	32.8

Table 6: UE ACLR/3.84 MHz at 2.5 MHz frequency separation from channel edge

Table 6 shows that the dominant contribution to the uplink ACIR from UMTS/LTE/WiMAX UE to UMTS BS is the UMTS/LTE/WiMAX UE ACLR.

6 CALCULATIONS OF LTE/WIMAX RECEIVER REJECTION AND ACS VALUES FOR INTERFERENCE FROM GSM AND UMTS

6.1 BS Receiver rejection derived from narrow band blocking

The BS receiver rejections at 300 kHz frequency offset from channel edge derived from the narrow band blocking levels for UMTS, LTE, and WiMAX are given in Table 7.

BS	Frequency offset (kHz)	ACS test	Rejection (dB)	Interfering signal
UTRA-FDD (5MHz)	300	-47 dBm	51.4	GSM
LTE(1.4 MHz)	252.5	-49 dBm	54.9	LTE 1 RB
LTE(3 MHz)	247.5	-49 dBm	50.9	LTE 1 RB
LTE(5 MHz)	342.5	-49 dBm	48.7	LTE 1 RB
LTE(10 MHz)	347.5	-49 dBm	48.7	LTE 1 RB
LTE(15 MHz)	362.5	-49 dBm	48.7	LTE 1 RB
LTE(20 MHz)	342.5	-49 dBm	48.7	LTE 1 RB
WiMAX (5 MHz)	300	-53 dBm	44.4	GSM
WiMAX (10 MHz)	300	-50 dBm	44.4	GSM

Table 7: BS receiver rejection at 300 kHz frequency offset derived from narrow band blocking

Note 1: the values of BS receiver rejection are calculated on the basis of the following formula:

$ACS\_relative = ACS\_test – Noise\_floor – 10*\log_{10}(10^{M/10}–1)$

where:

M is the desensitisation defined in the narrow band blocking test (6 dB is taken), the noise floor is calculated with bandwidths given in section 3 and 4 for LTE and WiMAX.

LTE BS (≥5 MHz) receiver rejection is 2.7 dB less than UMTS BS. It must also be taken into account that in the standard different types of interference have been considered for the UTRA and E-UTRA narrowband blocking requirements. In this context, it should be noted that also the modulation of the interferer influences the interferer impact. UTRA blocking is defined with a narrowband interferer based on GMSK modulation which is a constant envelope modulation (no crest factor in the interferer), while for E-UTRA a single RB interferer (OFDM modulated) with a crest factor of 5-7 dB is defined. The resulting impact is that the E-UTRA OFDM modulated narrowband interferer level of -49 dBm is a few dB more stringent as interfering scenario due to crest factor compared to UTRA GMSK modulated interferer of -47 dBm.

The results given in the Table 7 show that WiMAX BS receiver rejection at 300 kHz frequency offset is 7 dB lower compared to UMTS BS.

6.2 UE Receiver rejection derived from narrow band blocking

UE receiver rejection at 300 kHz frequency offset from channel edge is derived from the narrow band blocking. The derived UE receiver rejection values are given in Table 8. It should be noted the LTE 15 MHz and 20 MHz channels UE reference sensitivity in 900 MHz band is not defined, so the narrow band blocking for LTE UE 15 MHz and 20 MHz channel in 900 MHz band may not apply.

BS	Frequency offset (kHz)	ACS test	Desen sitisation (dB)	Rejection (dB) (NF=12 dB)	Rejection (dB) (NF=8 dB)	Interfering signal
UTRA-FDD (5MHz)	300	-56 dBm	10	30,6	34,6	GSM
LTE(1.4 MHz)	207.5	-55 dBm	19	27.7	31.7	CW
LTE(3 MHz)	202.5	-55 dBm	15	27.8	31.8	CW
LTE(5 MHz)	207.5	-55 dBm	13	27.7	31.7	CW
LTE(10 MHz)	212.5	-55 dBm	10	27.9	31.9	CW
LTE(15 MHz)	202.5	-55 dBm	11	25.0	29	CW
LTE(20 MHz)	207.5	-55 dBm	13	21.6	25.6	CW
WiMAX (5 MHz)	300	-53 dBm	16	26.3	30.3	GSM
WiMAX (10 MHz)	300	-53 dBm	13	26.4	30.4	GSM

Table 8: UE receiver rejection at 300 kHz frequency offset derived from narrow band blocking

Note: the values of UE receiver rejection are calculated on the basis of the following formula:

$ACS\_relative = ACS\_test - Noise\_floor - 10*\log_{10}(10^{M/10}-1)$

Where: M is the desensitisation defined in the narrow band blocking test (see Table 8), the noise floor is calculated with a bandwidth defined in section 3 and 4.

The results in the Table 8 show that both LTE and WiMAX UE have lower receiver rejection at 300 kHz frequency offset than UMTS UE.

6.3 BS receiver rejection (ACS) derived from adjacent channel selectivity

LTE/WiMAX BS ACS values are given in Annex 1 and Annex 2 as test condition (interferer level in dBm for a useful signal 6 dB above reference sensitivity). The BS receiver rejection at 2.5 MHz frequency offset from channel edge can be derived with the formula below

$ACS\_relative = ACS\_test - Noise\_floor - 10*\log_{10}(10^{M/10}-1)$

The derived UMTS/LTE/WiMAX BS ACS values at 2.5 MHz frequency offset from channel edge are given in Table 9. The associated ACIR (dB) with UMTS UE ACLR of 33 dB is also obtained and given in Table 9.

BS	Frequency offset (MHz)	ACS (dB)	UMTS UE ACLR (dB)	ACIR (dB)
UTRA-FDD (5MHz)	2.5	46.4	33	32.8
LTE(1.4 MHz)	2.5	51.9	33	32.9
LTE(3 MHz)	2.5	47.9	33	32.8
LTE(5 MHz)	2.5	45.7	33	32.7
LTE(10 MHz)	2.5	42.7	33	32.5
LTE(15 MHz)	2.5	40.9	33	32.3
LTE(20 MHz)	2.5	39.7	33	32.1
WiMAX (5 MHz)	2.5	46	33	32.7
WiMAX (10 MHz)	2.5	Not defined	33	

Table 9: BS receiver ACS at 2.5 MHz frequency offset and ACIR

In Table 9, the ACS value for LTE 1.4 MHz channel is derived with the in-band blocking level of -43 dBm. The ACS value for LTE 3 MHz channel is derived with the ACS test value of -52 dBm at 1.5 MHz frequency offset. The LTE 3 MHz channel BS receiver rejection at 2.5 MHz frequency offset should be better than 47.9 dB given in Table 9.

It can be seen that in the co-existence scenario between UMTS UE and LTE/WiMAX BS, the uplink ACIR is equivalent to the case of UMTS UE to UMTS BS (ACIR=32.8 dB).

6.4 UE receiver rejection (ACS) derived from adjacent channel selectivity

LTE and WiMAX UE ACS values are given in Annex 1 and Annex 2. For LTE 5 MHz channel and WiMAX 5 MHz channel, the ACS value is 33 dB, for other LTE channel bandwidths and WiMAX 10 MHz channel, the technical specifications do not provide sufficient information to calculate the UE receiver rejection at 2.5 MHz frequency offset.

The LTE 5 MHz channel and WiMAX 5 MHz channel UE ACS value and the associated ACIR with UMTS BS ACLR of 48.6 dB are given in Table 10. For other LTE/WiMAX channels, it is not possible to derive the ACIR values, since UE receiver rejection at 2.5 MHz frequency offset is not specified.

BS	Frequency offset (MHz)	ACS (dB)	UMTS BS ACLR (dB)	ACIR (dB)
UTRA-FDD (5MHz)	2.5	33	48.6	32.9
LTE(5 MHz)	2.5	33	48.6	32.9
WiMAX (5 MHz)	2.5	33	48.6	32.9

Table 10: UE receiver ACS at 2.5 MHz frequency offset and ACIR (only for LTE and WiMAX 5 MHz channel)

7 COMPARISON BETWEEN LTE AND WIMAX SYSTEM PARAMETERS

7.1 Transmitter parameters comparison

7.1.1 BS OOB emissions

LTE base station emission masks are given in Annex 1. WiMAX base station emission masks are described in Annex 2. Figure 3 gives the graphical comparison of UMTS/LTE/WiMAX Spectrum Emission Masks (SEMs).

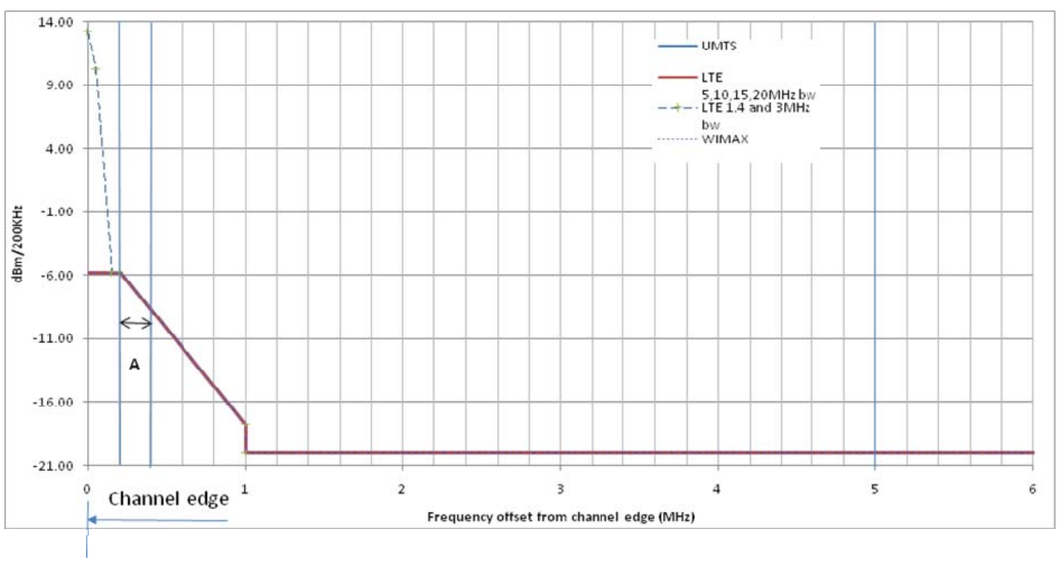

Figure 3: Graphical comparison of Base station SEMs

The above plots show that both LTE and WiMAX masks are identical to the UMTS spectrum emission mask. The LTE mask for 1.4 and 3 MHz bandwidth also follows the UMTS spectrum mask from 0.2 MHz onward.

OOB (Out Of Band) leakage power integrated over the first adjacent 200 kHz GSM channel corresponding to 300 kHz frequency separation from the GSM carrier to the UMTS/LTE/WiMAX channel edge is -7.1dBm. With the assumption of 43 dBm Tx power of the base station, the ACLR over 200 kHz GSM channel is estimated as 43 – (-7.1) = 50.1 dB.

Since LTE and WiMAX BS spectrum mask is the same, it is assumed that the interference from LTE and WiMAX downlink to GSM/UMTS downlink should be similar. This is also clear from Table 3 and Table 4, describing ACIR values for interference from LTE/WiMAX into GSM/UMTS.

7.1.2 UE OOB emissions

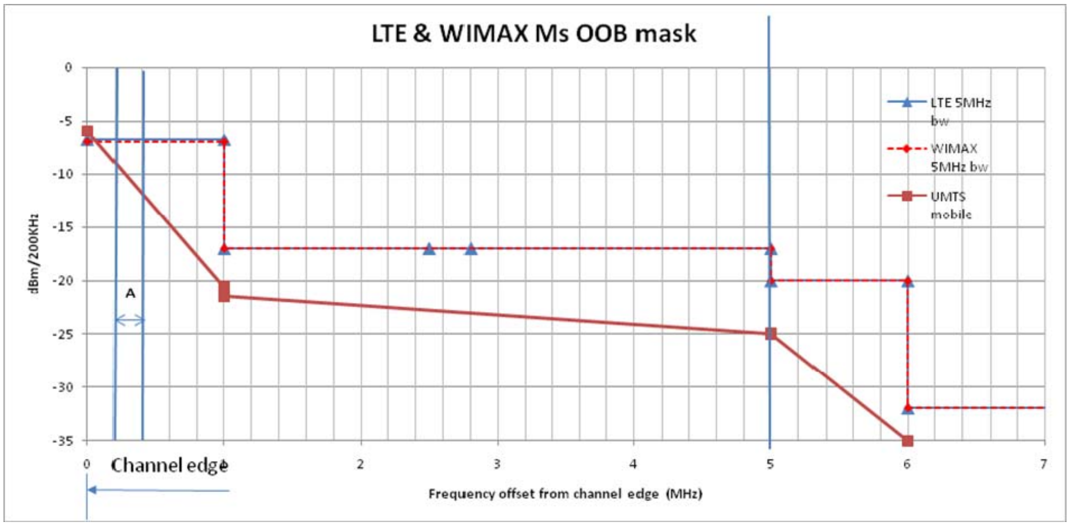

Figure 4: Graphical comparison of LTE and WiMAX Mobile station SEMs (5MHz bandwidth)

The comparison of LTE and WiMAX mobile station spectrum emission masks (5 MHz channel bandwidth) are plotted in Figure 4. For LTE and WiMAX 5 MHz channels, OOB leakage power integrated over first adjacent 200 kHz channel is -6.97 dBm. For UMTS UE, the OOB leakage power integrated over the first adjacent 200 kHz channel is -10.4 dBm. This difference shows that LTE and WiMAX 5 MHz channel spectrum emission masks are worse than UMTS UE. Note further that the relationship between UE spectrum masks of LTE and WiMAX will differ depending on the bandwidth used. In Table 5 and Table 6, ACIR values for interference from different LTE/WiMAX bandwidths into GSM and UMTS are presented in detail.

7.2 Receiver parameters comparison

Receiver rejection and ACS for LTE and WiMAX BS and UE are calculated and described in Section 6, where the results are also compared with UMTS receiver characteristics. The results indicate differences between LTE and WiMAX, to be taken into account in the analysis of interference from GSM and UMTS to LTE/WiMAX.

7.3 Conclusions

In this section, the LTE and WiMAX BS and UE RF parameters, such as transmitter spectrum emission mask, ACLR, ACS, receiver rejection derived from narrow band blocking requirements, as well as ACIR, are compared.

For the LTE/WiMAX base stations, it is clear that interference to GSM and UMTS will be very similar. For interference from LTE/WiMAX terminals, and for interference from GSM and UMTS to LTE/WiMAX, the results indicate that a separate analysis is necessary for the two systems.

These comparisons provide very useful information on the interference analysis described in the following sections, but do not lead to a conclusion on the carrier spacing between different systems in co-existence.

8 CHANNEL RASTERS FOR GSM/UMTS/LTE/WIMAX AND IMPLICATIONS ON CARRIER SEPARATIONS

8.1 Channel rasters of GSM, UMTS LTE and WiMAX

Channel rasters of GSM, UMTS, LTE, and WiMAX are summarised in Table 11. The carrier separation between two systems operating in adjacent bands depend the co-existence study results, but the implementation of the carrier separation is directly impacted by the channel raster.

GSM	200 kHz
UMTS	200 kHz
LTE	100 kHz
WiMAX	100 kHz

Table 11: Channel raster

8.2 Carrier separations between GSM and UMTS/LTE/WiMAX

An example of the frequency arrangements of a GSM carrier and an UMTS carrier is plotted in Figure 5. In this example, the frequency separation between the UMTS carrier frequency and the nearest GSM carrier is 2.8 MHz.

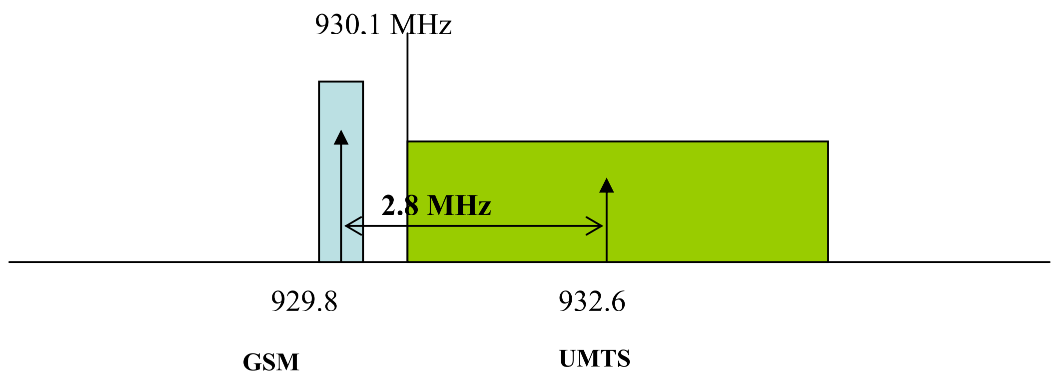

Figure 5: Frequency arrangement of a GSM carrier and an UMTS carrier

Table 11 gives an example of some possible carrier spacing between GSM carrier and UMTS/LTE/WiMAX carriers based on the channel rasters in Table 12. Other carrier positions are also possible.

System	Carrier position	Carrier spacing (MHz)	From GSM carrier to UMTS/LTE/WiMAX channel edge (kHz)
GSM	929.8	-	-
UMTS (5 MHz)	932.4 932.6 932.8	2.6 2.8 3.0	100 300 500
LTE (1.4 MHz)	930.7 930.8 930.9	0.9 1.0 1.1	200 300 400
LTE (3 MHz)	931.5 931.6 931.7	1.7 1.8 1.9	200 300 400
LTE (5 MHz)	932.5 932.6 932.7	2.7 2.8 2.9	200 300 400
LTE (10 MHz)	935 935.1 935.2	5.2 5.3 5.4	200 300 400
LTE (15 MHz)	937.5 937.6 937.8	7.7 7.8 7.9	200 300 400
LTE (20 MHz)	940.0 940.1 940.2	10.2 10.3 10.4	200 300 400
WiMAX (5 MHz)	932.5 932.6 932.7.	2.7 2.8 2.9.	200 300 400
WiMAX (10 MHz)	935 935.1 935.2	5.2 5.3 5.4	200 300 400

Table 12: An example of some possible carrier spacings between GSM and UMTS/LTE/WiMAX

Table 12 shows that a frequency separation of 300 kHz between the nearest GSM carrier centre frequency and UMTS, WiMAX, or LTE is possible.

8.3 GSM system outage due to interference from LTE/WiMAX

The following analysis considers the implications on GSM outage arising from the 200 kHz and 300 kHz separation between the nearest GSM carrier centre frequency and LTE/WiMAX channel edge.

As a comparison, first an ACIR at 300 kHz separation is derived, with a power sum used over four 200 kHz channels:

2nd adjacent channel (towards interferer)
1st adjacent channel (towards interferer)
Wanted channel
1st adjacent channel (away from interferer).

Figure 6 shows the relation of these channels to the adjacent wideband emissions.

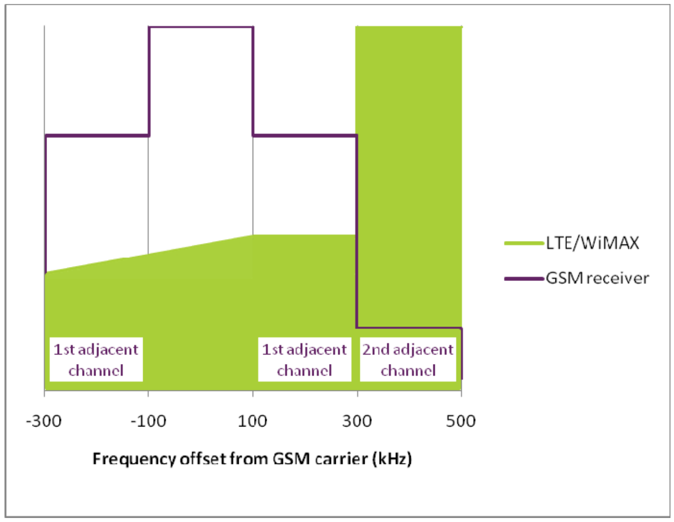

Figure 6: GSM receiver adjacent channels (300 kHz separation)

The interfering system's in-band emissions appear only in the GSM receiver 2nd adjacent channel.

The power sum for 300 kHz separation is as follows:

	OOB (dBm)	ACS (dB)	Received power (dBm)	Received power (mW)	
2nd adjacent channel	29.0206	50	-20.9794	0.007981	
1st adjacent channel	-5.76091	18	-23.760913	0.004206	
Co-channel	-7.17512	0	-7.1751223	0.191641	
1st adjacent channel	-10.1751	18	-28.175122	0.001522	
			Total	0.20535	-6.9dBm

Therefore ACIR is 43 - (-6.9) = 49.9dB

For 200 kHz separation the relation between the channels is shown in Figure 7.

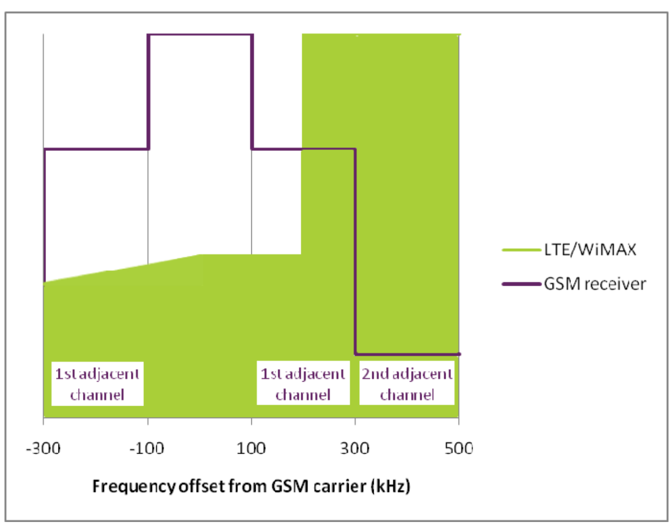

Figure 7: GSM receiver adjacent channels (200 kHz separation)

The interfering system's in-band emissions appear partly within the GSM receiver 1st adjacent channel.

	OOB (dBm)	**ACS (dB)**	**Received power (dBm)**	**Received power (mW)**	
2nd adjacent channel	29.0206	50	-20.9794	0.007981	
1st adjacent channel	26.01174	18	8.0117439	6.326659	
Co-channel	-6.10997	0	-6.1099743	0.244908	
1st adjacent channel	-8.67512	18	-26.675122	0.00215	
			Total	6.581698	8.2dBm

Therefore ACIR is 43 - (8.2) = 34.8dB, the change from 300 kHz separation to 200 kHz separation results in an ACIR degradation of 15.1dB.

The simulation results of interference from LTE to GSM are presented in section 9.1. The graph of GSM downlink outage at different values of ACIR. The source document R4-061288 provides both the graph and the following Table:

ACIR (dB)	**Downlink Capacity Loss (%)**
15	71.84215909
20	41.13877266
25	17.88612643
30	6.02937805
35	1.73542824
40	0.42671551
45	0.08533184
50	0.01878589

Therefore the implication of the different separation on GSM outage is as follows:

Separation (kHz)	**ACIR (dB)**	**GSM Outage (%)**
300	50	0.02
200	35	1.74

The GSM outage criterion was based on C/I=9 dB. In a real network, especially for GSM data service GPRS/Edge, the required C/I is usually more than 9 dB. In this case, the reduction of the frequency offset from 300 kHz to 200 kHz may introduce more than 1.74% GSM system outage. This analysis takes into account only interference from LTE/WiMAX BS to GSM MS; the interference in the opposite direction from GSM to LTE/WiMAX was not considered.

9 CO-EXISTENCE BETWEEN LTE AND GSM

9.1 Interference from LTE (EUTRA) to GSM

The results of the simulations regarding interference from EUTRA to GSM presented in sections 6.1.3.1 and 6.1.3.2 in 3GPP Report TR36.942 [3] are summarized below.

a) GSM DL outage due to interference from LTE DL

The same GSM system outage criterion, C/I=9 dB, used in 3GPP TR25.816 (in line with ECC Report 082) was used in the 3GPP Report TR36.942. The simulation scenarios and assumptions are also taken from the 3GPP Report TR25.816 (same as in ECC Report 082). The simulation results are given in Figure 7.19 and Table 7.13 of 3GPP TR36.942 [3], and are included below (Figure 8 and Figure 9).

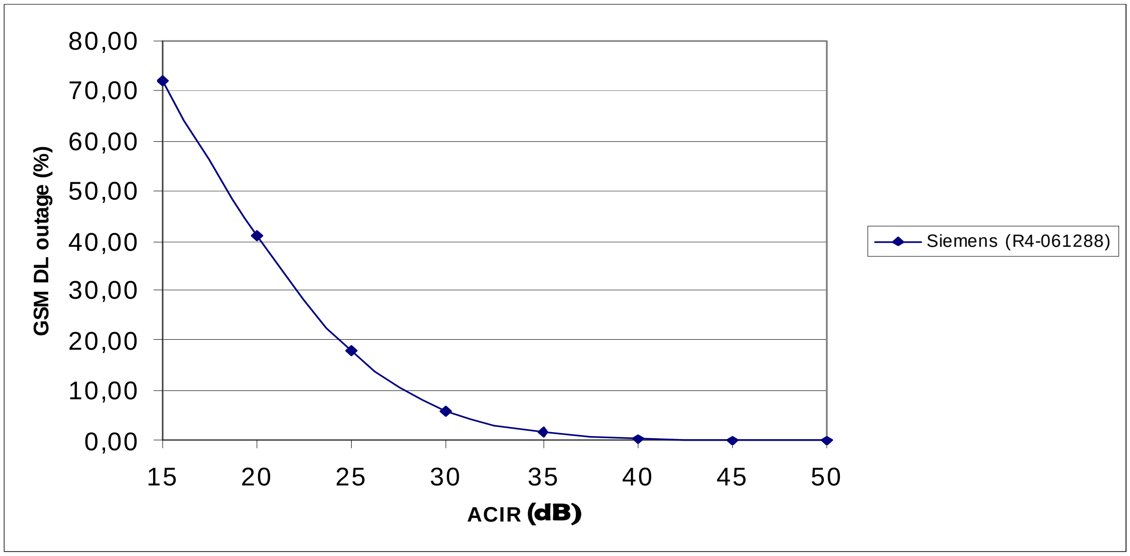

Figure 8: GSM downlink outage (3GPP TR36.942: Figure 7.19)

It can be seen that for 5% GSM DL outage based on C/I=9 dB, the required ACIR is about 30 dB. As described in 3GPP Reports TR25.816 and TR36.942, the dominant factor is considered as UTRA/EUTRA ACLR, not GSM MS ACS. If a more restrictive GSM protection criteria is used, e.g. 2%, the ACIR requirement will increase to roughly 35 dB. As the ACLR requirements on E-UTRA/LTE and WiMAX are higher than that, performance degradation of an adjacent GSM system should be very limited.

b) GSM UL outage due to interference from LTE UL

Simulation results on GSM UL outage due to interference from LTE UL can be found in Figure 7.19a in section 7.1.3.2 of 3GPP TR36.942[3].

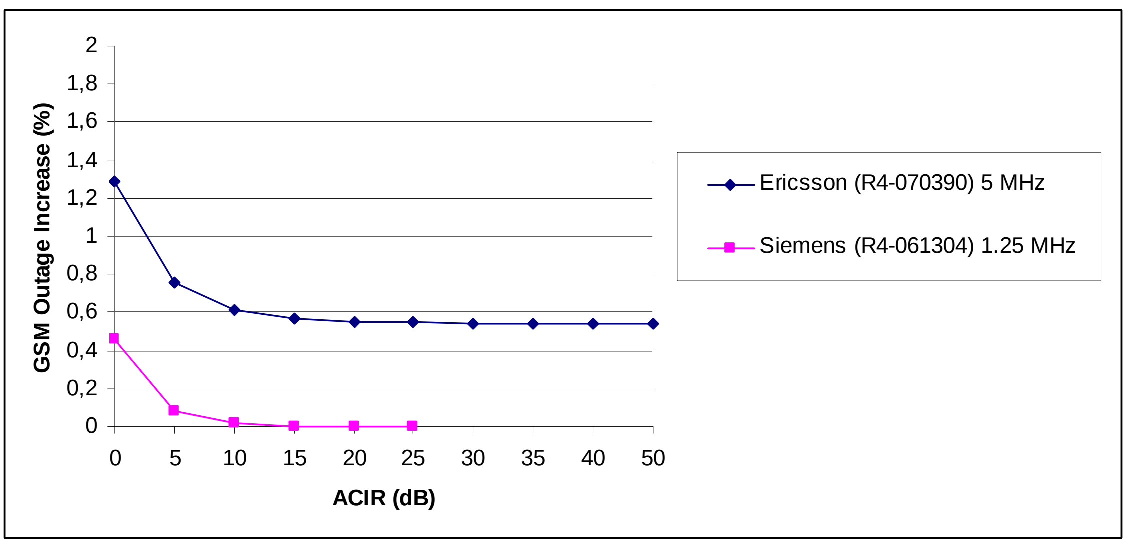

Figure 9: GSM uplink outage (3GPP TR36.942: Figure 7.19a)

The results show that the GSM UL outage is very small even for very low levels of ACIR. At ACIR=5 dB, the GSM UL outage is below 0.8%, as shown in the Figure 9.

It should be noted that the simulation results of interference from LTE to GSM is limited only to some deployment scenarios, and not all of the LTE channel bandwidth have been considered in 3GPP Report TR36.942.

Based on the simulation results and the discussions presented above, it can be concluded that 300 kHz offset from LTE channel edge (separation between the nearest GSM carrier centre frequency and LTE channel edge) is sufficient for the protection of GSM UL/DL against interferences from LTE.

Although the downlink interference from LTE to GSM was only simulated for one LTE bandwidth in 3GPP Report 36.942, Figure 10 and Table 7 show that interference to GSM for other LTE bandwidths will be no worse. Furthermore, 3GPP RAN4 has recommended to extend the conclusions from 900 MHz (LS from 3GPP ECC-PT1(09)178), for which the simulations were carried out, to the 1800 MHz frequency band, assuming that the cell sizes are appropriately scaled according to the propagation losses resulting in comparable signal to noise ratio distributions. Additionally, it should be noted that for both downlink and uplink ACIR there is a considerable margin in comparison to the required level.

9.2 Interference from GSM to LTE (EUTRA)

It is noted that the potential interference from GSM UL/DL to LTE UL/DL have not been analysed through simulations. However, the UMTS and GSM co-existence study results given in 3GPP Report TR25.816 and ECC Report 082 show that the dominant factor of interference from GSM to UMTS is the UMTS BS and UE receiver blocking performance.

The UMTS and LTE BS and UE receiver rejections derived from the narrow band blocking characteristics defined in 3GPP technical specifications were summarized and compared in section 6 (Table 7). As described in section 7, the calculated LTE BS receiver rejection with the narrow band blocking levels is 2.7 dB worse than UMTS BS, but by considering the difference of the interference signal types, the UMTS BS and LTE BS narrow band blocking performances can be considered as equivalent at 300 kHz frequency offset from UMTS/LTE channel edge.

LTE UE receiver rejection derived from narrow band blocking levels are several dB worse than UMTS UE (Table 8) depending the LTE channel bandwidths, for LTE 5 MHz and 10 MHz channel, it is 3 dB worse than UMTS UE receiver rejection at 300 kHz frequency offset from LTE channel edge. On the basis that the LTE system with OFDM modulation is more robust than the WCDMA UMTS system, the interference from GSM downlink to LTE UE should not be a big problem. In practice, in order to minimise the GSM downlink interference to LTE, the GSM BCCH channel without power control should not be placed at the first adjacent to LTE channel at 300 kHz frequency separation.

9.3 Conclusions

The simulated results of interference from LTE to GSM uplink and downlink have shown that LTE and GSM can co-exist under the condition of 300 kHz frequency separation between the nearest GSM carrier centre frequency and the LTE channel edge.

Although the LTE BS narrow band blocking is slightly worse (2.7 dB) than UMTS BS, by considering the difference of interferer signals defined in the UMTS and LTE BS narrow band blocking requirement, it can be shown that LTE BS and UMTS BS have equivalent narrow band blocking performance at 300 kHz frequency separation between the nearest GSM carrier centre frequency and the LTE channel edge. A similar conclusion can be drawn for the UE.

Since the narrow-band blocking performance of UMTS and LTE is equivalent, the results from ECC Report 82 carry over to LTE for GSM interference, which shows that this type of interference will not be a problem.

It should be recalled that the LTE receiver rejections are derived from the narrow band blocking requirements, which are based on a separation of 200 kHz between the GSM channel edge and the LTE channel edge. These receiver rejection values would not be applicable to a narrower frequency separation. This supports the conclusion that 200 kHz should be the minimum separation between the GSM channel edge and the LTE channel edge for uncoordinated operation between neighbouring LTE and GSM networks. For a smaller frequency separation, the interference from LTE to GSM should not be a problem as analysed in section 9.3, but LTE system may suffer some potential interference from GSM.

Based on the interference analysis between LTE and GSM, the frequency spacing between GSM carrier and LTE carrier are summarised in Table 13.

	Frequency spacing between GSM carrier centre frequency and LTE carrier centre frequency	Frequency spacing between GSM carrier centre frequency and LTE channel edge	Frequency spacing between GSM channel edge and LTE channel edge
LTE 1.4 MHz	1 MHz	300 kHz	200 kHz
LTE 3 MHz	1.8 MHz	300 kHz	200 kHz
LTE 5 MHz	2.8 MHz	300 kHz	200 kHz
LTE 10 MHz	5.3 MHz	300 kHz	200 kHz
LTE 15 MHz	7.8 MHz	300 kHz	200 kHz
LTE 20 MHz	10.3 MHz	300 kHz	200 kHz

Table 13: Minimum frequency spacing between GSM carrier and LTE carrier

Provided there is an agreement between network operators, the recommended frequency spacing between GSM and LTE can be reduced if some other interference mitigation measures are taken, for example, better equipment performance, coordinated deployment, etc. The implementation of the recommended minimum frequency spacing should also take into account the system channel raster limitation as described in section 8.

10 CO-EXISTENCE BETWEEN LTE (EUTRA) AND UMTS (UTRA)

The co-existence between UTRA and EUTRA has been studied at 2 GHz. The simulations assumptions and results are reported in 3GPP TR36.942, and are summarized in sections 10.1 and 10.2 below.

10.1 Interference from LTE (EUTRA) to UMTS

The simulations results below are based on the assumption of a 5 MHz E-UTRA aggressor systems, 2 GHz frequency band was used in the simulations, and macro cells (cell range 500 m) in an urban area with uncoordinated deployment as defined in 3GPP TR36.942.

Simulation results for downlink interference are presented in Figure 10.

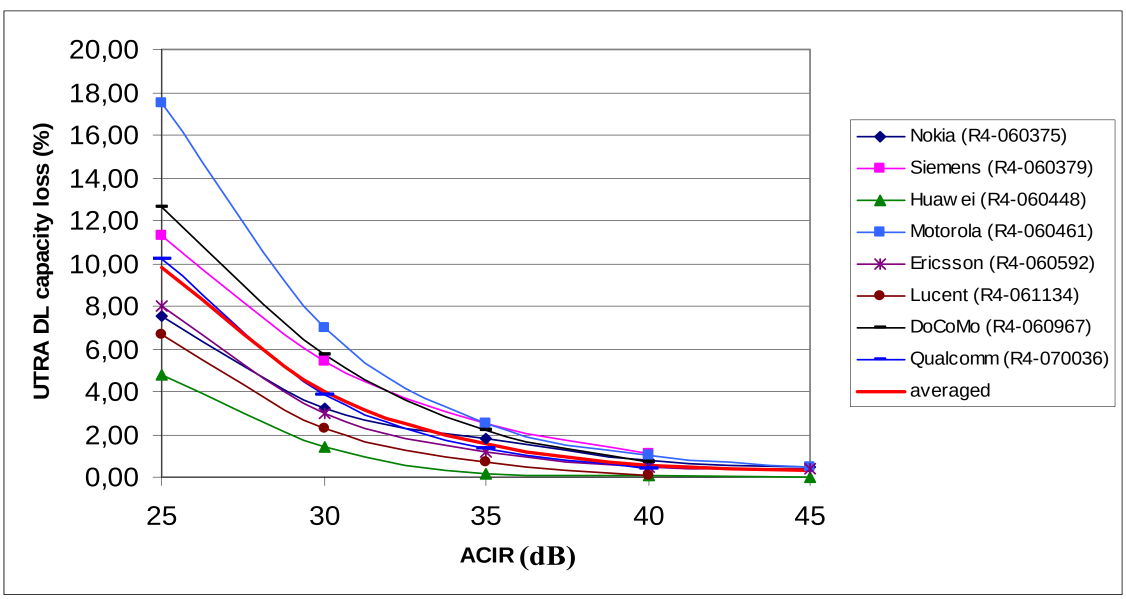

Figure 10: UTRA FDD capacity loss due to interference from LTE

The simulation results presented in the Figure 10 show that for UTRA-FDD downlink capacity loss less than 5%, the required ACIR is about 28 dB. As shown in the Table 8, the LTE to UMTS DL ACIR=32.9 dB at frequency offset of 2.5 MHz between UMTS carrier and LTE channel edge.

Simulation results for uplink interference are presented in Figure 11. The power control used in the simulations is described in 3GPP TR 36.942, Section 5.1.1.6:

$$P_t = P_{\max} \times \min\left\{1, \max\left[R_{\min}, \left(\frac{PL}{PL_{x-ile}}\right)^{\gamma}\right]\right\} \tag{10-1}$$

The parameters are chosen to be 0.8 for γ and $PL_{x\text{-ile}}$, equal to 129 and 133 for 10 and 5 MHz bandwidth respectively. This power control scheme is closely related to the one suggested in the E-UTRA specification, and provides a good balance between throughput and transmit power.

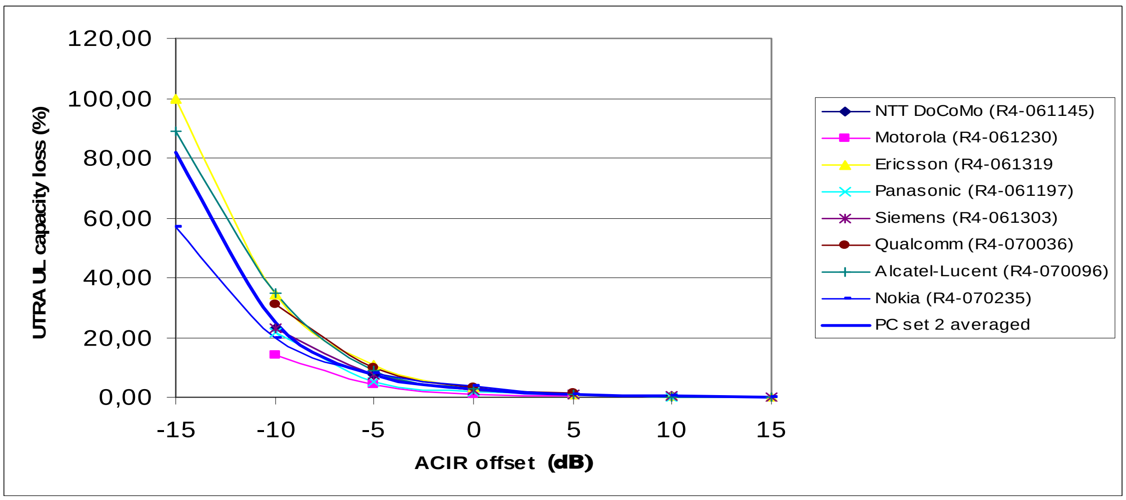

Figure 11: UTRA FDD uplink capacity loss due to interference from LTE

As shown in the Figure 11, at 5% UTRA-FDD uplink capacity loss, the required ACIR offset (relative to 33 dB) is -3 dB. That means ACIR=30 dB is required for ensuring <5% UTRA-FDD uplink capacity loss. This requirement is met, since the ACIR from LTE to UMTS uplink as given in the Table 9 is 32.8 dB.

10.2 Interference from UMTS to LTE (EUTRA)

3GPP 36.942 does not contain any results on interference from UMTS to LTE. However, UMTS is not a worse interferer than LTE itself, so the results for LTE vs LTE, see Section 11 below, are sufficient to show that UMTS will not cause excessive interference to LTE.

10.3 Conclusions

Based on the interference analysis, the frequency separation between LTE (EUTRA-FDD) channel edge and UTRA carrier frequency is proposed as 2.5 MHz or more. The frequency separations needed between a UMTS carrier and LTE carriers of different bandwidths are summarized in Table 14.

	Frequency spacing between UMTS carrier centre frequency and LTE carrier centre frequency	Frequency spacing between UMTS carrier centre frequency and LTE channel edge	Frequency spacing between UMTS channel edge and LTE channel edge
LTE 1.4 MHz	3.2 MHz	2.5 MHz	0 kHz
LTE 3 MHz	4 MHz	2.5 MHz	0 kHz
LTE 5 MHz	5 MHz	2.5 MHz	0 kHz
LTE 10 MHz	7.5 MHz	2.5 MHz	0 kHz
LTE 15 MHz	10 MHz	2.5 MHz	0 kHz
LTE 20 MHz	12.5 MHz	2.5 MHz	0 kHz

Table 14: Frequency spacing between UMTS and LTE

11 CO-EXISTENCE BETWEEN LTE SYSTEMS AT 900/1800 MHz

11.1 Simulation results of interference between LTE SYSTEMS at 900/1800 MHz

The co-existence between LTE systems has been studied at 2 GHz. The simulations assumptions and results are reported in 3GPP TR36.942, and are summarized in this section.

The simulations results below are based on the assumption of a 10 MHz LTE aggressor system, a 10 MHz LTE victim system, 2 GHz frequency band was used in the simulations and macro cells (cell range 500 m) in an urban area with uncoordinated deployment as defined in 3GPP TR36.942.

Simulation results for average E-UTRA downlink throughput loss are presented in Figure 12: average LTE (E-UTRA) downlink throughput loss. Simulation results for 5% CDF throughput E-UTRA throughput loss are presented in Figure 15.

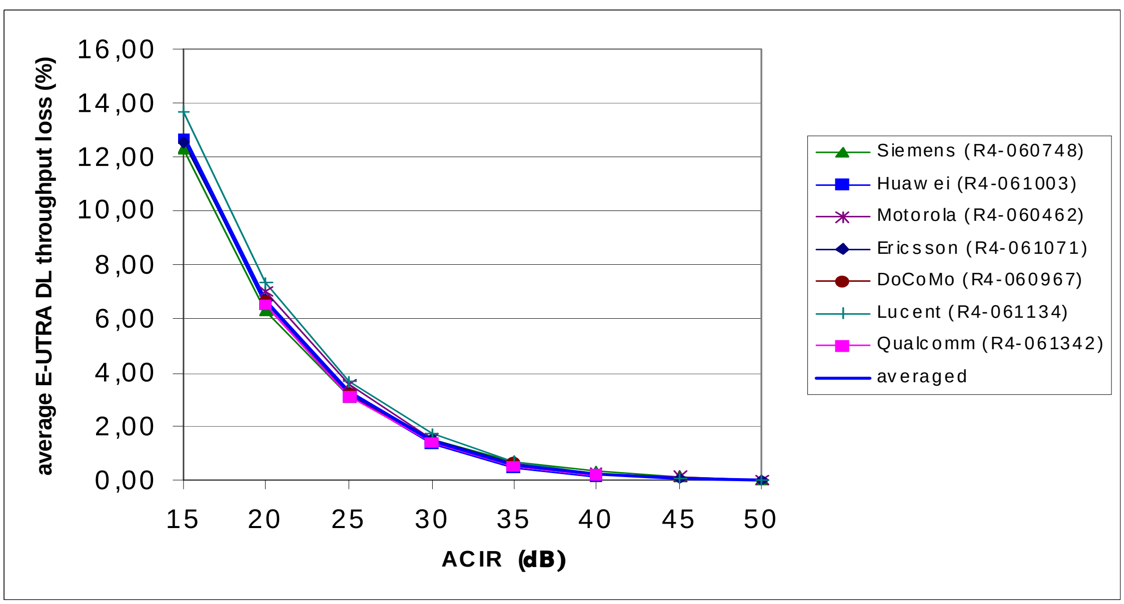

Figure 12: average LTE (E-UTRA) downlink throughput loss

The simulation results plotted in the Figure 12 show that the required ACIR is 24 dB for an average throughput loss <=5%. LTE BS ACLR=45 dB, UE ACS=33 dB, the ACIR=32.7 dB, this is above the required ACIR of 24 dB.

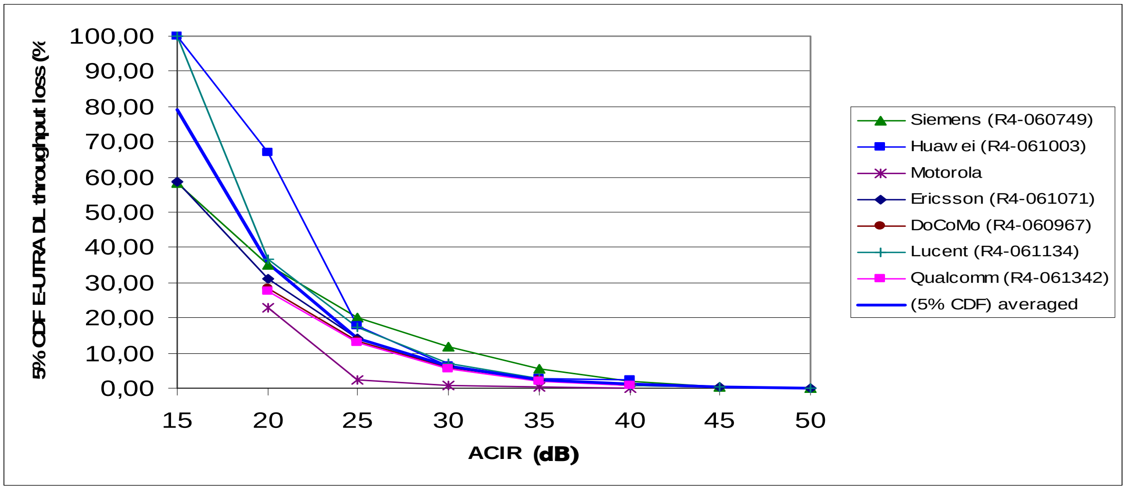

Figure 13: 5% CDF LTE (E-UTRA) downlink throughput loss

Simulation results for average E-UTRA uplink throughput loss are presented in Figure 14. Power control as described in Section 10.1 above has been used. Simulation results for 5% CDF throughput E-UTRA throughput loss are presented in Figure 15.

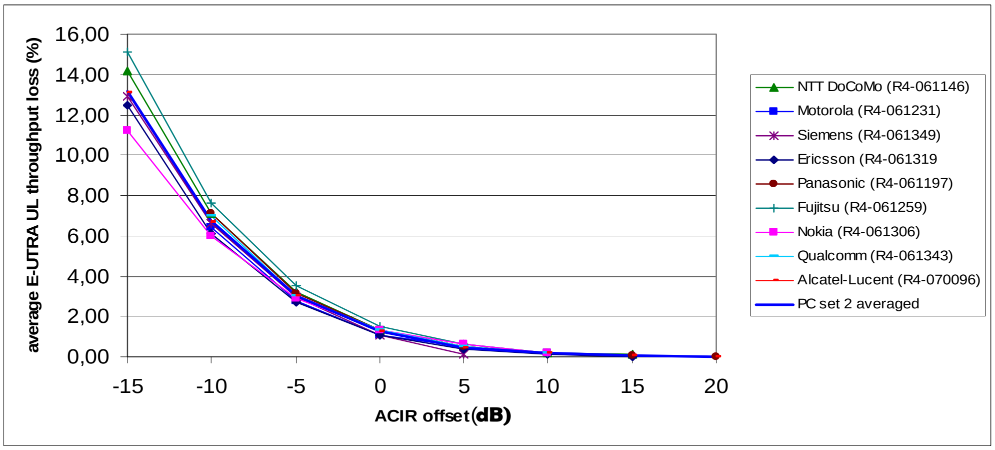

Figure 14: Average LTE(E-UTRA) uplink throughput loss

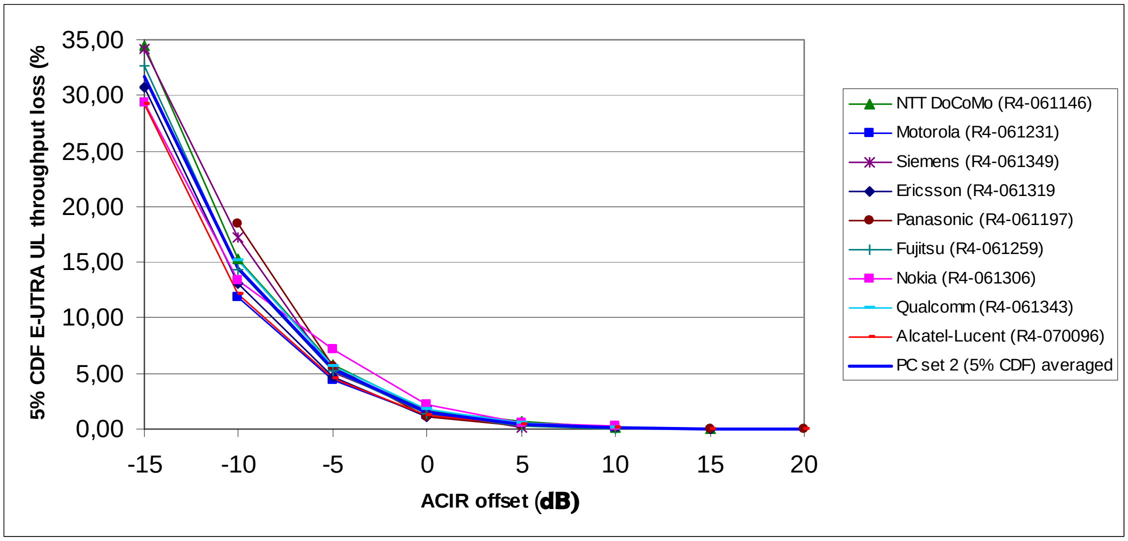

Figure 15: 5% CDF LTE(E-UTRA) uplink throughput loss

The simulated average UL throughput loss as function of ACIR offset plotted in the Figure 14 show that an ACIR offset of -7 dB correspond to 5% UL average throughput loss. That means the required UL ACIR is 30-7=23 dB. With LTE UE ACLR=30 dB and LTE BS ACS=45,7 dB the combined ACIR is 29,9 dB, which is also above the required ACIR=23 dB.

11.2 Carrier spacing between LTE(E-UTRA) systems in 900/1800 MHz bands

Based on the simulation results on the co-existence between LTE systems for the ACIR values achieved when deploying two uncoordinated E-UTRA systems on adjacent carriers with "nominal channel spacing". This nominal channel spacing is defined in 3GPP TR36.101 [2] subclause 5.7.1:

$$\text{Nominal Channel spacing} = (BW_{Channel(1)} + BW_{Channel(2)})/2 \qquad (11\text{-}1)$$

Since the spacing is based on the sum of half the channel bandwidth of each of the adjacent carriers, there is no explicit guard band needed between the carriers. The nominal channel spacing(carrier frequency separation) between adjacent LTE carriers for different channel bandwidths are given in Table 11. The frequency spacing, channel edge to channel edge between LTE channel edges is thus 0 kHz

Channel bandwidth, MHz	1.4	3	5	10	15	20
1.4	1.4	2.2	3.2	5.7	8.2	10.7
3	2.2	3	4	6.5	9	11.5
5	3.2	4	5	7.5	10	12.5
10	5.7	6.5	7.5	10	12.5	15
15	8.2	9	10	12.5	15	17.5
20	10.7	11.5	12.5	15	17.5	20

Table 15: Nominal channel spacing (carrier frequency separation) between adjacent carrier centre frequencies

12 IMPACT OF CELL RANGE AND SIMULATION FREQUENCY ON ACIR

As the simulations carried out in e.g. 3GPP TR36.942 has not been carried out for all different frequency bands in question, it is of interest to understand whether results will be different as a consequence of switching frequency bands.

As indicated in the document [9] from 3GPP, appropriate scaling of cell sizes lead to comparable signal to noise ratio distributions for another frequency band than what has been applied in some simulations. Consequently it is reasonable to assume that for different frequency bands (different propagation conditions) both wanted and interfering signals will be attenuated in a similar way. The signal to noise ratio was a coexistence study criteria in order to check the throughput loss in the presence of interferers. The conclusions based on the simulation results in 2 GHz band can be extended to 900/1800 MHz bands.

Furthermore, the impact of cell range and simulation frequency is analysed in 3GPP TR36.942 by comparing downlink scenarios with simulation frequency of 900MHz (1.25MHz system bandwidth) and 2GHz (10MHz system bandwidth) and cell ranges of 500m, 2000m and 5000m in urban and rural area environment.

On the basis of the simulation results it can be assumed that the worst case scenario is 2 GHz, urban environment, 500m cell range, although the differences between the different scenarios are not that big. The conclusion is thus that it is appropriate to extend the conclusions from 2 GHz to the 900 MHz and 1800 MHz frequency bands for interference between LTE and UMTS or GSM, assuming that the cell sizes are appropriately scaled according to the propagation losses.

13 CO-EXISTENCE BETWEEN WIMAX AND GSM SYSTEMS

13.1 Interference from WiMAX into GSM

The comparison between LTE and WiMAX system parameters (section 5) analysed the BS OOB emissions and with particular regard to the BS Tx spectrum emission masks. As the WiMAX BS spectrum emission mask is aligned to the LTE and UMTS BS spectrum emission masks, it can be assumed that interference into the GSM downlink should not be a problem based on the interference simulation results presented in section 9.1.

The interference from WiMAX UE to GSM UL has not been simulated. The parameters comparison described in section 5 indicate that WiMAX UE spectrum emission mask is similar to LTE UE, and the results for LTE UE into GSM UL in Section 9.2 show that the GSM outage is relatively insensitive to sensible levels of ACIR. Even very low levels of ACIR do not cause excessive GSM system outage. With the same UE emission mask profile and therefore ACLR calculation results, there is no reason to believe that the WiMAX UE into GSM UL scenario would yield any significantly different results.

13.2 Interference from GSM into WiMAX

No simulation results of interference from GSM systems into WiMAX systems are available at this time.

13.3 Conclusions

It should be recalled that the WiMAX receiver rejections are derived from the narrow band blocking requirements, which are based on a separation of 200 kHz between the GSM channel edge and the WiMAX channel edge. These receiver rejection values would not be applicable to a narrower frequency separation. This supports the conclusion that 200 kHz should be the minimum separation between the GSM channel edge and the WiMAX channel edge.

Based on the analysis of interference from WiMAX BS to GSM DL, the recommended minimum frequency spacings are summarised in Table 16, bearing in mind that the potential interference from WiMAX UE to GSM UL, as well as the interference from GSM UL/DL to WiMAX UL/DL have not been analysed through simulations.

	Frequency spacing between GSM carrier centre frequency and WiMAX carrier centre frequency	**Frequency spacing between GSM carrier centre frequency and WiMAX channel edge**	**Frequency spacing between GSM channel edge and WiMAX channel edge**
WiMAX 5 MHz	2.8 MHz	300 kHz	200 kHz
WiMAX 10 MHz	5.3 MHz	300 kHz	200 kHz

Table 16: Frequency spacing between GSM and WiMAX

14 CO-EXISTENCE BETWEEN WIMAX AND UMTS SYSTEMS

14.1 Simulation method and assumptions

14.1.1 BS antenna pattern

For statistical analysis, both horizontal antenna pattern and vertical antenna pattern should be considered. In this study, BS antenna pattern is assumed to be the one described in section 3.2.1 in Recommendation ITU-R F.1336-2[12]. The parameter k in the antenna pattern equation is assumed to be 0, which is for antenna with improved side-lobe performance. The 3 dB beamwidth in azimuth plane is set to 65 degrees.

14.1.2 MS and UE antenna pattern

WiMAX UE antenna pattern and UMTS UE antenna pattern are assumed to be OMNI antenna.

14.1.3 Propagation models

For macro urban deployment scenario, the propagation model described in Section 5.1.4.2 in [21] is used in this study.

$$L = 40(1-0.004\times \mathrm{Dhb}) \log(R) - 18\log(Dhb) + 21\log(f) + 80. \qquad (14\text{-}1)$$

where, R is the distance in km;

f is the carrier frequency in MHz;

Dhb is the BS antenna height above rooftop level in m.

For macro rural deployment scenario, Hata model is used.

$$L = 69.55 + 26.16 \log f - 13.82\log(H_b) + [44.9 - 6.55\log(H_b)]\log R - 4.78(\log f)^2 + 18.33 \log f - 40.94 \qquad (14\text{-}2)$$

where, R is the distance in km;

f is the carrier frequency in MHz;

H_b is the BS antenna height above ground in m.

14.1.4 Network layout

Three-sector clover-leaf cellular layout is used in this study as shown in the following Figure 16. D is the distance between two base stations within a system. R is the sector range which is 500 meters for rural deployment scenario and 5000 meters for urban deployment scenario.

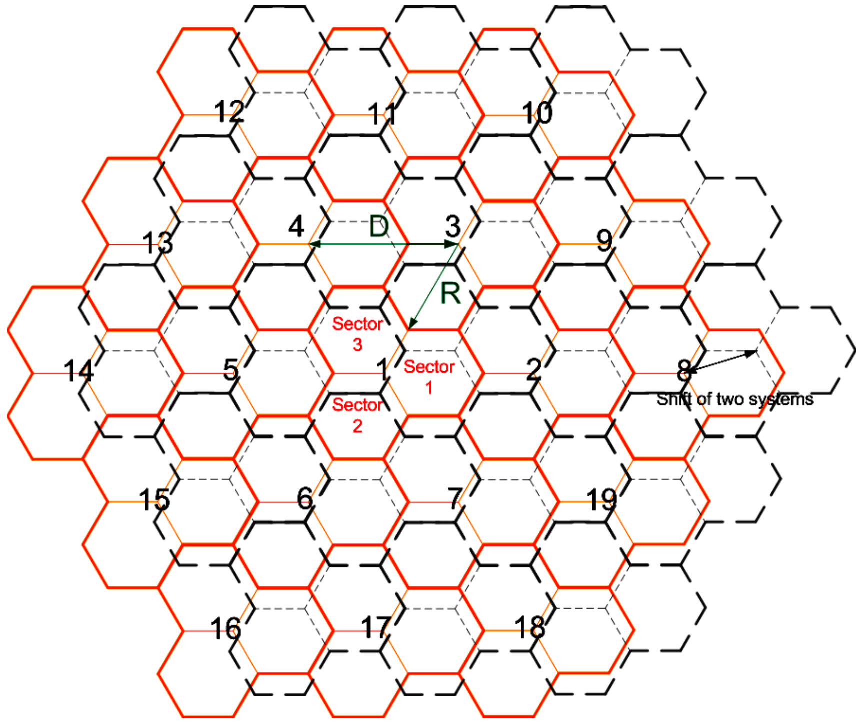

Figure 16: Network layout of large area multiple systems deployment

In the above Figure, the two colours indicate overlay of two different systems, WiMAX and WiMAX/UMTS, in the same area. The simulation area is wrapped around to remove edge effects.

Frequency reuse of 1 is assumed in both systems.

14.1.5 SINR modelling

SINR is given by:

$$SINR = S - 10\log_{10}\left(\sum_{i=1}^{n_C} 10^{\frac{I_{C,i}}{10}} + \sum_{j=1}^{n_A} 10^{\frac{I_{A,j}}{10}} + 10^{\frac{N}{10}}\right) \tag{14-3}$$

$$N = -174 + 10\log_{10}(BW\ in\ Hz) + NF \tag{14-4}$$

where:

S is the desired signal strength in dBm at the receiver

n_C is the number of co-channel interfering transmissions

$I_{C,i}$ is the co-channel interference received from the i^{th} transmitter in dBm

n_A is the number of adjacent channel interfering transmissions

$I_{A,j}$ is the adjacent channel interference received from the j^{th} transmitter in dBm as reduced by the ACS and ACLR

N is the thermal noise in dBm, and

NF is the system noise Figure in dB.

14.1.6 WiMAX UL power control

Power control in a mobile WiMAX UE is a mandatory feature identified in the Mobile WiMAX specification and is detailed in the IEEE 802.16.

Under normal operational conditions, the WiMAX UE determines its Tx power by the following equation,

$$P(dBm) = L + C/N + NI - 10 \times log10(R) + Offset\_SSperSS + Offset\_BsperSS \quad (14\text{-}5)$$

where:

P is the Tx power level (dBm) per a subcarrier for the current transmission, including UE Tx antenna gain;
L is the estimated average current UL propagation loss. It shall include MS TX antenna gain and path loss, but exclude the BS Rx antenna gain;
C/N is the target C/N of the modulation/FEC rate for the current transmission;
R is the number of repetitions for the modulation/FEC rate;
NI is the estimated average power level (dBm) of the noise and interference per a subcarrier at BS, not including BS Rx antenna gain;
Offset_SSperSS is the correction term for UE-specific power offset. It is controlled by UE. Its initial value is zero;
Offset_BSperSS is the correction term for UE-specific power offset. It is controlled by BS with power control messages.

In the simulation, target *C/N* including *R* is provided in Table 16. Initially, BS decides each MS's suitable UL target *C/N* by its reported DL CINR.

$$C/N\_target = 10 \times log_{10}(max(SINR_{min}, \gamma_{IoT} \times CINR_{DL} - 0.5)) \quad (14\text{-}6)$$

where:

$SINR_{min}$ is the minimum UL SINR target of the system in linear scale, decided by BS;
γ_{IOT} is the fairness and *IoT* control factor, which is between 0.1 and 0.4;
$CINR_{DL}$ is the MS's DL CINR in linear scale, which is measured by MS and to be reported to BS.

Following is the UL power control procedure in the simulation:

- Step 1: BS decides MS's MCS level by using the calculated *C/N_target* and Table 20.
- Step 2: MS starts with a certain power level by WiMAX power control equation.
- Step 3: Each MS's UL SINR is calculated, including interference from the other system.
- Step 4: If MS's UL SINR is lower than its MCS required SINR and the MS still has enough power room, the MS will increase its TX power by 0.5 dB by setting Offset_BSperSS value.
- Step 5: If MS's UL SINR is higher than or equals to its "MCS required SINR plus 0.5 dB" and the MS's TX power is not less than "minimum TX power plus 0.5 dB", the MS will reduce its TX power by 0.5 dB by setting Offset_BSperSS value.
- Step 6: Go to step 3. Repeat 150 steps in the simulations, and then collect statistics.

14.2 Interference from WiMAX to UMTS

14.2.1 UMTS system performance evaluation criteria

UMTS uplink loading in single system case is evaluated according to a 6 dB noise rise over the thermal noise [21]. A simulation is run with a predefined number of users. At the end of power control, the average noise rise is measured. If it is lower than or higher than 6 dB, the number of users is increased or decreased respectively until the 6 dB noise rise is reached. The number of users corresponding to the 6 dB noise rise is defined as $N_{\_UL\_single}$.

In the multi-system case with additional interference from WiMAX, UMTS uplink loading is determined according to the 6 dB noise rise and it is defined as $N_{\_UL\_multi}$.

UMTS uplink capacity loss due to additional interference from WiMAX is calculated by:

$$CL_{\_UL\_loss} = 1 - (N_{\_UL\_multi} / N_{\_UL\_single}) \quad (14\text{-}7)$$

UMTS downlink single system simulation is run to find the number of users $N_{\_DL\_single}$, which fulfils the relation:

$$P(Eb/No < threshold, N_{\_DL\_single}) \leq 5\% \quad (14\text{-}8)$$

Multi-system simulation with interference from WiMAX is run to find the number of users $N_{\_DL\_multi}$, which fulfils the relation:

$$P(Eb/No < threshold,\ N_{\_DL\_multi}) \leq 5\% \qquad (14\text{-}9)$$

The capacity loss in DL is calculated as:

$$CL_{\_DL\_loss} = 1 - (N_{\_DL\_multi} / N_{\_DL\_single}) \qquad (14\text{-}10)$$

UMTS capacity loss of 5% is set as the system protection criterion.

14.2.2 Simulation results in the 900 MHz band

14.2.2.1 WiMAX BS interfering UMTS UE in Urban Area

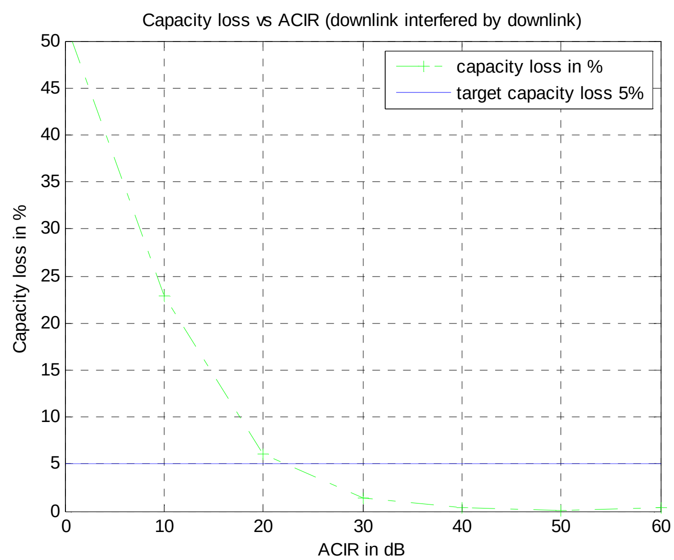

Figure 17: UMTS DL capacity loss due to interference from WiMAX DL in urban area

The results show that the required ACIR from WiMAX BS to UMTS UE is less than 23 dB. As described in section 5 that the ACIR from WiMAX BS to UMTS UE is 32.7 dB, which is above the required ACIR value. In consequence, it can be concluded that no additional isolation is needed in this interfering path. Therefore, no guard band is needed.

14.2.2.2 WiMAX BS interfering UMTS UE in Rural Area

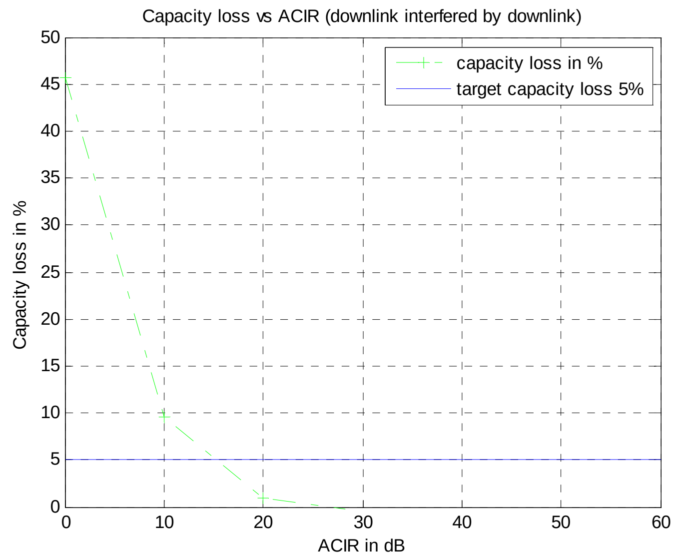

Figure 18: UMTS DL capacity loss due to interference from WiMAX DL in urban area

The results show that the required ACIR from WiMAX BS to UMTS UE is less than 32.7 dB. No additional isolation is needed in this interfering path for successful coexistence. No guard band is needed.

14.2.2.3 WiMAX UE interfering UMTS BS in Urban Area

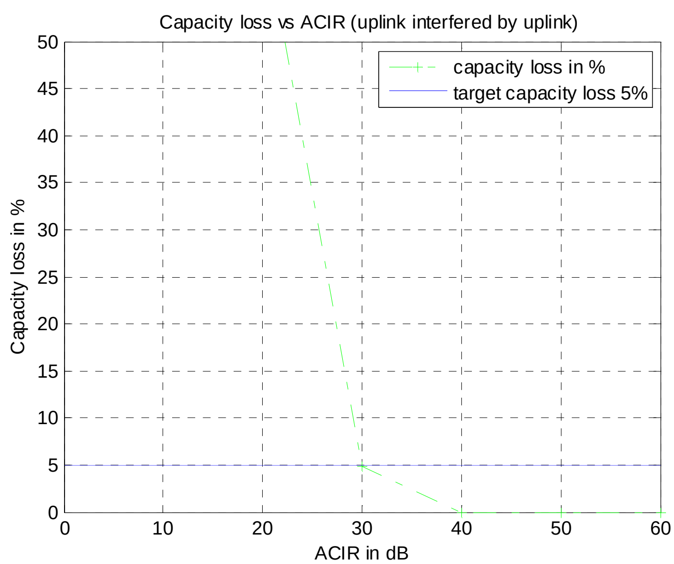

Figure 19: UMTS UL capacity loss due to interference from WiMAX UL in urban area

The results show that the required ACIR from WiMAX MS to UMTS BS is about 29.9 dB. The ACIR=32.8 dB was given in the Table 6. No additional isolation is needed in this interfering path for successful coexistence. No guard band is needed.

14.2.2.4 WiMAX UE interfering UMTS BS in Rural Area

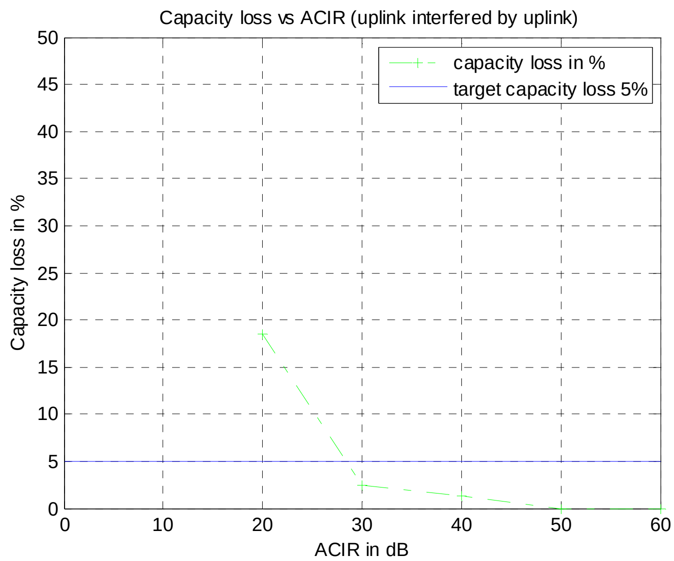

Figure 20: UMTS UL capacity loss due to interference from WiMAX UL in rural area

The results show that the required ACIR from WiMAX UE to UMTS BS is about 28 dB which is less than the 32.8 dB given in the Table 6. No additional isolation is needed in this interfering path for successful coexistence. No guard band is needed.

14.2.3 Simulation results in the 1800 MHz band

14.2.3.1 WiMAX BS interfering UMTS UE in Urban Area

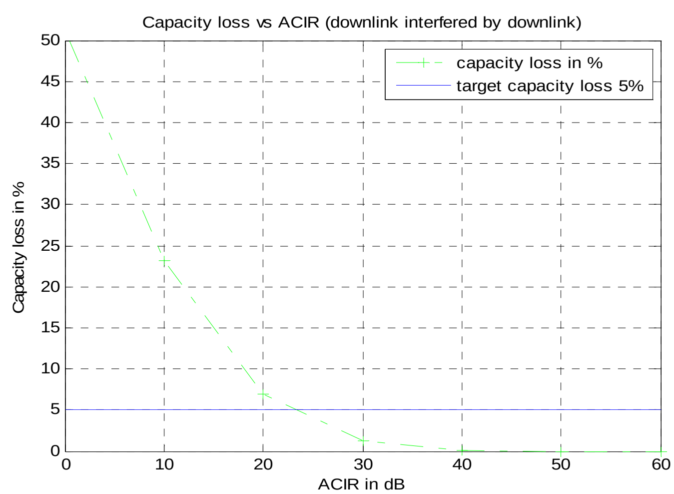

Figure 21: UMTS DL capacity loss due to interference from WiMAX DL in urban area

The results show that the required ACIR from WiMAX BS to UMTS UE is less than 32.7 dB. No additional isolation is needed in this interfering path for successful coexistence. No guard band is needed.

14.2.3.2 WiMAX BS interfering UMTS UE in Rural Area

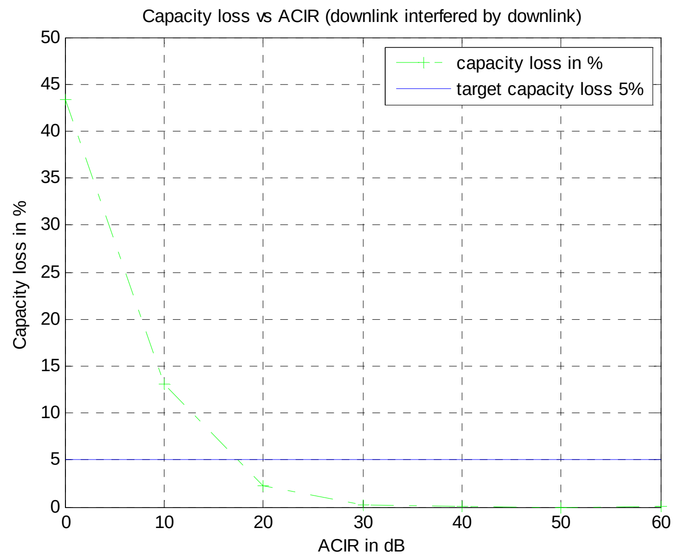

Figure 22: UMTS DL capacity loss due to interference from WiMAX DL in rural area

The results show that the required ACIR from WiMAX BS to UMTS UE is less than 32.8 dB. No additional isolation is needed in this interfering path for successful coexistence. No guard band is needed.

14.2.3.3 WiMAX UE interfering UMTS BS in Urban Area

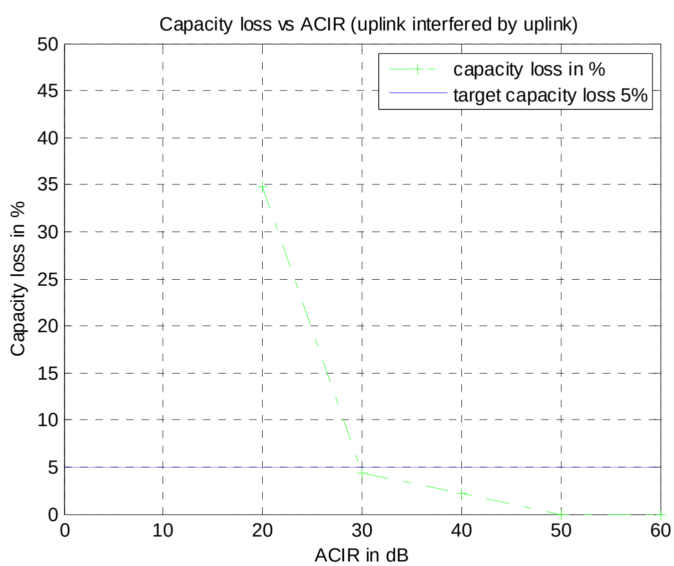

Figure 23: UMTS UL capacity loss due to interference from WiMAX UL in urban area

The results show that the required ACIR from WiMAX UE to UMTS BS is less than 29.9 dB which is below the ACIR value of 32.8 dB given in the Table 6. No additional isolation is needed in this interfering path for successful coexistence. No guard band is needed.

14.2.3.4 WiMAX UE interfering UMTS BS in Rural Area

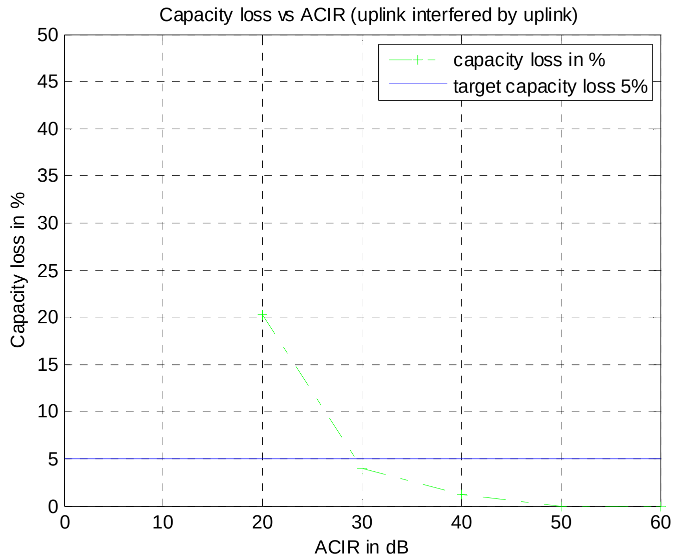

Figure 24: UMTS DUL capacity loss due to interference from WiMAX DUL in rural area

The results show that the required ACIR from WiMAX UE to UMTS BS is less than 29.9 dB, below the ACIR of 32.8 dB given in the Table 6. No additional isolation is needed in this interfering path for successful coexistence. No guard band is needed.

14.3 Interference from UMTS to WiMAX

14.3.1 WiMAX system performance evaluation criteria

WiMAX system protection criterion is described in section 15.

14.3.2 Simulation results in the 900 MHz band

14.3.2.1 UMTS BS interfering WiMAX UE in Urban Area

The simulation results of the WiMAX system DL modulation efficiency loss due to interference from UMTS DL in urban area are plotted in Figure 24.

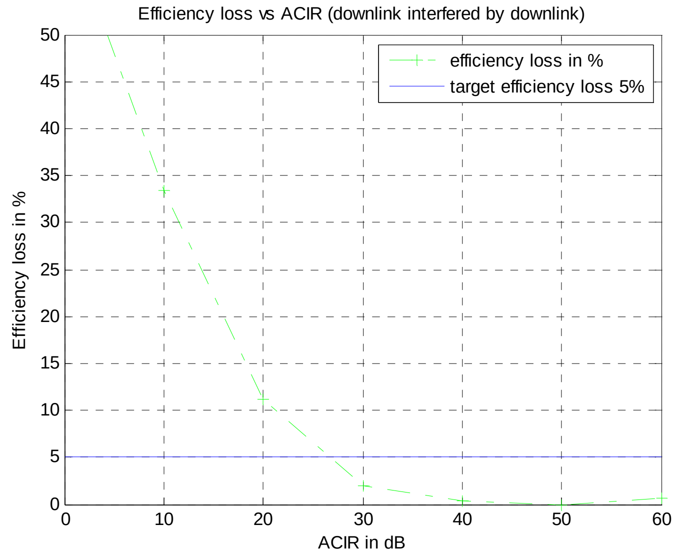

Figure 25: WiMAX DL modulation efficiency loss due to interference from UMTS DL in urban area

The results in Figure 25 show that the required ACIR from UMTS BS to WiMAX UE is less than 26 dB for 5% modulation efficiency loss. Even the WiMAX ACS value over 3.84 MHz is not defined in the annex 2, it can reasonably be assumed that the ACIR from UMTS BS to WiMAX UE is above the required ACIR of 26 dB. In consequence, it can be concluded that no additional isolation is needed in this interfering path. Therefore no guard band is needed.

14.3.2.2 UMTS BS interfering WiMAX UE in Rural Area

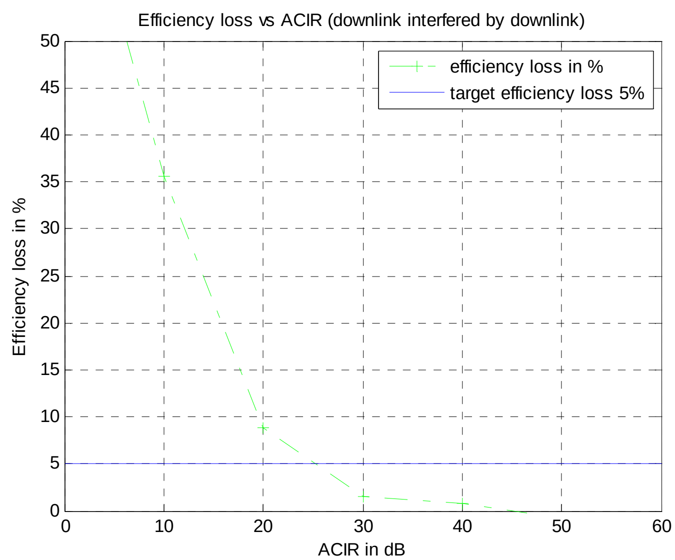

Figure 26: WiMAX DL modulation efficiency loss due to interference from UMTS DL in rural area

The results show that the required ACIR from UMTS BS to WiMAX UE is about 25 dB for 5% modulation efficiency loss. Even the WiMAX ACS value over 3.84 MHz is not defined in the annex 2, it can reasonably be assumed that the ACIR from UMTS BS to WiMAX UE is above the required ACIR of 26 dB. In consequence, it can be concluded that no additional isolation is needed in this interfering path. Therefore no guard band is needed.

14.3.2.3 UMTS UE interfering WiMAX BS in Urban Area

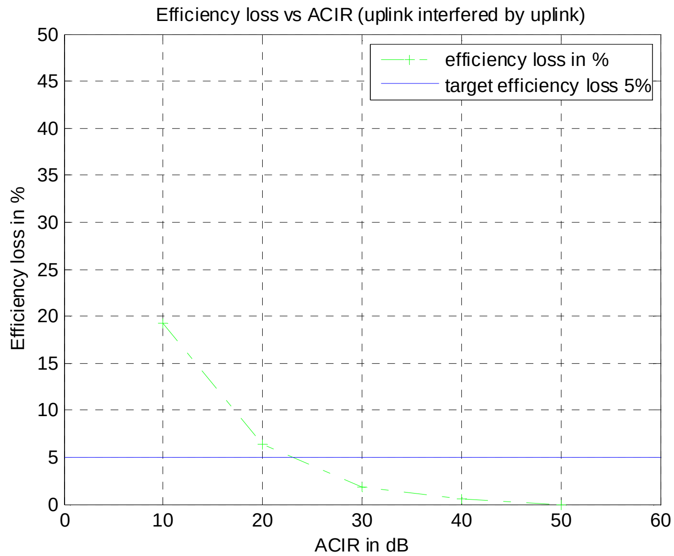

Figure 27: WiMAX UL modulation efficiency loss due to interference from UMTS UL in urban area

The results show that the required ACIR from UMTS UE to WiMAX BS is 22 dB, less than 32.8 dB for 5% modulation efficiency loss. No additional isolation is needed in this interfering path for successful coexistence. No guard band is needed.

14.3.2.4 UMTS UE interfering WiMAX BS in Rural Area

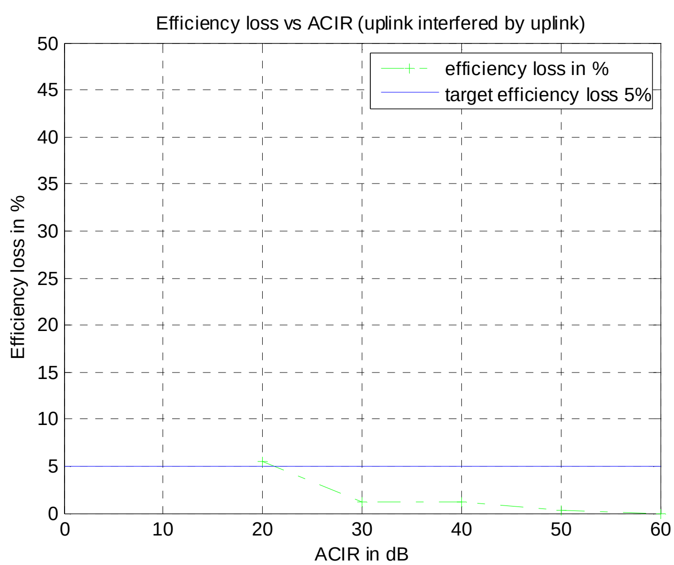

Figure 28: WiMAX UL modulation efficiency loss due to interference from UMTS UL in rural area

The results show that the required ACIR from UMTS UE to WiMAX BS is less than 32.8 dB for 5% modulation efficiency loss. No additional isolation is needed in this interfering path for successful coexistence. No guard band is needed.

14.3.3 Simulation results in the 1800 MHz band

14.3.3.1 UMTS BS interfering WiMAX UE in Urban Area

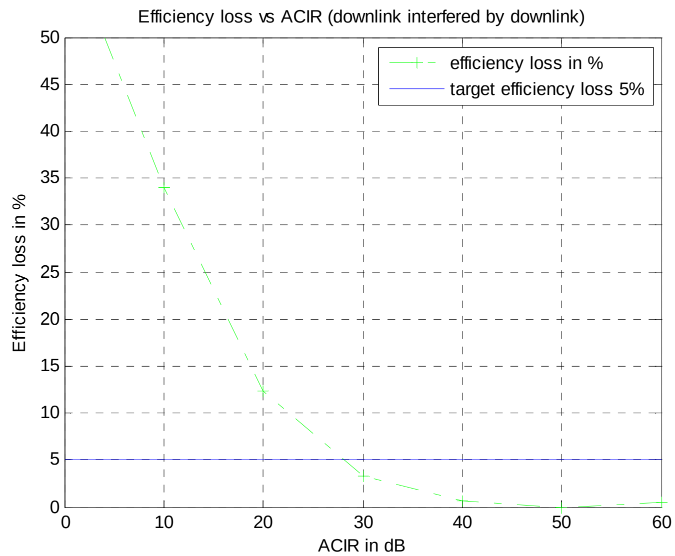

Figure 29: WiMAX DL modulation efficiency loss due to interference from UMTS DL in rural area

The results show that the required ACIR from UMTS BS to WiMAX UE is about 28 dB for 5% modulation efficiency loss. Even the WiMAX ACS value over 3.84 MHz is not defined in Annex 2, it can reasonably be assumed that the ACIR from UMTS BS to WiMAX UE is above the required ACIR of 28 dB. In consequence, it can be concluded that no additional isolation is needed in this interfering path. Therefore no guard band is needed.

14.3.3.2 UMTS BS interfering WiMAX UE in Rural Area

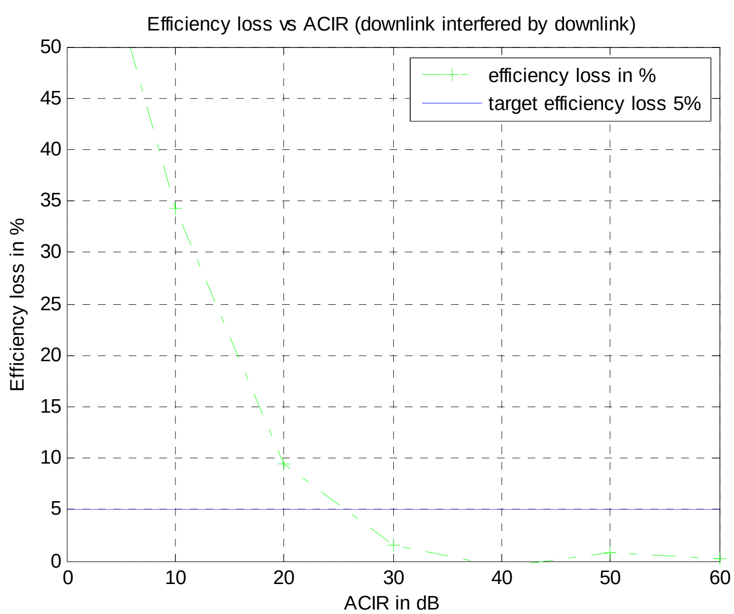

Figure 30: WiMAX DL modulation efficiency loss due to interference from UMTS DL in rural area

The results show that the required ACIR from UMTS BS to WiMAX UE is about 25 dB for 5% modulation efficiency loss. Even the WiMAX ACS value over 3.84 MHz is not defined in the annex 2, it can reasonably be assumed that the ACIR from UMTS BS to WiMAX UE is above the required ACIR of 25 dB. In consequence, it can be concluded that no additional isolation is needed in this interfering path. Therefore no guard band is needed.

14.3.3.3 UMTS UE interfering WiMAX BS in Urban Area

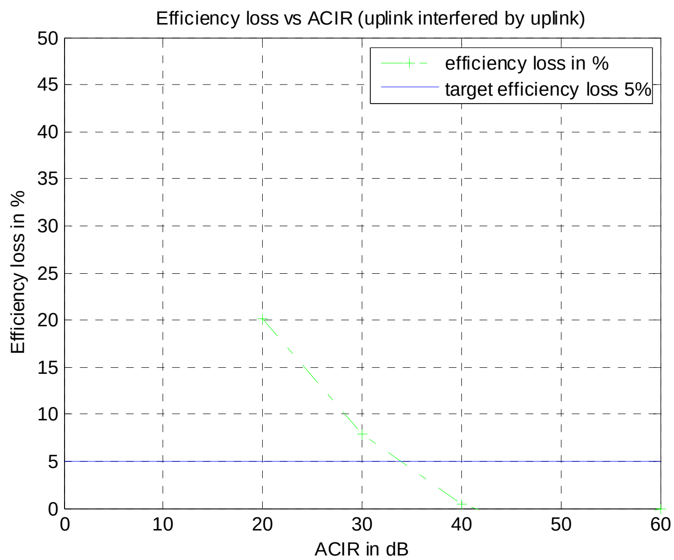

Figure 31: WiMAX UL modulation efficiency loss due to interference from UMTS UL in urban area

The results show that the required ACIR from UMTS UE to WiMAX BS is about 33 dB for 5% modulation efficiency loss. It is not believed additional isolation is needed in this situation.

14.3.3.4 UMTS UE interfering WiMAX BS in Rural Area

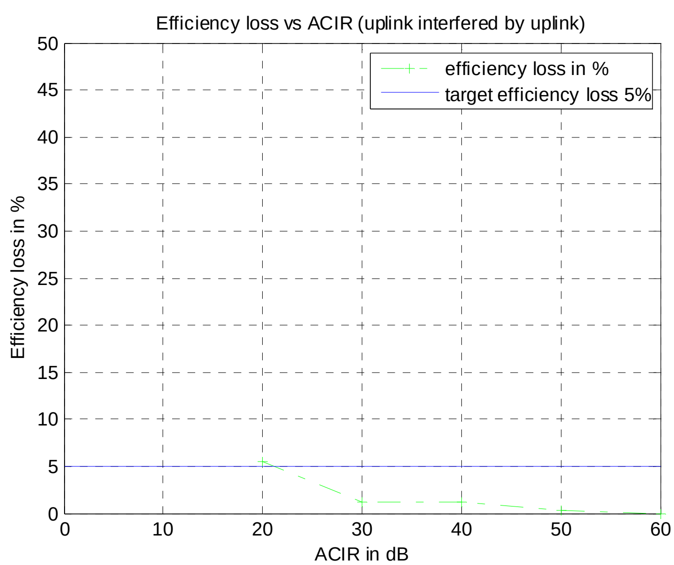

Figure 32: WiMAX UL modulation efficiency loss due to interference from UMTS UL in rural area

The results show that the required ACIR from UMTS UE to WiMAX BS is less than 20 dB for 5% modulation efficiency loss. No additional isolation is needed in this interfering path for successful coexistence. No guard band is needed.

14.4 Conclusion

Based on the simulation results of interference between WiMAX and UMTS systems, the minimum frequency spacings are summarised in Table 17.

	Frequency spacing between UMTS carrier centre frequency and WiMAX carrier centre frequency	Frequency spacing between UMTS carrier centre frequency and WiMAX channel edge	Frequency spacing between UMTS channel edge and WiMAX channel edge
WiMAX 5 MHz	5.0 MHz	2.5 MHz	0 kHz
WiMAX 10 MHz	7.5 MHz	2.5 MHz	0 kHz

Table 17: Minimum frequency spacings between UMTS and WiMAX

15 CO-EXISTENCE BETWEEN WIMAX SYSTEMS AT 900/1800 MHZ BANDS

15.1 Simulation method and assumptions

15.1.1 Simulation method

The same simulation method and assumptions described in section 14.1 are used for the WiMAX to WiMAX simulations.

15.1.2 WiMAX system performance evaluation criteria

WiMAX system level simulation is run for both without and with interference from another system (WiMAX or UMTS) to get the performance of single system case and performance of multiple system case. Spectral efficiency degradation due to interference from another system is then calculated. A WiMAX system protection criterion is 5% spectral efficiency loss.

WiMAX system level simulation is run for both without and with interference from another system (WiMAX or UMTS) to get the performance of single system case and performance of multiple system case. Spectral efficiency degradation due to interference from another system is then calculated. A WiMAX system protection criterion is 5% spectral efficiency loss.
In order to get WiMAX system level performance, WiMAX link level performance results have to be obtained. The following Table shows the WiMAX link level performance simulation results in AWGN. WiMAX physical layer is modeled. Neither ARQ nor scheduler gain (multi-user diversity) is included. The following Table gives the required SNR to achieve the corresponding coding and modulation schemes for 1% packet error rate (PER) of 100 bytes convolutional turbo-coded (CTC) packets. Each result is averaged over 10,000 packets.

	SNR	Modulation efficiency relative to 1/2 rate-coded QPSK
QPSK CTC ½,6	–5.88	1/6
QPSK CTC ½,4	–4.12	1/4
QPSK CTC ½,2	–1.1	0.5
QPSK CTC ½	1.9	1
QPSK CTC ¾	5.2	1.5
16-QAM CTC ½	7.2	2
16-QAM CTC ¾	11.6	3
64-QAM CTC 2/3	15.6	4
64-QAM CTC ¾	17.3	4.5

Table 18: Signal to noise ratio and modulation efficiency of WiMAX physical layer for 1% PER

The WiMAX average modulation efficiency is calculated based on each link's instantaneous SINR and the SNR values in the above Table, assuming that the interference is noise-like. It is given by:

$$\overline{ME} = \frac{\sum_{i=1}^{N} MEi}{N} \qquad (15\text{-}1)$$

where:

MEi: modulation efficiency of the *i*th link

N: number of total links.

The loss in the modulation efficiency is calculated by:

$$\mathrm{ME\_loss} = 1 - \frac{\overline{\mathrm{ME}}\mathrm{multi}}{\overline{\mathrm{ME}}\mathrm{single}} \qquad (15\text{-}2)$$

where:

$\overline{\mathrm{ME}}\mathrm{single}$: average modulation efficiency of the WiMAX system without UMTS interference

$\overline{\mathrm{ME}}\mathrm{multi}$: average modulation efficiency of the WiMAX system when coexisting with a UMTS system.

Although modulation efficiency loss is a different criterion to that used for UMTS (Capacity loss) and for LTE (Throughput loss), it represents a measure of the impact of interference across a network as a reduction in spectrum capacity due to the incoming interference.

15.2 Simulation results in 900 MHz band

15.2.1 WiMAX BS interfering WiMAX UE in urban area

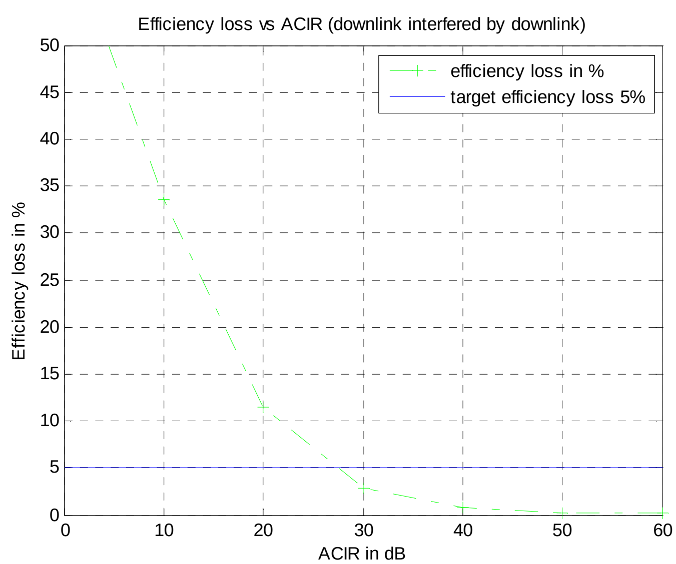

Figure 33: WiMAX DL modulation efficiency loss due to interference from WiMAX DL in urban area

The results show that the required ACIR from WiMAX BS to WiMAX UE is less than 32.7 dB for 5% modulation efficiency loss. No additional isolation is needed in this case. No guard band is needed.

15.2.2 WiMAX BS interfering WiMAX UE in rural area

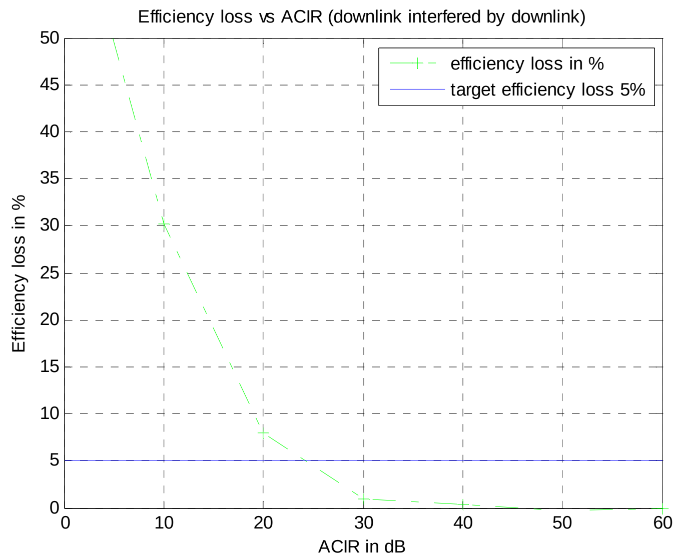

Figure 34: WiMAX DL modulation efficiency loss due to interference from WiMAX DL in rural area

The results show that the required ACIR from WiMAX BS to WiMAX UE is less than 32.7 dB for 5% modulation efficiency loss. No additional isolation is needed in this interfering path for successful coexistence. No guard band is needed.

15.2.3 WiMAX UE interfering WiMAX BS in urban area

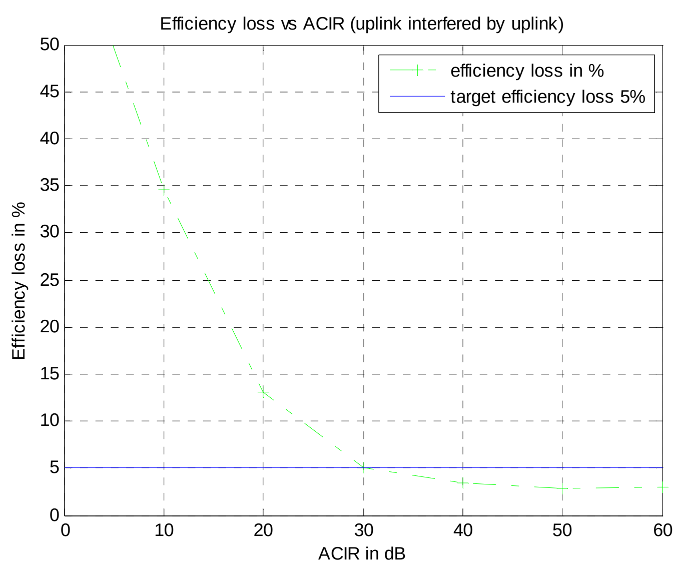

Figure 35: WiMAX UL modulation efficiency loss due to interference from WiMAX UL in urban area

The results show that the required ACIR from WiMAX UE to WiMAX BS is 30 dB for 5% modulation efficiency loss. No additional isolation is needed in this interfering path for successful coexistence. No guard band is needed.

15.2.4 WiMAX UE interfering WiMAX BS in rural area

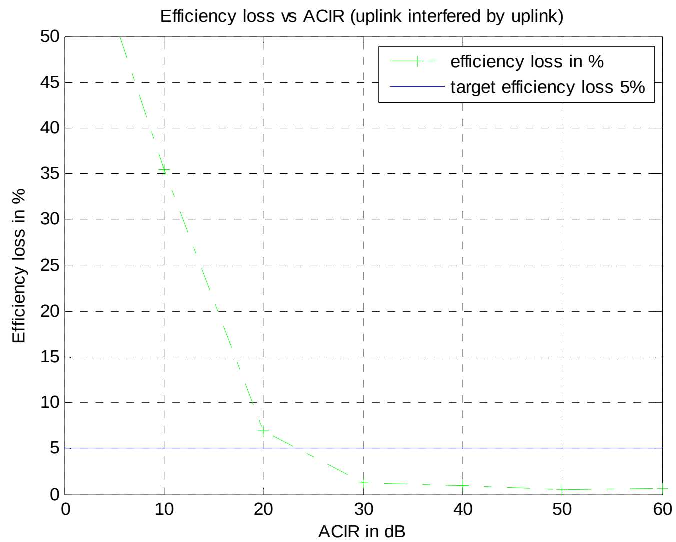

Figure 36: WiMAX UL modulation efficiency loss due to interference from WiMAX UL in rural area

The results show that the required ACIR from WiMAX UE to WiMAX BS is less than 29.9 dB for 5% modulation efficiency loss. No additional isolation is needed in this interfering path for successful coexistence. No guard band is needed.

15.3 Simulation results in 1800 MHz band

15.3.1 WiMAX BS interfering WiMAX UE in urban area

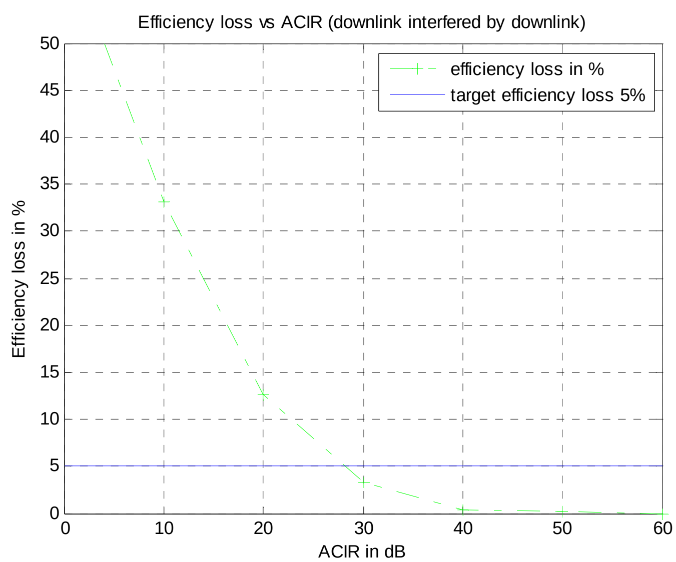

Figure 37: WiMAX DL modulation efficiency loss due to interference from WiMAX DL in urban area

The results show that the required ACIR from WiMAX BS to WiMAX UE is less than 32.7 dB for 5% modulation efficiency loss. No additional isolation is needed in this interfering path for successful coexistence. No guard band is needed.

15.3.2 WiMAX BS interfering WiMAX UE in rural area

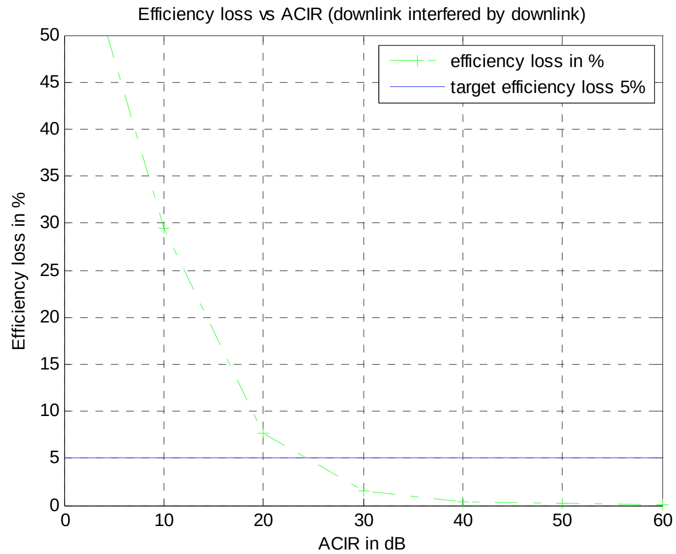

Figure 38: WiMAX DL modulation efficiency loss due to interference from WiMAX DL in rural area

The results show that the required ACIR from WiMAX BS to WiMAX UE is less than 32.7 dB. No additional isolation is needed in this interfering path for successful coexistence. No guard band is needed.

15.3.3 WiMAX UE interfering WiMAX BS in urban area

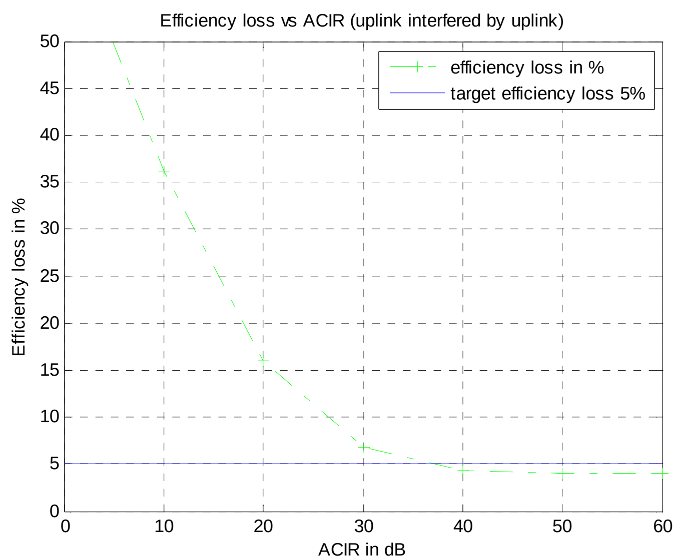

Figure 39: WiMAX UL modulation efficiency loss due to interference from WiMAX UL in urban area

The results show that the required ACIR from WiMAX UE to WiMAX BS is about 35 dB, which is 5 dB higher than the calculated 29.9 dB. If there is no additional isolation from WiMAX UE to WiMAX BS, the efficiency loss is 7%, which is slightly higher than 5%. It is noted that the practical equipment normally outperforms the minimum ACLR and ACS requirement.

15.3.4 WiMAX UE interfering WiMAX BS in rural area

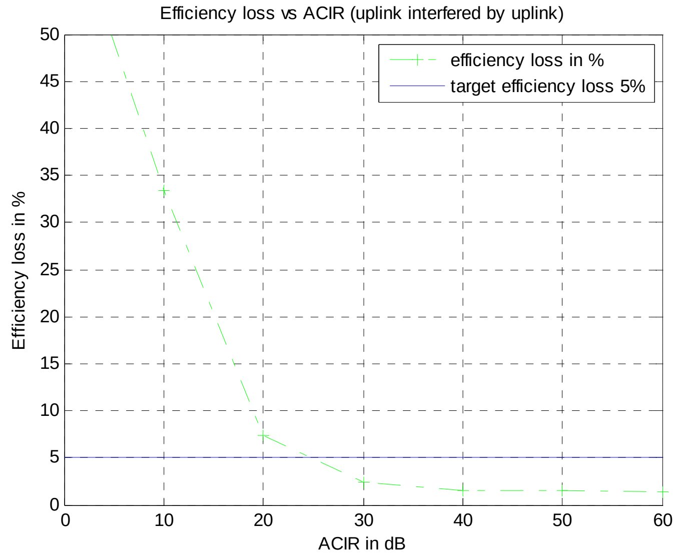

Figure 40: WiMAX UL modulation efficiency loss due to interference from WiMAX UL in rural area

The results show that the required ACIR from WiMAX UE to WiMAX BS is less than 29.9 dB. No additional isolation is needed in this interfering path for successful coexistence. No guard band is needed.

15.4 Conclusions

Based on the simulation results, it is concluded that no additional isolation is needed from WiMAX BS to WiMAX UE and from WiMAX UE to WiMAX BS for successful coexistence of two WiMAX systems in both 900 MHz and 1800 MHz bands for both urban and rural deployment scenarios. No guard band is needed.

The nominal carrier separations are summarised in Table 19.

	WiMAX 5 MHz	**WiMAX 10 MHz**
WiMAX 5 MHz	5 MHz	7.5 MHz
WiMAX 10 MHz	7.5 MHz	10 MHz

Table 19: Nominal frequency separation between WiMAX carrier centre frequencies

The frequency spacing between WiMAX system channel edges is recommended as 0 kHz.

16 CO-EXISTENCE BETWEEN WIMAX AND LTE SYSTEMS AT 900/1800 MHz

Based on the similarity between LTE and WiMAX parameters, it is assumed it is possible that the interference from LTE to WiMAX or WiMAX to LTE is not worse than WiMAX itself. LTE and WiMAX systems can operate using different channel bandwidths and the ACIR between LTE and WiMAX in different channel bandwidths is not easy to derive, since the ACLR and ACS are not specified in this situations. For a same channel bandwidth between LTE and WiMAX (5 MHz and 10 MHz), the ACIR can be calculated based on the parameter sets in sections 3 and 4. The results are given in Table 20.

Direction	ACIR (dB)
WiMAX to LTE Uplink	30
LTE to WiMAX Uplink	30
WiMAX to LTE Downlink	32.9
LTE to WiMAX Downlink	32.9

Table 20: ACIR between LTE and WiMAX (UL/DL) using the same channel bandwidth

For BS, this assumption is justified, because BS usually uses all available frequency resources and therefore usually transmits with the constant maximum permitted transmit power. Therefore, the interference caused by an interfering BS to a victim mobile station is dominated the mobile ACS. More precisely, the interference from LTE to WiMAX or WiMAX to LTE is expected to be in the same order and not worse than WiMAX/LTE itself.

In this case, from the DL interference perspective, it can be assumed that the results for WiMAX vs WiMAX and LTE vs LTE, see Section 15 and Section 11 above, are sufficient to show that LTE will not cause excessive interference to WiMAX or that WiMAX will not cause excessive interference to LTE. It is noted that the WiMAX UE power control range(from 23 dBm to -22 dBm) is 18 dB smaller compared to LTE UE power control range from 23 dBm to -40 dBm..

It is noted that the ACLR figures for LTE and WiMAX are similar. Although these figures are not directly applicable to the interference scenario between LTE and WiMAX since they refer to interference from LTE to LTE and WiMAX to WiMAX respectively (assumed difference in channel occupation between LTE and WiMAX), this gives an indication that interference between LTE and WiMAX and vice versa will be limited.

The uplink interference between LTE and WiMAX has not been analysed through simulations.

17 CONCLUSIONS

Based on the analysis of the simulation results of the interference between LTE/WiMAX and GSM, the frequency separation between the LTE/WiMAX channel edge and the nearest GSM carrier's channel edge is derived as follows:

1) When LTE/WiMAX networks in 900/1800 MHz band and GSM900/1800 networks are in uncoordinated operation, the recommended frequency separation between the LTE channel edge and the nearest GSM carrier's channel edge is 200 kHz or more.

2) When LTE/WiMAX networks in 900/1800 MHz band 900/1800 and GSM900/1800 networks are in coordinated operation (co-located sites), no frequency separation is required between the LTE channel edge and the nearest GSM carrier's channel edge.

These recommended frequency separations between LTE/WiMAX and GSM can be reduced at national level based agreement between mobile operators, in that case the wideband system LTE/WiMAX may suffer some interference (narrow band blocking effect) from GSM.

Based on the analysis of the simulation results of the interference between LTE/WiMAX and UMTS, there is no frequency separation required between the LTE/WiMAX channel edge and the UMTS carrier's channel edge.

Based on the analysis of the simulation results of the interference between LTE systems with different channel bandwidths, there is no requirement on frequency separation between LTE channel edges for the different channel bandwidths.

Based on the analysis of the simulation results of the interference between WiMAX systems with different channel bandwidths, there is no requirement on frequency separation between WiMAX channel edges for the different channel bandwidths.

Based on a simple analysis of system parameters, CEPT concluded that the downlink interference from LTE to WiMAX and from WiMAX to LTE does not require frequency separation between channel edges. It is noted that the ACLR figures for LTE and WiMAX are similar. Although these figures are not directly applicable to the interference scenario between LTE and WiMAX since they refer to interference from LTE to LTE and WiMAX to WiMAX respectively (assumed difference in channel occupation between LTE and WiMAX), this gives an indication that interference between LTE and WiMAX and vice versa will be limited.

The uplink interference between LTE and WiMAX has not been analysed through simulations.

Note:
It should be noted that EC Decision 2009/766/EC and ECC Decision (06)01 define the required frequency separation as the separation between the two carriers' centre frequencies. This approach is straight-forward for both GSM and UMTS as those technologies have fixed carrier separations of 200 kHz and 5 MHz respectively.
Since both LTE and WiMAX have multiple possible channel bandwidths, the required frequency separation for those technologies is defined in a generic way based on the separation between the channel edges of the respective carriers. This generic edge-to-edge separation can then be converted into the appropriate separation of the carriers' centre frequencies taking into account the relevant channel bandwidths.
For example, for a 5 MHz LTE/WiMAX system the generic edge-to-edge separation (uncoordinated) of 200 kHz results in a separation between the LTE/WiMAX and GSM carriers' centre frequencies of 2.8 MHz, whereas for a 10 MHz LTE/WiMAX system the generic edge-to-edge separation (uncoordinated) of 200 kHz results in a separation between the LTE and GSM carriers' centre frequencies of 5.3 MHz.

ANNEX 1 : LTE SYSTEM PARAMETERS

LTE BS and UE transmitter and receiver characteristics are defined in ETSI EN301908-14 and EN301908-13 respectively. The LTE system parameters given in this Annex are from ETSI EN301908-14 V8.7.0[1] and EN301908-13 V8.7.0.[2].

A1.1 LTE BS Spectrum mask

Emissions shall not exceed the maximum levels specified in the tables below, where:

- Δf is the separation between the channel edge frequency and the nominal -3 dB point of the measuring filter closest to the carrier frequency.
- f_offset is the separation between the channel edge frequency and the centre of the measuring filter.
- f_offset_{max} is the offset to the frequency 10 MHz outside the downlink operating band.
- Δf_{max} is equal to f_offset_{max} minus half of the bandwidth of the measuring filter.

Frequency offset of measurement filter -3dB point, Δf	Frequency offset of measurement filter centre frequency, f_offset	Minimum requirement	Measurement bandwidth (Note 3)
0 MHz ≤ Δf < 0.2 MHz	0.015MHz ≤ f_offset < 0.215MHz	-14 dBm	30 kHz
0.2 MHz ≤ Δf < 1 MHz	0.215MHz ≤ f_offset < 1.015MHz	$-14dBm-15\cdot\left(\frac{f\_offset}{MHz}-0.215\right)dB$	30 kHz
(Note 4)	1.015MHz ≤ f_offset < 1.5 MHz	-26 dBm	30 kHz
1 MHz ≤ Δf ≤ 10 MHz	1.5 MHz ≤ f_offset < 10.5 MHz	-13 dBm	1 MHz
10 MHz ≤ Δf ≤ Δf_{max}	10.5 MHz ≤ f_offset < f_offset_{max}	-15 dBm	1 MHz

Table 21: Regional operating band unwanted emission limits in band 3 and 8 for 5, 10, 15 and 20 MHz channel bandwidth for Category B

Frequency offset of measurement filter -3dB point, Δf	Frequency offset of measurement filter centre frequency, f_offset	Minimum requirement	Measurement bandwidth (Note 3)
0 MHz ≤ Δf < 0.05 MHz	0.015 MHz ≤ f_offset < 0.065 MHz	$5dBm-60\cdot\left(\frac{f_{offset}}{MHz}-0.015\right)dB$	30 kHz
0.05 MHz ≤ Δf < 0.15 MHz	0. 065 MHz ≤ f_offset < 0.165 MHz	$2dBm-160\cdot\left(\frac{f_{offset}}{MHz}-0.065\right)dB$	30 kHz
0.15 MHz ≤ Δf < 0.2 MHz	0.165MHz ≤ f_offset < 0.215MHz	-14 dBm	30 kHz
0.2 MHz ≤ Δf < 1 MHz	0.215MHz ≤ f_offset < 1.015MHz	$-14dBm-15\cdot\left(\frac{f\_offset}{MHz}-0.215\right.$	30 kHz
(Note 4)	1.015MHz ≤ f_offset < 1.5 MHz	-26 dBm	30 kHz
1 MHz ≤ Δf ≤ 10 MHz	1.5 MHz ≤ f_offset < 10.5 MHz	-13 dBm	1 MHz
10 MHz ≤ Δf ≤ Δf_{max}	10.5 MHz ≤ f_offset < f_offset_{max}	-15 dBm	1 MHz

Table 22: Regional operating band unwanted emission limits in band 3 and 8 for 1.4 and 3 MHz channel bandwidth for Category B

A1.2 LTE UE Spectrum mask

Spectrum emission limit (dBm) / Channel bandwidth							
Δf_{OOB} (MHz)	**1.4 MHz**	**3.0 MHz**	**5 MHz**	**10 MHz**	**15 MHz**	**20 MHz**	**Measurement bandwidth**
± 0-1	-10	-13	-15	-18	-20	-21	30 kHz
± 1-2.5	-10	-10	-10	-10	-10	-10	1 MHz
± 2.5-2.8	-25	-10	-10	-10	-10	-10	1 MHz
± 2.8-5		-10	-10	-10	-10	-10	1 MHz
± 5-6		-25	-13	-13	-13	-13	1 MHz
± 6-10			-25	-13	-13	-13	1 MHz
± 10-15				-25	-13	-13	1 MHz
± 15-20					-25	-13	1 MHz
± 20-25						-25	1 MHz

Table 23: General E-UTRA spectrum emission mask

Spectrum emission limit (dBm) / Channel bandwidth							
Δf_{OOB} (MHz)	**1.4 MHz**	**3.0 MHz**	**5 MHz**	**10 MHz**	**15 MHz**	**20 MHz**	**Measurement bandwidth**
± 0-1	-10	-13	-15	-18	-20	-21	30 kHz
± 1-2.5	-13	-13	-13	-13	-13	-13	1 MHz
± 2.5-5	-25	-13	-13	-13	-13	-13	1 MHz
± 5-6		-25	-13	-13	-13	-13	1 MHz
± 6-10			-25	-13	-13	-13	1 MHz
± 10-15				-25	-13	-13	1 MHz
± 15-20					-25	-13	1 MHz
± 20-25						-25	1 MHz

Table 24: Additional requirements

Spectrum emission limit (dBm)/ Channel bandwidth							
Δf_{OOB} (MHz)	**1.4 MHz**	**3.0 MHz**	**5 MHz**	**10 MHz**	**15 MHz**	**20 MHz**	**Measurement bandwidth**
± 0-1	-10	-13	-15	-18	-20	-21	30 kHz
± 1-2.5	-13	-13	-13	-13	-13	-13	1 MHz
± 2.5-5	-25	-13	-13	-13	-13	-13	1 MHz
± 5-6		-25	-25	-25	-25	-25	1 MHz
± 6-10			-25	-25	-25	-25	1 MHz
± 10-15				-25	-25	-25	1 MHz
± 15-20					-25	-25	1 MHz
± 20-25						-25	1 MHz

Table 25: Additional requirements

The additional requirements of the spectrum mask may not be met by all of the UE on the market, it is proposed to use the general requirement of spectrum mask in the co-existence study which represents the worst case.

A1.3 LTE BS ACLR

E-UTRA transmitted signal channel bandwidth $BW_{Channel}$, MHz	**BS adjacent channel centre frequency offset below the first or above the last carrier centre frequency transmitted**	**Assumed adjacent channel carrier (informative)**	**Filter on the adjacent channel frequency and corresponding filter bandwidth**	**ACLR limit**
1.4, 3.0, 5, 10, 15, 20	$BW_{Channel}$	E-UTRA of same BW	Square (BW_{Config})	45 dB
	2 x $BW_{Channel}$	E-UTRA of same BW	Square (BW_{Config})	45 dB
	$BW_{Channel}$ /2 + 2.5 MHz	3.84 Mcps UTRA	RRC (3.84 Mcps)	45 dB
	$BW_{Channel}$ /2 + 7.5 MHz	3.84 Mcps UTRA	RRC (3.84 Mcps)	45 dB
NOTE 1: $BW_{Channel}$ and BW_{Config} are the channel bandwidth and transmission bandwidth configuration of the E-UTRA transmitted signal on the assigned channel frequency. NOTE 2: The RRC filter shall be equivalent to the transmit pulse shape filter defined in TS 25.104 [6], with a chip rate as defined in this Table.				

Table 26: Base Station ACLR in paired spectrum

A1.4 LTE UE ACLR

	Channel bandwidth / E-UTRA$_{ACLR1}$ / measurement bandwidth					
	1.4 MHz	**3.0 MHz**	**5 MHz**	**10 MHz**	**15 MHz**	**20 MHz**
E-UTRA$_{ACLR1}$	30 dB	30 dB	30 dB	30 dB	30 dB	30 dB
Adjacent channel centre frequency offset (in MHz)	+1.4 / -1.4	+3.0 / -3.0	+5 / -5	+10 / -10	+15 / -15	+20 / -20

Table 27: General requirements for E-UTRAACLR

	Channel bandwidth / $UTRA_{ACLR1/2}$ / measurement bandwidth					
	1.4 MHz	**3.0 MHz**	**5 MHz**	**10 MHz**	**15 MHz**	**20 MHz**
$UTRA_{ACLR1}$	33 Db	33 dB	33 dB	33 dB	33 dB	33 dB
Adjacent channel centre frequency offset (in MHz)	$0.7+BW_{UTRA}/2$	$1.5+BW_{UTRA}/2$	$+2.5+BW_{UTRA}/2$ / $-2.5-BW_{UTRA}/2$	$+5+BW_{UTRA}/2$ / $-5-BW_{UTRA}/2$	$+7.5+BW_{UTRA}/2$ / $-7.5-BW_{UTRA}/2$	$+10+BW_{UTRA}/2$ / $-10-BW_{UTRA}/2$
$UTRA_{ACLR2}$	-	-	36 dB	36 dB	36 dB	36 dB
Adjacent channel centre frequency offset (in MHz)	-	-	$+2.5+3*BW_{UTRA}/2$ / $-2.5-3*BW_{UTRA}/2$	$+5+3*BW_{UTRA}/2$ / $-5-3*BW_{UTRA}/2$	$+7.5+3*BW_{UTRA}/2$ / $-7.5-3*BW_{UTRA}/2$	$+10+3*BW_{UTRA}/2$ / $-10-3*BW_{UTRA}/2$
E-UTRA channel Measurement bandwidth	-	-	4.5 MHz	9.0 MHz	13.5 MHz	18 MHz
UTRA 5MHz channel Measurement bandwidth*	-	-	3.84 MHz	3.84 MHz	3.84 MHz	3.84 MHz
UTRA 1.6MHz channel measurement bandwidth**	-	-	1.28 MHz	1.28MHz	1.28MHz	1.28MHz
* Note: Applicable for E-UTRA FDD co-existence with UTRA FDD in paired spectrum. ** Note: Applicable for E-UTRA TDD co-existence with UTRA TDD in unpaired spectrum.						

Table 28: Requirements for UTRAACLR1/2

A1.5 LTE BS Spurious Emissions

The transmitter spurious emission limits apply from 9 kHz to 12,75 GHz, excluding the frequency range from 10 MHz below the lowest frequency of the downlink operating band up to 10 MHz above the highest frequency of the downlink operating band.

Frequency range	**Maximum Level**	**Measurement Bandwidth**	**Note**
9 kHz ↔ 150 kHz	-36 dBm	1 kHz	Note 1
150 kHz ↔ 30 MHz	-36 dBm	10 kHz	Note 1
30 MHz ↔ 1 GHz	-36 dBm	100 kHz	Note 1
1 GHz ↔ 12.75 GHz	-30 dBm	1 MHz	Note 2
NOTE 1: Bandwidth as in Recommendation ITU-R SM.329 [2] , s4.1 NOTE 2: Bandwidth as in Recommendation ITU-R SM.329 [2] , s4.1. Upper frequency as in Recommendation ITU-R SM.329 [2] , s2.5 Table 1			

Table 29: BS Spurious emissions limits, Category B

System type for E-UTRA to co-exist with	Frequency range for co-existence requirement	Maximum Level	Measurement Bandwidth	Note
GSM900	921 - 960 MHz	-57 dBm	100 kHz	This requirement does not apply to E-UTRA BS operating in band 8
	876 - 915 MHz	-61 dBm	100 kHz	For the frequency range 880-915 MHz, this requirement does not apply to E-UTRA BS operating in band 8, since it is already covered by the requirement in sub-clause 6.6.4.2.
DCS1800	1805 - 1880 MHz	-47 dBm	100 kHz	This requirement does not apply to E-UTRA BS operating in band 3.
	1710 - 1785 MHz	-61 dBm	100 kHz	This requirement does not apply to E-UTRA BS operating in band 3, since it is already covered by the requirement in sub-clause 6.6.4.2.
UTRA FDD Band I or E-UTRA Band 1	2110 - 2170 MHz	-52 dBm	1 MHz	This requirement does not apply to E-UTRA BS operating in band 1,
	1920 - 1980 MHz	-49 dBm	1 MHz	This requirement does not apply to E-UTRA BS operating in band 1, since it is already covered by the requirement in sub-clause 6.6.4.2.
UTRA FDD Band III or E-UTRA Band 3	1805 - 1880 MHz	-52 dBm	1 MHz	This requirement does not apply to E-UTRA BS operating in band 3.
	1710 - 1785 MHz	-49 dBm	1 MHz	This requirement does not apply to E-UTRA BS operating in band 3, since it is already covered by the requirement in sub-clause 6.6.4.2.
UTRA FDD Band VII or E-UTRA Band 7	2620 - 2690 MHz	-52 dBm	1 MHz	This requirement does not apply to E-UTRA BS operating in band 7.
	2500 - 2570 MHz	-49 dBm	1 MHz	This requirement does not apply to E-UTRA BS operating in band 7, since it is already covered by the requirement in sub-clause 6.6.4.2.
UTRA FDD Band VIII or E-UTRA Band 8	925 - 960 MHz	-52 dBm	1 MHz	This requirement does not apply to E-UTRA BS operating in band 8.
	880 - 915 MHz	-49 dBm	1 MHz	This requirement does not apply to E-UTRA BS operating in band 8, since it is already covered by the requirement in sub-clause 6.6.4.2.

Table 30: BS Spurious emissions limits for E-UTRA BS for co-existence with systems operating in other frequency bands

A1.6 LTE UE Spurious Emissions

Frequency Range	Maximum Level	Measurement Bandwidth
9 kHz ≤ f < 150 kHz	-36 dBm	1 kHz
150 kHz ≤ f < 30 MHz	-36 dBm	10 kHz
30 MHz ≤ f < 1000 MHz	-36 dBm	100 kHz
1 GHz ≤ f < 12.75 GHz	-30 dBm	1 MHz

Table 31: Spurious emissions limits

E-UTRA Band	**Spurious emission**						
	Protected band	Frequency range (MHz)			Level (dBm)	Bandwidth (MHz)	Comment
3 (1800 MHz)	E-UTRA Band 1, 3, 7, 8, 33, 34, 38	FDL_low	-	FDL_high	-50	1	
8 (900 MHz)	E-UTRA Band 1, 8, 7, 33, 34, 38, 39, 40	FDL_low	-	FDL_high	-50	1	
	E-UTRA band 3	1805	-	1830	-50	1	Note 4
	E-UTRA band 3	1805	-	1880	-36	0.1	Note 2,4
	E-UTRA band 3	1830	-	1880	-50	1	Note 4
	E-UTRA band 7	2640	-	2690	-50	1	Note 4
	E-UTRA band 7	2640	-	2690	-36	0.1	Note 2,4
Note 1	FDL_low and FDL_high refer to each E-UTRA frequency band specified in Table 5.5-1 of 3GPP TS36.104[1]						
2	As exceptions, measurements with a level up to the applicable requirements defined in Table 6.6.3.1-2 are permitted for each assigned E-UTRA carrier used in the measurement due to 2nd or 3rd harmonic spurious emissions. An exception is allowed if there is at least one individual RE within the transmission bandwidth (see Figure 5.6-1 of 3GPP TS36.104[1) for which the 2nd or 3rd harmonic, i.e. the frequency equal to two or three times the frequency of that RE, is within the measurement bandwidth.						

Table 32: Requirements

A1.7LTE BS Reference sensitivity

E-UTRA channel bandwidth, MHz	Reference measurement channel	Reference sensitivity power level, PREFSENS, dBm
1.4	FRC A1-1 in Annex A.1	-106.8
3	FRC A1-2 in Annex A.1	-103.0
5	FRC A1-3 in Annex A.1	-101.5
10	FRC A1-3 in Annex A.1*	-101.5
15	FRC A1-3 in Annex A.1*	-101.5
20	FRC A1-3 in Annex A.1*	-101.5
Note*: $P_{REFSENS}$ is the power level of a single instance of the reference measurement channel. This requirement shall be met for each consecutive application of a single instance of FRC A1-3 mapped to disjoint frequency ranges with a width of 25 resource blocks each		

Table 33: BS reference sensitivity levels

A1.8 LTE UE Reference sensitivity

Channel bandwidth							
E-UTRA Band	1.4 MHz (dBm)	3 MHz (dBm)	5 MHz (dBm)	10 MHz (dBm)	15 MHz (dBm)	20 MHz (dBm)	Duplex Mode
3 (1800 MHz)	-102.2	-99.2	-97	-94	-92.2	-91	FDD
8 (900 MHz)	-102.2	-99.2	-97	-94			FDD

Table 34: Reference sensitivity QPSK PREFSENS

It should be pointed out that the UE reference sensitivity levels include 3 dB two-way Rx div gain.

A1.9 LTE BS ACS

E-UTRA channel bandwidth, MHz	Wanted signal mean power, dBm	Interfering signal mean power, dBm	Interfering signal centre frequency offset from the channel edge of the wanted signal, MHz	Type of interfering signal
1.4	$P_{REFSENS}$ + 11dB*	-52	0.7025	1.4MHz E-UTRA signal
3	$P_{REFSENS}$ + 8dB*	-52	1.5075	3MHz E-UTRA signal
5	$P_{REFSENS}$ + 6dB*	-52	2.5025	5MHz E-UTRA signal
10	$P_{REFSENS}$ + 6dB*	-52	2.5075	5MHz E-UTRA signal
15	$P_{REFSENS}$ + 6dB*	-52	2.5125	5MHz E-UTRA signal
20	$P_{REFSENS}$ + 6dB*	-52	2.5025	5MHz E-UTRA signal
Note*: $P_{REFSENS}$ depends on the channel bandwidth as specified in Table 33.				

Table 35: Adjacent channel selectivity

A1.10 LTE UE ACS

Channel bandwidth							
Rx Parameter	Units	1.4 MHz	3 MHz	5 MHz	10 MHz	15 MHz	20 MHz
ACS	dB	33.0	33.0	33.0	33.0	30	27

Table 36: Adjacent channel selectivity

A1.11 LTE BS In-band & Out-of-band Blocking

Operating band	Centre frequency of interfering signal, MHz	Interfering signal mean power, dBm	Wanted signal mean power, dBm	Interfering signal centre frequency minimum frequency offset from the channel edge of the wanted signal, MHz	Type of interfering signal
3 (1800 MHz)	(F_{UL_low} -20) to (F_{UL_high} +20)	-43	$P_{REFSENS}$ +6dB*	See Table 38	See Table 38
	1 to (F_{UL_low} -20) (F_{UL_high} +20) to 12750	-15	$P_{REFSENS}$ +6dB*	—	CW carrier
8 (900 MHz)	(F_{UL_low} -20) to (F_{UL_high} +10)	-43	$P_{REFSENS}$ +6dB*	See Table 38	See Table 38
	1 to (F_{UL_low} -20) (F_{UL_high} +10) to 12750	-15	$P_{REFSENS}$ +6dB*	—	CW carrier

Table 37: Blocking performance requirement for

E-UTRA channel BW, MHz	Interfering signal centre frequency minimum offset to the channel edge of the wanted signal, MHz	Type of interfering signal
1.4	2.1	1.4MHz E-UTRA signal
3	4.5	3MHz E-UTRA signal
5	7.5	5MHz E-UTRA signal
10	7.5	5MHz E-UTRA signal
15	7.5	5MHz E-UTRA signal
20	7.5	5MHz E-UTRA signal

Table 38: Interfering signals for blocking performance requirement for

A1.12 LTE UE In-band & Out-of-band Blocking

Rx Parameter	Units	Channel bandwidth					
		1.4 MHz	3 MHz	5 MHz	10 MHz	15 MHz	20 MHz
Wanted signal mean power	dBm	REFSENS + channel bandwidth specific value below					
		6	6	6	6	7	9
$BW_{Interferer}$	MHz	1.4	3	5	5	5	5
$F_{Ioffset, case 1}$	MHz	2.1+0.0125	4.5+0.0075	7.5+0.0125	7.5+0.0025	7.5+0.0075	7.5+0.0125
$F_{Ioffset, case 2}$	MHz	3.5+0.0075	7.5+0.0075	12.5+0.0075	12.5+0.0125	12.5+0.0025	12.5+0.0075
Note 1: The transmitter shall be set to 4dB P_{UMAX} at the minimum uplink configuration specified in Table 7.3.1-2 of 3GPP TS 36.101[2]. Note 2: The interferer consists of the Reference measurement channel specified in Annex A.3.2 with set-up according to Annex C.3.1 of 3GPP TS 36.101[2]							

Table 39: In band blocking parameters

E-UTRA band	Parameter	Units	Case 1	Case 2	Case 3
	$P_{Interferer}$	dBm	-56	-44	-30
	$F_{Interferer}$ (Offset)	MHz	$=-BW/2 - F_{Ioffset, case 1}$ & $=+BW/2 + F_{Ioffset, case 1}$	$\leq -BW/2 - F_{Ioffset, case 2}$ & $\geq +BW/2 + F_{Ioffset, case 2}$	-BW/2 – 9 MHz & -BW/2 – 15 MHz
3 (1800 MHz) 8 (900 MHz)	$F_{Interferer}$	MHz	(Note 2)	F_{DL_low} -15 to F_{DL_high} +15	

Note

1 For certain bands, the unwanted modulated interfering signal may not fall inside the UE receive band, but within the first 15 MHz below or above the UE receive band.

2 For each carrier frequency the requirement is valid for two frequencies:

a. the carrier frequency -BW/2 -FIoffset, case 1 and

b. the carrier frequency + BW/2 + FIoffset, case 1.

3 $F_{interferer}$ range values for unwanted modulated interfering signal are interferer centre frequencies.

4 Case 3 only applies to assigned UE channel bandwidth of 5 MHz.

Table 40: In-band blocking

Rx Parameter	Units	Channel bandwidth					
		1.4 MHz	**3 MHz**	**5 MHz**	**10 MHz**	**15 MHz**	**20 MHz**
Wanted signal mean power	dBm	REFSENS + channel bandwidth specific value below					
		6	6	6	6	7	9

Note 1: The transmitter shall be set to 4dB below P_{UMAX} at the minimum uplink configuration specified in Table 7.3.1-2 of 3GPP TS 36.101[2].
Note 2: Reference measurement channel is specified in Annex A.3.2.

Table 41: Out-of-band blocking parameters

E-UTRA band	Parameter	Units	Frequency			
			range 1	**range 2**	**range 3**	**range 4**
	$P_{Interferer}$	dBm	-44	-30	-15	-15
3(1800 MHz) 8(900 MHz)	$F_{Interferer}$ (CW)	MHz	F_{DL_low} -15 to F_{DL_low} -60	F_{DL_low} -60 to F_{DL_low} -85	F_{DL_low} -85 to 1 MHz	-
			F_{DL_high} +15 to F_{DL_high} + 60	F_{DL_high} +60 to F_{DL_high} +85	F_{DL_high} +85 to +12750 MHz	-

Table 42: Out of band blocking

A1.13 LTE BS Narrow Band Blocking

Wanted signal mean power, dBm	Interfering signal mean power, dBm	Type of interfering signal
$P_{REFSENS}$ + 6dB*	-49	See Table 7.5.1-2
Note*: $P_{REFSENS}$ depends on the channel bandwidth as specified in Table 33.		

Table 43: Narrowband blocking requirement

E-UTRA Assigned BW, MHz	Interfering RB centre frequency offset to the channel edge of the wanted signal, kHz	Type of interfering signal
1.4	252.5+m*180, m=0, 1, 2, 3, 4, 5	1.4 MHz E-UTRA signal, 1 RB*
3	247.5+m*180, m=0, 1, 2, 3, 4, 7, 10, 13	3 MHz E-UTRA signal, 1 RB*
5	342.5+m*180, m=0, 1, 2, 3, 4, 9, 14, 19, 24	5 MHz E-UTRA signal, 1 RB*
10	347.5+m*180, m=0, 1, 2, 3, 4, 9, 14, 19, 24	5 MHz E-UTRA signal, 1 RB*
15	352.5+m*180, m=0, 1, 2, 3, 4, 9, 14, 19, 24	5 MHz E-UTRA signal, 1 RB*
20	342.5+m*180, m=0, 1, 2, 3, 4, 9, 14, 19, 24	5 MHz E-UTRA signal, 1 RB*
Note*: Interfering signal consisting of one resource block adjacent to the wanted signal		

Table 44: Interfering signal for Narrowband blocking requirement

A1.14 LTE UE Narrow Band Blocking

Parameter	Unit	Channel Bandwidth					
		1.4 MHz	3 MHz	5 MHz	10 MHz	15 MHz	20 MHz
P_w	dBm	$P_{REFSENS}$ + channel-bandwidth specific value below					
		22	18	16	13	14	16
P_{uw} (CW)	dBm	-55	-55	-55	-55	-55	-55
F_{uw} (offset for Δf = 15 kHz)	MHz	0.9075	1.7025	2.7075	5.2125	7.7025	10.2075
F_{uw} (offset for Δf = 7.5 kHz)	MHz						
Note 1: The transmitter shall be set a 4 dB below P_{UMAX} at the minimum uplink configuration specified in Table 7.3.1-2 of 3GPP TS 36.101[2]. Note 2: Reference measurement channel is specified in Annex A.3.2.							

Table 45: Narrow-band blocking

A1.15 LTE power control range and protection ratio

<u>LTE BS power control range:</u>

Release 8 LTE DL power control is an option, it is proposed not to use the DL power control for LTE in the co-existence with GSM and UMTS.

<u>LTE UE power control range</u>

Maximum Output power: 23 dBm
Minimum Output Power: -40 dBm

<u>LTE protection ratio</u>

<u>LTE protection ratio:</u> 5% cell average throughput loss
The following mapping Table between the throughput and C/I can be found in the 3GPP Report TR36.942, Annex A.

	Throughput			
SNIR	bps/Hz		kbps per 375kHz RB	
dB	DL	UL	DL	UL
-15	0	0	0	0
-14	0	0	0	0
-13	0	0	0	0
-12	0	0	0	0
-11	0	0	0	0
-10	0.08	0.06	31	21
-9	0.10	0.07	38	26
-8	0.13	0.08	48	32
-7	0.16	0.10	59	39
-6	0.19	0.13	73	48
-5	0.24	0.16	89	59
-4	0.29	0.19	109	73
-3	0.35	0.23	132	88
-2	0.42	0.28	159	106
-1	0.51	0.34	190	127
0	0.60	0.40	225	150
1	0.71	0.47	265	176
2	0.82	0.55	308	206
3	0.95	0.63	356	237
4	1.09	0.72	408	272
5	1.23	0.82	463	309

	Throughput			
SNIR	bps/Hz		kbps per 375kHz RB	
dB	DL	UL	DL	UL
6	1.39	0.93	521	347
7	1.55	1.04	582	388
8	1.72	1.15	646	430
9	1.90	1.26	711	474
10	2.08	1.38	778	519
11	2.26	1.51	847	565
12	2.44	1.63	917	611
13	2.63	1.76	988	658
14	2.82	1.88	1059	706
15	3.02	2.00	1131	750
16	3.21	2.00	1204	750
17	3.41	2.00	1277	750
18	3.60	2.00	1350	750
19	3.80	2.00	1424	750
20	3.99	2.00	1498	750
21	4.19	2.00	1572	750
22	4.39	2.00	1646	750
23	4.40	2.00	1650	750
24	4.40	2.00	1650	750
25	4.40	2.00	1650	750

Table 46: Look-Up-Table of UL and DL Throughput vs. SNIR for Baseline E-UTRA Coexistence Studies

ANNEX 2 : WIMAX SYSTEM PARAMETERS

A2.1 Spectral emission mask

MS and BS Spectrum emission mask for 5 MHz and 10 MHz channel bandwidths are given respectively in the Table 47 to Table 50.

Segment Number	Offset from channel centre (MHz)	Integration Bandwidth (kHz)	Allowed Emission Level (dBm/Integration Bandwidth) as measured at the antenna port
1	2.5 to <3.5	50	-13
2	3.5 to < 7.5	1000	-10
3	7.5 to <8.5	1000	-13
4	8.5 to <12.5	1000	-25

Table 47: MS Spectrum Emission Mask: 5 MHz

Segment Number	Offset Δf from channel centre (MHz)	Integration Bandwidth (kHz)	Allowed Emission Level (dBm/Integration Bandwidth) as measured at the antenna port
1	2.5 to <2.7	30	-14
2	2.7 to <3.5	30	-14-15(Δ*f*-2.7)
3	3.5 to <4.0	30	-26
4	4.0 to <12.5	1000	-13

Table 48: BS Spectrum Emission Mask - Europe: 5 MHz

Segment Number	Offset from channel centre (MHz)	Integration Bandwidth (kHz)	Allowed Emission Level (dBm/Integration Bandwidth) as measured at the antenna port
1	5.0 to < 6.0	50	-13
2	6.0 to < 10.0	1000	-10
3	10.0 to < 11.0	1000	-13
4	11.0 to ≤25.0	1000	-25

Table 49: MS Spectrum Emission Mask: 10 MHz

Segment Number	Offset Δf from channel centre (MHz)	Integration Bandwidth (kHz)	Allowed Emission Level (dBm/Integration Bandwidth) as measured at the antenna port
1	5.0 to <5.2	30	-14
2	5.2 to <6.0	30	-14-15(Δ*f*-5.2)
3	6.0 to <6.5	30	-26
4	6.5 to <15.0	1000	-13
5	15.0 to <25.0	1000	-15

Table 50: BS Spectrum Emission Mask - Europe: 10 MHz

Note: This spectrum mask does not apply beyond 10 MHz outside the downlink operating band, where the spurious emission requirement applies.

A2.2 Transmitter Spurious Emissions for 900 MHz and 1800 MHz

This section provides Spurious Emission limits for MS and BS operations in 900 and 1800 MHz bands.

Spurious Emission for MS

The spurious emission limits for MS are given in Table 51 and Table 52. Table 53 and Table 54 give the additional spurious emissions for MS. The spurious emissions levels define in the Table 51 to Table 54 apply to frequency offsets which are greater than 2.5 times the channel bandwidth from the MS centre frequency.

No	Transmitter Centre Frequency (f_c) (MHz)	Spurious Frequency (*f*) Range	Integration Bandwidth	Maximum Emission Level (dBm)
1.	880-915	9 kHz ≤ *f* <150 kHz	1 kHz	-36
2.	880-915	150 kHz ≤ *f* <30 MHz	10 kHz	-36
3.	880-915	30 MHz ≤ *f* <1000 MHz	100 kHz	-36
4.	880-915	1 GHz ≤ *f* <12.75 GHz	1 MHz	-30

Table 51: Spurious Emission for MS (900 MHz)

No	Transmitter Centre Frequency (f_c) (MHz)	Spurious Frequency (*f*) Range	Integration Bandwidth	Maximum Emission Level (dBm)
1.	1710-1785	9 kHz ≤ *f* <150 kHz	1 kHz	-36
2.	1710-1785	150 kHz ≤ *f* <30 MHz	10 kHz	-36
3.	1710-1785	30 MHz ≤ *f* <1000 MHz	100 kHz	-36
4.	1710-1785	1 GHz ≤ *f* <12.75 GHz	30 kHz, If 12.5 MHz <=< *f* < 50 MHz 300 kHz, If 50 MHz<=< *f* < 60 MHz 1 MHz, If 60 MHz<=< *f*	-30

Table 52: Spurious Emission for MS (1800 MHz)

No	Transmitter Centre Frequency (f_c) (MHz)	Spurious Frequency (*f*) Range (MHz)	Measurement Bandwidth (MHz)	Maximum Emission Level (dBm)
1.	880-915	925-960	1	-50
2.		1805-1880	1	-50

Table 53: Additional Spurious Emission for MS (900 MHz)

With respect to the spurious frequencies of Item 2 (entire range) of Table 53 exceptions in measurements are allowed for harmonic spurious emissions where the harmonics are 2nd or 3rd harmonics of in channel transmissions. In these exception cases, the maximum emission level (-36 dBm/100KHz) of Item 3 in Table 51 is applicable.

No	Transmitter Centre Frequency (f_c) (MHz)	Spurious Frequency (f) Range (MHz)	Measurement Bandwidth (MHz)	Maximum Emission Level (dBm)
1.	1710-1785	1805-1880	1	-50
2.		925-960	1	-50

Table 54: Additional Spurious Emission for MS (1800 MHz)

Spurious Emission for BS

The transmitter spurious emission limits apply from 9 kHz to 12,75 GHz, excluding the frequency range from 10 MHz below the lowest frequency of the downlink operating band up to 10 MHz above the highest frequency of the downlink operating band.

No	Transmitter Centre Frequency (f_c) (MHz)	Spurious Frequency (f) Range	Integration Bandwidth	Maximum Emission Level (dBm)
1.	925 -960	9 kHz ≤ f <150 kHz	1 kHz	-36
2.	925 -960	150 kHz ≤ f <30 MHz	10 kHz	-36
3.	925 -960	30 MHz ≤ f <1000 MHz	100 kHz	-36
4.	925 -960	1 GHz ≤ f <12.75 GHz	1 MHz	-30

Table 55: Spurious Emission for BS (900 MHz)

No	Transmitter Centre Frequency (f_c) (MHz)	Spurious Frequency (f) Range	Integration Bandwidth	Maximum Emission Level (dBm)
1.	1805-1880	9 kHz ≤ f <150 kHz	1 kHz	-36
2.	1805-1880	150 kHz ≤ f <30 MHz	10 kHz	-36
3.	1805-1880	30 MHz ≤ f <1000 MHz	100 kHz	-36
4.	1805-1880	1 GHz ≤ f <12.75 GHz	30 kHz, If 12.5 MHz <=f < 50 MHz 300 kHz, If 50 MHz<=f < 60 MHz 1 MHz, If 60 MHz<=f	-30

Table 56: Spurious Emission for BS (1800 MHz)

Table 57 specifies limits to protect BS receivers against its intra-system BS transmit emissions.

No	Transmitter Centre Frequency (f_c) (MHz)	Spurious Frequency (f) Range (MHz)	Measurement Bandwidth	Maximum Level
1.	925 -960	880-915	100 kHz	-96 dBm
2.	1805-1880	1710 – 1785	100 kHz	-96 dBm

Table 57: BS Spurious Emissions Limits for protection of the BS receiver

The spurious emission limits specified in Table 58 may be required by local or regional regulations.

No	Transmitter Centre Frequency (f_c) (MHz)	Spurious Frequency (*f*) Range (MHz)	Measurement Bandwidth	Maximum Emission Level (dBm)
1.	1850-1880	1850–1910 1930–1990	100 KHz	-61
2.	1850-1880	1850–1910 1930–1990	1 MHz	-49
3.	1850-1880	1850–1910	1 MHz	-52
4.	1844.9 - 1879.9	1749.9 –1784.9 1844.9–1879.9	1 MHz	-52

Table 58: Additional Spurious Emission for BS (1800 MHz)

A2.3 Receiver Adjacent Channel Selectivity for 900 MHz and 1800 MHz

This section provides Receiver Adjacent Channel Selectivity numbers for MS and BS operations in 900 and 1800 MHz bands.

The Receiver Adjacent Channel Selectivity is defined as follows[1]. The receiver Adjacent Channel Selectivity (ACS) is a measure of the receiver's ability to receive a wanted signal at its assigned channel frequency in the presence of an adjacent channel signal at a given frequency offset from the centre frequency of the assigned channel. ACS is the interferer power level (in dB) relative to thermal noise (Nth). To reference the receiver adjacent values properly, a sensitivity level is defined as the signal level for Bit Error Ratio (BER) $\leq 10^{-6}$ (or equivalent PER) performance for AWGN channel, over the channel bandwidth (5 MHz), corresponding to the most robust modulation and coding rate supported by the technology. Nth is the receiver thermal noise of the equipment as declared by the manufacturer and is equal to kTBwF where Bw is the bandwidth of the equipment and F is the receiver noise Figure. f_c is the centre frequency of the assigned channel.

ACS limits for MS 5 MHz channel and 10 MHz channel are given in Table 59 and Table 60. ACS limits for BS 5 MHz channel and 10 MHz channel are given in Table 61 and Table 62.

Description	In-channel	Interferer on 1st adjacent channel	Interferer on 2nd adjacent channel
ACS limit (dB)		33	47
Power (dBm)	$P_{SENS5} + 3$	Nth +33	Nth +47
Centre frequency (MHz) for 5MHz channel bandwidth	f_c	$f_c \pm 5$ MHz	$f_c \pm 10$ MHz

Table 59: ACS Limits for MS 5 MHz

Description	In-channel	Interferer on 1st adjacent channel	Interferer on 2nd adjacent channel
ACS limit (dB)		33	47
Power (dBm)	$P_{SENS10} + 3$	Nth +33	Nth +47
Centre frequency (MHz) for 10MHz channel bandwidth	f_c	$f_c \pm 10$ MHz	$f_c \pm 20$ MHz

Table 60: ACS Limits for MS 10 MHz

[1] The same definition is contained in ETSI EN302 544-1 and -2.

Description	In-channel	Interferer on 1st adjacent channel	Interferer on 2nd adjacent channel
ACS limit (dB)		46	56
Power (dBm)	P_{SENS5} + 3	Nth +46	Nth +56
Centre frequency (MHz) for 5MHz channel bandwidth	f_c	f_c ± 5 MHz	f_c ± 10 MHz

Table 61: ACS Limits for BS 5 MHz

Description	In-channel	Interferer on 1st adjacent channel	Interferer on 2nd adjacent channel
ACS limit (dB)		46	56
Power (dBm)	P_{SENS10} + 3	Nth +46	Nth +56
Centre frequency (MHz) for 10MHz channel bandwidth	f_c	f_c ± 10 MHz	f_c ± 20 MHz

Table 62: ACS Limits for BS 10 MHz

A2.4 Receiver Blocking CharacteristicS

This section provides Receiver Blocking Characteristics for MS and BS operations in 900 and 1800 MHz bands.

The Receiver Blocking Characteristics is defined as follows[2].The blocking characteristic is a measure of the receiver ability to receive a wanted signal at its assigned channel frequency in the presence of an unwanted interferer on frequencies other than those of the adjacent channels.

A2.4.1 Receiver Blocking Characteristics for MS

In-Band Receiver Blocking Characteristics for MS

The In-band blocking performance specification applies to interfering signals with centre frequency within the ranges specified in Table 63 to Table 66, using a 1 MHz step size. The blocking performance shall apply to all frequencies except those at which a spurious response occur.

P_{SENS5} and P_{SENS10} are the sensitivity levels at BER ≤ 10^{-6}, for 5 MHz and 10 MHz channels respectively, corresponding to the most robust modulation and coding rate supported by the user equipment. The wanted signal with the most robust modulation and coding supported by the MS shall be used. The wanted signal with the most robust modulation and coding supported by the MS shall be used. BER performance specification at BER ≤ 10^{-6} (or equivalent PER) shall be met when the following signals are coupled to MS antenna input.

[2] The same definition is contained in ETSI EN302 544-1 and -2.

Centre frequency of interfering signal (MHz)	Interfering signal mean power (dBm)	Wanted signal mean power (dB)	Minimum offset of interfering signal from the channel edge (MHz)	Type of interfering signal
925 to 960	-49	P_{SENS5} +6	12.5	Modulation and coding equal to those of the wanted signal

Table 63: Receiver In-Band Blocking Limits for MS (900 MHz): 5 MHz Channel BW

Centre frequency of interfering signal (MHz)	Interfering signal mean power (dBm)	Wanted signal mean power (dB)	Minimum offset of interfering signal from the channel edge (MHz)	Type of interfering signal
925 to 960	-49	P_{SENS10} +6	25	Modulation and coding equal to those of the wanted signal

Table 64: Receiver In-Band Blocking Limits for MS (900 MHz): 10 MHz Channel

Centre frequency of interfering signal (MHz)	Interfering signal mean power (dBm)	Wanted signal mean power (dB)	Minimum offset of interfering signal from the channel edge (MHz)	Type of interfering signal
1805 to 1880	-49	P_{SENS5} +6	12.5	Modulation and coding equal to those of the wanted signal

Table 65 Receiver In-Band Blocking Limits for MS (1800 MHz): 5 MHz Channel

Centre frequency of interfering signal (MHz)	Interfering signal mean power (dBm)	Wanted signal mean power (dB)	Minimum offset of interfering signal from the channel edge (MHz)	Type of interfering signal
1805 to 1880	-49	P_{SENS10} +6	25	Modulation and coding equal to those of the wanted signal

Table 66: Receiver In-Band Blocking Limits for MS (1800 MHz): 10 MHz Channel

Out-of-Band Receiver Blocking Characteristics for MS

The out of band blocking performance specification applies to a CW interfering signals with centre frequency within the ranges specified in Table 67 and Table 68.

The out of band blocking assumes an out of band filtering that was not applicable to in band blocking numbers. The blocking performance shall apply to all frequencies except those at which a spurious response occur. Please note that although the In-band blocking numbers of Section above general for various bands, the Out of Band Blocking numbers of this section are specific to the 900-1800 MHz study.

P_{SENS5} and P_{SENS10} are the sensitivity levels at BER ≤ 10^{-6}, for 5 MHz and 10 MHz channels respectively, corresponding to the most robust modulation and coding rate supported by the user equipment. The wanted signal with the most robust modulation and coding supported by the MS shall be used. The wanted signal with the most robust modulation and coding supported by the MS shall be used. BER performance specification at BER ≤ 10^{-6} (or equivalent PER) shall be met when the following signals are coupled to MS antenna input.

Centre frequency of interfering signal (MHz)	**Interfering signal mean power (dBm)**	**Wanted signal mean power (dB)**	**Minimum offset of interfering signal centre frequency from the wanted signal channel centre (MHz)**	**Type of interfering signal**
880-915	-44	P_{SENS5} +6	15	Modulation and coding equal to those of the wanted signal

Table 67: Receiver Out of Band Blocking Limits for MS (900 MHz): 5 MHz Channel

Centre frequency of interfering signal (MHz)	**Interfering signal mean power (dBm)**	**Wanted signal mean power (dB)**	**Minimum offset of interfering signal centre frequency from the wanted signal channel centre (MHz)**	**Type of interfering signal**
880-915	-44	P_{SENS10} +6	20	Modulation and coding equal to those of the wanted signal

Table 68: Receiver Out of Band Blocking Limits for MS (900 MHz): 10 MHz Channel

Centre frequency of interfering signal (MHz)	**Interfering signal mean power (dBm)**	**Wanted signal mean power (dB)**	**Minimum offset of interfering signal centre frequency from the wanted signal channel centre (MHz)**	**Type of interfering signal**
1710-1785	-44	P_{SENS5} +6	25	Modulation and coding equal to those of the wanted signal

Table 69: Receiver Out of Band Blocking Limits for MS (1800 MHz): 5 MHz Channel

Centre frequency of interfering signal (MHz)	Interfering signal mean power (dBm)	Wanted signal mean power (dB)	Minimum offset of interfering signal centre frequency from the wanted signal channel centre (MHz)	Type of interfering signal
1710-1785	-44	P_{SENS10} +6	30	Modulation and coding equal to those of the wanted signal

Table 70: Receiver Out of Band Blocking Limits for MS (1800 MHz): 10 MHz Channel

A2.4.2. Receiver Blocking Characteristics for BS

The blocking performance specification applies to interfering signals with centre frequency within the ranges specified in Table 71 to Table 74, using a 1 MHz step size. P_{SENS5} and P_{SENS10} are the sensitivity levels at BER ≤ 10^{-6}, for 5 MHz and 10 MHz channels, corresponding to the most robust modulation and coding rate supported by the base station. The wanted signal with the most robust modulation and coding supported by the BS shall be used. BER performance specification at BER ≤ 10^{-6} (or equivalent PER) shall be met when the following signals are coupled to BS antenna input.

Table 71 to Table 74 cover both in-band and out of band blocking numbers.

Centre frequency of interfering signal (MHz)	Interfering signal mean power (dBm)	Wanted signal mean power (dB)	Minimum offset of interfering signal from the channel edge (MHz)	Type of interfering signal
880 to 915	-40	P_{SENS5} +6	12.5	Modulation and coding equal to those of the wanted signal
860 to 880 915 to 925	-40	P_{SENS5} +6	12.5	Modulation and coding equal to those of the wanted signal
1 to 860 925 to 12750	-15	P_{SENS5} +6	–	CW carrier

Table 71: Receiver Blocking Limits for BS (900 MHz): 5 MHz Channel

Centre frequency of interfering signal (MHz)	Interfering signal mean power (dBm)	Wanted signal mean power (dB)	Minimum offset of interfering signal from the channel edge (MHz)	Type of interfering signal
880 to 915	-40	P_{SENS10} +6	25	Modulation and coding equal to those of the wanted signal
860 to 880 915 to 925	-40	P_{SENS10} +6	25	Modulation and coding equal to those of the wanted signal
1 to 860 925 to 12750	-15	P_{SENS10} +6	–	CW carrier

Table 72: Receiver Blocking Limits for BS (900 MHz): 10 MHz Channel

Centre frequency of interfering signal (MHz)	Interfering signal mean power (dBm)	Wanted signal mean power (dB)	Minimum offset of interfering signal from the channel edge (MHz)	Type of interfering signal
1710 to 1785	-40	P_{SENS5} +6	12.5	Modulation and coding equal to those of the wanted signal
1690 to 1710 1785 to 1805	-40	P_{SENS5} +6	12.5	Modulation and coding equal to those of the wanted signal
1 to 1690 1805 to 12750	-15	P_{SENS5} +6	–	CW carrier

Table 73: Receiver Blocking Limits for BS (1800 MHz): 5 MHz Channel

Centre frequency of interfering signal (MHz)	Interfering signal mean power (dBm)	Wanted signal mean power (dB)	Minimum offset of interfering signal from the channel edge (MHz)	Type of interfering signal
1710 to 1785	-40	P_{SENS10} +6	25	Modulation and coding equal to those of the wanted signal
1690 to 1710 1785 to 1805	-40	P_{SENS10} +6	25	Modulation and coding equal to those of the wanted signal
1 to 1690 1805 to 12750	-15	P_{SENS10} +6	–	CW carrier

Table 74: Receiver Blocking Limits for BS (1800 MHz): 10 MHz Channel

A2.4.3 Narrow Band Receiver Blocking Characteristics for MS

The narrow band blocking performance specification of this section applies to a GSM interfering signals with centre frequency starting at 300 KHz from the wanted signal channel edge. The blocking performance shall apply to all frequencies except those at which a spurious response occur.

P_{SENS5} and P_{SENS10} are the sensitivity levels at BER $\leq 10^{-6}$, for 5 MHz and 10 MHz channels respectively, corresponding to the most robust modulation and coding rate supported by the user equipment. The wanted signal with the most robust modulation and coding supported by the MS shall be used. BER performance specification at BER $\leq 10^{-6}$ (or equivalent PER) shall be met when the following signals are coupled to MS antenna input.

Table 75 to Table 78 cover the narrow band blocking numbers.

Centre frequency of interfering signal (MHz)	Interfering signal mean power (dBm)	Wanted signal mean power (dB)	Minimum offset of interfering signal from the channel edge (KHz)	Type of interfering signal
925 to 960	-53	P_{SENS5} +16	300	GSM

Table 75: Narrow Band Blocking Limits for MS (900 MHz): 5 MHz Channel

Centre frequency of interfering signal (MHz)	Interfering signal mean power (dBm)	Wanted signal mean power (dB)	Minimum offset of interfering signal from the channel edge (KHz)	Type of interfering signal
925 to 960	-53	P_{SENS10} +13	300	GSM

Table 76: Narrow Band Blocking Limits for MS (900 MHz): 10 MHz Channel

Centre frequency of interfering signal (MHz)	Interfering signal mean power (dBm)	Wanted signal mean power (dB)	Minimum offset of interfering signal from the channel edge (MHz)	Type of interfering signal
1805 to 1880	-53	P_{SENS5} +16	300	GSM

Table 77: Narrow Band Blocking Limits for MS (1800 MHz): 5 MHz Channel

Centre frequency of interfering signal (MHz)	Interfering signal mean power (dBm)	Wanted signal mean power (dB)	Minimum offset of interfering signal from the channel edge (MHz)	Type of interfering signal
1805 to 1880	-53	P_{SENS10} +13	300	GSM

Table 78: Narrow Band Blocking Limits for MS (1800 MHz): 10 MHz Channel

A2.4.4 Narrow Band Receiver Blocking Characteristics for BS

The narrow band blocking performance specification of this section applies to a GSM interfering signals with centre frequency starting at 300 kHz from the wanted signal channel edge. The blocking performance shall apply to all frequencies except those at which a spurious response occur.

P_{SENS5} and P_{SENS10} are the sensitivity levels at BER ≤ 10^{-6}, for 5 MHz and 10 MHz channels respectively, corresponding to the most robust modulation and coding rate supported by the user equipment. The wanted signal with the most robust modulation and coding supported by the MS shall be used. BER performance specification at BER ≤ 10^{-6} (or equivalent PER) shall be met when the following signals are coupled to MS antenna input.

Table 79 to Table 82 cover the narrow band blocking numbers.

Centre frequency of interfering signal (MHz)	Interfering signal mean power (dBm)	Wanted signal mean power (dB)	Minimum offset of interfering signal from the channel edge (KHz)	Type of interfering signal
880-915	-53	P_{SENS5} +6	300	GSM

Table 79: Narrow Band Blocking Limits for BS (900 MHz): 5 MHz Channel

Centre frequency of interfering signal (MHz)	Interfering signal mean power (dBm)	Wanted signal mean power (dB)	Minimum offset of interfering signal from the channel edge (KHz)	Type of interfering signal
880-915	-50	P_{SENS10} +6	300	GSM

Table 80: Narrow Band Blocking Limits for BS (900 MHz): 10 MHz Channel

Centre frequency of interfering signal (MHz)	Interfering signal mean power (dBm)	Wanted signal mean power (dB)	Minimum offset of interfering signal from the channel edge (MHz)	Type of interfering signal
1710-1785	-53	P_{SENS5} +6	300	GSM

Table 81: Narrow Band Blocking Limits for BS (1800 MHz): 5 MHz Channel

Centre frequency of interfering signal (MHz)	Interfering signal mean power (dBm)	Wanted signal mean power (dB)	Minimum offset of interfering signal from the channel edge (MHz)	Type of interfering signal
1710-1785	-50	P_{SENS10} +6	300	GSM

Table 82: Narrow Band Blocking Limits for BS (1800 MHz): 10 MHz Channel

ANNEX 3 : GSM BS/UE ACS

When analysing the interference from a wideband system such as LTE or WiMAX to a narrow band system, such as GSM, using the term ACIR will have some difficulty, since GSM system has 200 kHz channel bandwidth, LTE 5 MHz channel has 4.5 MHz channel bandwidth, WiMAX 5 MHz channel has a channel bandwidth of 4.75 MHz.

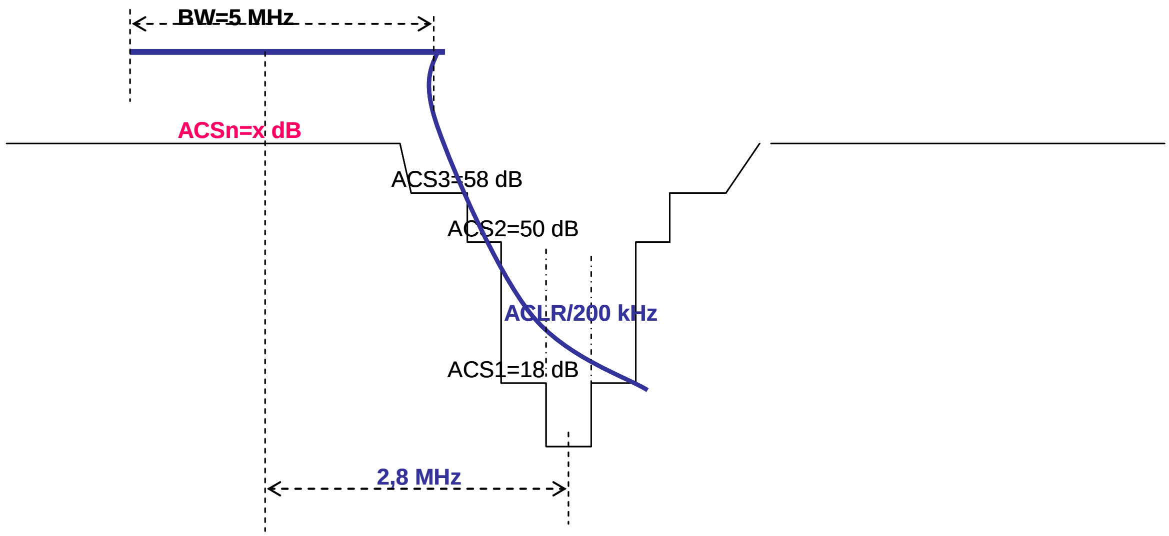

Figure 41: ACLR and ACS between LTE/WiMAX 5 MHz channel and GSM 200 kHz channel

As shown in Figure 41, LTE/WiMAX 5 MHz channel, the ACLR/200 kHz is calculated with the spectrum emission mask by the integration of the spectrum emission mask over 200 kHz centered at 2.8 MHz carrier separation. Since LTE and WiMAX have the same spectrum emission mask, the calculated ACLR/200 kHz at 2.8 MHz carrier separation between LTE/WiMAX and GSM is 50 dB with the assumption of 43 dBm Tx power. The GSM ACS at 2.8 MHz frequency offset needs to be calculated.

GSM ACS can be derived from the protection ratios specified in 3GPP TS 45.005 and EN301 502:

C/I (co-channel) = 9dB
C/I_a1=-9 dB (first adjacent 200 kHz channel)
C/I_a2=-41 dB (second adjacent 200 kHz channel)
C/I_a3=-49 dB (third adjacent 200 kHz channel)

Therefore

ACS_1=18 dB (first adjacent 200 kHz channel)
ACS_2=50 dB (second adjacent 200 kHz channel)
ACS_3=58 dB (third adjacent 200 kHz channel)

GSM in-band blocking levels are defined in 3GPP TS45.005 section 5.1, which is copied below.

Frequency band	GSM 400, T-GSM 810, P-, E- and R-GSM 900								DCS 1 800 & PCS 1 900			
	other MS		small MS (Note 1)		BTS except Multicarrier BTS		Multicarrier BTS (Note 2)		MS		BTS including. Multicarrier BTS	
	dBµV (emf)	dBm	dBµV (emf)	dBm	dBµV (emf)	dBm	dBµV (emf)	dBm	dBµV (emf)	dBm	dBµV (emf)	dBm
in-band												
600 kHz ≤ $\lvert f-f_o \rvert$ < 800 kHz	75	-38	70	-43	87	-26	78	-35	70	-43	78	-35
800 kHz ≤ $\lvert f-f_o \rvert$ < 1,6 MHz	80	-33	70	-43	97	-16	97	-16	70	-43	88	-25
1,6 MHz ≤ $\lvert f-f_o \rvert$ < 3 MHz	90	-23	80	-33	97	-16	97	-16	80	-33	88	-25
3 MHz ≤ $\lvert f-f_o \rvert$	90	-23	90	-23	100	-13	97	-16	87	-26	88	-25
out-of-band												
(a)	113	0	113	0	121	8	121	8	113	0	113	0
(b)	-	-	-	-	-	-	-	-	101	-12	-	-
(c)	-	-	-	-	-	-	-	-	101	-12	-	-
(d)	113	0	113	0	121	8	121	8	113	0	113	0

NOTE 1: For definition of small MS, see subclause 1.1.
NOTE 2: In case of either multicarrier BTS class with multicarrier receiver, the inband requirements for frequency offsets 800 kHz ≤ $\lvert f-f_o \rvert$ and blocking signal levels higher than -25 dBm, the performance shall be met X dB above the reference sensitivity level or input level for reference performance, whichever applicable, as specified in subclause 6.2 where X is
- 8 dB for blocking signal levels below -20 dBm, and
- 12 dB for blocking signal levels above -20 dBm.

The relaxed values for multicarrier BTS classes are not applicable for GSM-R usage.
The requirements apply to both multicarrier BTS classes.
The requirements for Multicarrier BTS apply to multicarrier BTS with multicarrier receiver.

Table 83: GSM BS/MS in-band blocking levels

Using the following formula (A3-1) and the in-band blocking levels define in the Table 1, the GSM BS and MS ACS value at different frequency offsets can be derived.

$$ACS\_relative = ACS\_test - Noise\_floor - 10*\log_{10}(10^{M/10} - 1) \qquad (A3\text{-}1)$$

Where ACS_test is the in-band blocking level in dBm defined in the Table 83. M is the desensitisation value defined in the Note 2 in Table 83.

The calculated GSM900/1800 BS and MS receiver rejection values are given in Table 84 to Table 87. In the calculation, 5 dB noise Figure is used for BS, and 12 dB noise Figure is used for MS.

900 MHz BS	
Frequency offset (MHz)	**BS Receiver Rejection (dB)**
0.2	18
0.4	50
0.6	58
0.8	88.2
1	88.2
1.2	88.2
1.4	88.2
1.6	88.2
1.8	88.2
2	88.2
2.2	88.2
2.4	88.2
2.6	88.2
2.8	88.2
3	91.2
3.2	91.2
3.4	91.2
3.6	91.2
3.8	91.2
4	91.2
4.2	91.2
4.4	91.2
4.6	91.2
4.8	91.2
5	91.2
≥5.3	91.2

Table 84: GSM900 BS receiver rejection

1800 MHz BS	
Frequency offset (MHz)	**BS Receiver Rejection (dB)**
0.2	18
0.4	50
0.6	58
0.8	83.7
1	83.7
1.2	83.7
1.4	83.7
1.6	83.7
1.8	83.7
2	83.7
2.2	83.7
2.4	83.7
2.6	83.7
2.8	83.7
3	83.7
3.2	83.7
3.4	83.7
3.6	83.7
3.8	83.7
4	83.7
4.2	83.7
4.4	83.7
4.6	83.7
4.8	83.7
5	83.7
≥5.3	83.7

Table 85: GSM1800 BS receiver rejection

900 MHz MS	
Frequency offset (MHz)	**MS Receiver Rejection (dB)**
0.2	18
0.4	50
0.6	58
0.8	58.7
1	58.7
1.2	58.7
1.4	58.7
1.6	58.7
1.8	68.7
2	68.7
2.2	68.7
2.4	68.7
2.6	68.7
2.8	68.7
3	68.7
3.2	78.7
3.4	78.7
3.6	78.7
3.8	78.7
4	78.7
4.2	78.7
4.4	78.7
4.6	78.7
4.8	78.7
5	78.7
≥ 5.3	78.7

Table 86: GSM900 MS receiver rejection

1800 MHz MS	
Frequency offset (MHz)	**MS Receiver Rejection (dB)**
0.2	18
0.4	50
0.6	58
0.8	58.7
1	58.7
1.2	58.7
1.4	58.7
1.6	58.7
1.8	68.7
2	68.7
2.2	68.7
2.4	68.7
2.6	68.7
2.8	68.7
3	68.7
3.2	75.7
3.4	75.7
3.6	75.7
3.8	75.7
4	75.7
4.2	75.7
4.4	75.7
4.6	75.7
4.8	75.7
5	75.7
≥ 5.3	75.7

Table 87: GSM1800 MS receiver rejection

Table 88 gives the GSM ACS values at different frequency offsets which are needed for the co-existence study between GSM and LTE/WiMAX different channel bandwidths, at 300 kHz frequency offset from GSM carrier frequency to LTE/WiMAX channel edge.

Carrier separation between GSM and LTE/WiMAX	**900 MHz band**		**1800 MHz band**	
	BS	**MS**	**BS**	**MS**
1,0 MHz (LTE 1,4 MHz)	88.2	58.7	83.7	58.7
1.8 MHz (LTE 3 MHz)	88.2	68.7	83.7	68.7
2.8 MHz (LTE/WiMAX 5 MHz)	88.2	68.7	83.7	68.7
5.3 MHz (LTE/WiMAX 10 MHz)	91.2	78.7	83.7	75.7
7.8 MHz (LTE 15 MHz)	91.2	78.7	83.7	75.7
10.3 MHz (LTE 20 MHz)	91.2	78.7	83.7	75.7

Table 88: GSM900/1800 BS/MS receiver ACS (dB) at different frequency offsets

ANNEX 4 : EC MANDATE TO CEPT

EUROPEAN COMMISSION
Information Society and Media Directorate-General

Electronic Communications Policy
Radio Spectrum Policy

Brussels, 15 June 2009
DG INFSO/B4

ADOPTED

Mandate to CEPT on the 900/1800 MHz bands

PURPOSE

The purpose of this Mandate is to contribute to putting into practice the concept of flexibility as advocated in the Opinion of the RSPG on Wireless Access Policy for Electronic Communications Services (WAPECS), by developing least restrictive technical conditions which are sufficient to avoid harmful interference in the frequency bands that have been tentatively identified by the RSC for the implementation of the WAPECS approach.

The technical conditions specific to each frequency band expected in response to this mandate will be considered for the introduction or amendment of harmonised technical conditions within the Community in order to achieve internal market objectives and facilitate cross-border coordination.

JUSTIFICATION

Pursuant to Article 4 of the Radio Spectrum Decision[3], the Commission may issue mandates to the CEPT for the development of technical implementing measures with a view to ensuring harmonised conditions for the availability and efficient use of radio spectrum. Such mandates shall set the task to be performed and the timetable therefore.

[3] Decision 676/2002/EC of the European Parliament and of the Council of 7 March 2002 on a regulatory framework for radio spectrum policy in the European Community, OJ L 108 of 24.4.2002.

Flexibility and facilitating market entry are key requirements for ensuring that information and communication technologies help to deliver growth and jobs, in line with the renewed Lisbon Strategy. The issue of flexible spectrum use has been identified as an important aspect by the Commission[4] as well as Member States[5] and the success of this approach will now depend on an optimal implementation on the basis of concrete measures at the level of specific frequency bands. In this context it is necessary to look into the technical conditions attached to the rights of use of spectrum with the aim of implementing the defined policy approach. Reviewing the results of the CEPT Mandate on WAPECS[6] as well as recent developments in the market place, it seems necessary to continue the process towards an environment with a similar and minimal set of conditions for electronic communications services across all the relevant frequency bands and all Member States, while taking into account the experience of Member States so far.

In December 2008 the European Council adopted conclusions[7] regarding the economic recovery plan, which inter alia include support for regulatory incentives to develop broadband internet, including in areas that are poorly served. Ensuring that state-of-the-art wireless broadband technologies have access to a number of spectrum bands so that both capacity and coverage can be achieved is an important aspect that will stimulate broadband deployment.

Concerning the bands 880-915 MHz / 925-960 MHz and 1710-1785 MHz / 1805-1880 MHz (900/1800 MHz bands) a draft Decision[8] has been approved by the RSC as a mechanism that will gradually introduce new technologies (i.e. technology neutrality) into the GSM bands and it will come into force when Council and Parliament agree on the amendment of the GSM Directive[9]. The annex to this draft Decision contains essential technical parameters for systems that have demonstrated the ability to coexist with GSM. In addition to UMTS, which is already in the list, there are signs that other technologies, such as LTE[10], are envisaged for deployment in the 900/1800 MHz bands by incumbent operators. In order to ensure that LTE is recognised through insertion into the annex of the decision on 900/1800 MHz as a technology that should be taken into account when conducting in band and adjacent band interference studies, there is a need for CEPT to study the technical implications in order to ensure coexistence as well as flexible spectrum use.

TASK ORDER AND SCHEDULE

CEPT is mandated to study the following issues:

Verify whether there are other technologies besides LTE developing equipment for 900/1800 MHz that would need to be studied concerning their coexistence with GSM at this stage.

Study the technical conditions under which LTE technology can be deployed in the 900/1800 MHz bands: With the aim of adding LTE and possibly other technologies (identified in Task 1) to the list in the annex of the draft decision on 900/1800 MHz frequency bands (see Footnote 6), technical coexistence parameters should be developed. A Block Edge Mask is not requested at this stage, noting that common and minimal (least restrictive) parameters would be appropriate after strategic decisions concerning the role of GSM as the reference technology for coexistence have been taken.

Investigate compatibility between UMTS and adjacent band systems above 960MHz: Noting that compatibility with systems outside of the 900/1800 MHz bands will be studied for LTE and any other identified technology at all band edges under Task 2, the aim of this task is to review the risk of interference between UMTS and existing and

4 Communication on "Rapid access to spectrum through more flexibility", COM(2007)50

5 RSPG Opinion on Wireless Access Policy for Electronic Communications Services (WAPECS)

6 http://ec.europa.eu/information_society/policy/ecomm/radio_spectrum/_document_storage/mandates/ec_to_cept_wapecs_06_06.pdf

7 *Presidency Conclusions*, Council of the European Union, Brussels, 12 December 2008 17271/08

8 http://ec.europa.eu/information_society/policy/ecomm/radio_spectrum/_document_storage/rsc/rsc20_public_docs/07_04%20final_900_1800.pdf

9 On 19.11.2008 the Commission issued a proposal for an amendment of the GSM Directive (see COM(2008) 762final), which is currently in co-decision procedure.

10 Long Term Evolution (LTE) is the next major step of technological development in the GSM and UMTS product line. It is currently being standardised by 3GPP.

planned aeronautical systems[11] above 960 MHz, in order to enable the development of all systems below and above 960 MHz without taking a risk relating to aeronautical safety.

The main deliverable for this Mandate will be a report, subject to the following delivery dates:

Delivery date	**Deliverable**
18 Sept. 2009	For the RSC#29: First progress report
27 Nov. 2009	For RSC#30: Second progress report including a final report on Task 1
10 March 2010	For RSC#31: Draft final report[12]
24 June 2010	For RSC#32: Final report

In implementing this mandate, the CEPT shall, where relevant, take the utmost account of Community law applicable and support the principles of technological neutrality, non-discrimination and proportionality insofar as technically possible.

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11 The review of planned systems should be based on the latest available information on the new aeronautical communication system being developed above 960 MHz in the context of the Single European Sky ATM Research (SESAR) programme.

12 Public consultation should take place based on this version of the text.

ANNEX 5 : LIST OF REFERENCES

[1] 3GPP TS36.104, V8.7.0 (Release 8) “Evolved Universal Terrestrial Radio Access (E-UTRA); Base Station (BS) radio transmission and reception”.

[2] 3GPP TS36.101, V8.7.0 (Release 8) “Evolved Universal Terrestrial Radio Access (E-UTRA); User Equipment (UE) radio transmission and reception”.

[3] 3GPP TR36.942, V8.2.0 (Release 8) “Evolved Universal Terrestrial Radio Access (E-UTRA); Radio Frequency (RF) system scenarios”.

[4] 3GPP TR25.816, V7.0.0 (Release 7) “UMTS 900 MHz Work Item Technical Report”.

[5] ECC Report 082 “Compatibility Study for UMTS Operating within the GSM900 and GSM1800 Frequency Bands”.

[6] 3GPP R4-039451 “LTE Operating Band Unwanted Emissions Revision”.

[7] ETSI EN 301 502, V9.1.0 “Global System for Mobile communications (GSM), Harmonized EN for Base Station Equipment covering the essential requirements of article 3.2 of the R&TTE Directive”.

[8] ETSI EN 301 908-14, V4.1.1 “Harmonised EN for IMT-2000, Evolved Universal Terrestrial Radio Access (E-UTRA) (BS) covering the essential requirements of article 3.2 of the R&TTE Directive”.

[9] ETSI EN 301 908-13, V4.1.1 “Harmonised EN for IMT-2000, Evolved Universal Terrestrial Radio Access (E-UTRA) (UE) covering the essential requirements of article 3.2 of the R&TTE Directive”.

[10] IEEE 802.16™-2009 “IEEE Standard for Local and metropolitan area networks Part 16: Air Interface for Broadband Wireless Access Systems”.

[11] WiMAX Forum™ “WiMAX Forum Mobile Radio Specifications; T23-005-R015v04-D; Release 1.5”.

[12] Recommendation ITU-R F.1336-2 “Reference radiation patterns of omnidirectional, sectoral and other antennas in point-to-multipoint systems for use in sharing studies in the frequency range from 1 GHz to about 70 GHz.”

[13] 3GPP TR25.942, V7.0.0 (Release 7) “Radio Frequency System Scenarios”.