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Characteristics of broadband wireless access systems operating in the land mobile service for use in sharing studies

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REPORT ITU-R M.2116-1

Characteristics of broadband wireless access systems operating in the land mobile service for use in sharing studies

(Questions ITU-R 1/5 and ITU-R 7/5)

(2007-2010)

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1 Introduction

This Report provides characteristics for a number of terrestrial broadband wireless access (BWA)[1] systems, including mobile and nomadic applications, operating, in the mobile service for use in sharing studies between these terrestrial BWA systems and other fixed or mobile systems.

2 Characteristics

Annex 1 contains technical and operational characteristics of mobile BWA[2] systems to be used for sharing studies for both mobile stations and base stations. It should be recognized that the footnotes in the Table provide important information on the derivation of particular values and any limits to their applicability for sharing studies. Therefore, these footnotes should be taken into account wherever referenced.

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[1] "Wireless access" and "BWA" are defined in Recommendation ITU-R F.1399.

[2] BWA radio interface standards can be found in Recommendation ITU-R M.1801. Radio interface standards for broadband wireless access systems, including mobile and nomadic operations, in the mobile service operating below 6 GHz.

3 IMT-2000 radio interfaces

Terrestrial IMT-2000 systems[3] meet the definition of BWA found in Recommendation ITU-R F.1399. In addition to the characteristics found in Annex 1, sharing characteristics of IMT-2000 systems in the 2 GHz range can be found in Report ITU-R M.2039 – Characteristics of terrestrial IMT-2000 systems for frequency sharing/interference analyses, and are not duplicated herein. These systems should also be considered in sharing analysis involving BWA systems[4].

Systems beyond IMT-2000 will also meet the criteria to be considered BWA, and as these systems are developed their characteristics should also be considered for sharing studies with BWA systems. Systems beyond IMT-2000 may be incorporated into future revisions of this Report directly or by reference.

4 RLAN characteristics

In addition to the characteristics found in Annex 1, characteristics of RLAN systems can be found in Recommendation ITU-R M.1450 – Characteristics of broadband radio local area networks, and are not duplicated herein.

Annex 1

Table 1 contains technical and operational characteristics for use in sharing studies in the 1-3 GHz frequency range, Tables 2a and 2b contain technical and operational characteristics for use in sharing studies for the 3.4-4.2 GHz band and Table 3 contains a list of acronyms and abbreviations.

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[3] IMT-2000 radio interface standards are described in Recommendation ITU-R M.1457. Detailed specifications of the terrestrial radio interfaces of International Mobile Telecommunications-2000 (IMT-2000).

[4] Recommendation ITU-R M.1823 provides values for some systems applicable to BWA.

TABLE 1

Technical and operational characteristics for use in sharing studies in the 1-3 GHz frequency range

Parameter	IEEE 802.16 (1)		HC-SDMA(2)		XGP (3)		T1.716/717(4)		ATIS.0700001.2004(5)		T1.723(6)		SCDMA BWA(7)	
	BS	**MS**	**BS**	**MS**	**BS**	**MS**	**BS**	**MS**	**BS**	**MS**	**BS**	**MS**	**BS**	**MS**
System														
Nominal channel BW (MHz)	5 {1a}		0.625 {1b}		10 {1c}		2 × 5 to 2 × 20 MHz (in 3.5 or 5 MHz increments)		5		1.25		5	
Modulation type	QPSK, 16-QAM, 64-QAM	QPSK, 16-QAM, 64-QAM	BPSK, QPSK, 8-PSK, 12-QAM, 16-QAM, 24-QAM	BPSK, QPSK, 8-PSK, 12-QAM, 16-QAM	BPSK, QPSK, 16-QAM, 64-QAM, 256-QAM	BPSK, QPSK, 16-QAM, 64-QAM, 256-QAM	QPSK	QPSK	QPSK, 8-PSK, 64-QAM	QPSK, 8-PSK 16-QAM	QPSK	BPSK, QPSK	QPSK, 8-PSK, 16-QAM, 64-QAM	QPSK, 8-PSK, 16-QAM, 64-QAM
Duplex method	TDD/FDD		TDD		TDD		FDD		TDD		FDD		TDD	
Access technique	TDMA/OFDMA		TDMA/FDMA/SDMA		TDMA/OFDMA		CDMA		CDMA		CDMA		CS-OFDMA	
No. of sectors	3 {3a}	Not applicable	3 {3b}	Not applicable	1 or more	Not applicable	Typically 3	Not applicable	Typically 3	Not applicable	Typically 3	Not applicable	Typically 3	Not applicable
Reuse factor	1:1, 1:3		1:1 {4a}		1:1		1:1, 1:3		1:1{4a}		1:1		1:1	
Antennas per sector	Not specified		12 {5a}	1	4 or more	1 or more	Not specified	Not specified	Not specified	1	Not specified	1	1 or more typically 8	1 or more
Co-located antenna minimum coupling loss (dB) {6}	30	Not applicable	30	Not applicable	30	Not applicable	30	Not applicable	30	Not applicable	30	Not applicable	30	Not applicable
Antenna gain (dBi)	18 {10a}	0 to 6 {10a}	15	0	12 or more	0 to 4	18 {10a}	0 to 6 {10a}	18 {10a}	0 to 6 {10a}	17 {10a}	0 to 6 {10a}	17{10a}	0 to 6 {10a}
Antenna height AGL (m)	15 to 30 {11}	≤ 1.5	15 to 45	≤ 1.5	15 to 45	≤ 1.5	15 to 30 {11}	≤ 1.5	15 to 30 {11}	≤ 1.5	15 to 30	≤ 1.5	15 to 30 {11}	≤ 1.5
Radiation pattern	Horizontal {7c} Vertical {7d}	Not specified	Adaptive {7b}	Omni-directional {7a}	Omni-directional {7a}	Omni-directional {7a}	Not specified	Not specified	Not specified	Not specified	Not specified	Not specified	Typically vertical	Typically vertical

TABLE 1 (*continued*)

Parameter	IEEE 802.16 [1]		HC-SDMA[2]		XGP [3]		T1.716/717[4]		ATIS.0700001.2004[5]		T1.723[6]		SCDMA BWA[7]	
	BS	**MS**	**BS**	**MS**	**BS**	**MS**	**BS**	**MS**	**BS**	**MS**	**BS**	**MS**	**BS**	**MS**
Transmitter														
Average power (dBm)	36 {8a}	20 {8a}	24.2 {8b}	20	40 {8a}	23 {8a}	36	20	24.2 {8b}	20	43	26	33 {8b}	23
TDD activity factor (dB) {9}	3		–1.76 {9a}	–4.77 {9b}	3		Not applicable		Variable 0 to –4.77		Not applicable		Variable –8.45 to 8.45	
Antenna gain (dBi)	18 {10a}	0 to 6 {10a}	15	0	12 or more	0 to 4	18 {10a}	0 to 6 {10a}	18 {10a}	0 to 6 {10a}	17 {10a}	0 to 6 {10a}	17 {10a}	0 to 6 {10a}
Antenna height AGL (m)	15 to 30 {11a}	≤ 1.5	15 to 45	≤ 1.5	15 to 45	1.5	15 to 30 {11b}	≤ 1.5	15 to 30 {11b}	≤ 1.5	15 to 30	≤ 1.5	15 to 30	≤ 1.5
Misc. losses (dB)	2 {12a}	0	1 {12b}	0	2 {12b}	0	2 {12b}	0	2 {12b}	0	< 2 {12b}	0	< 1	0
Adjacent Channel Leakage Ratio (ACLR) (dB)	{13a}		{13b}		{13d}		{13e}		{13e}		{13f}		{13e}	
ACLR_1 (dB)	53.5	33	53.5 {13c}	33	40	23	40 {13c}	33	40 {13c}	33	40 {13c}	33	40 {13c}	33
ACLR_2 (dB)	66	43	66 {13c}	43	60	33	50 {13c}	43	50 {13c}	43	50 {13c}	43	50 {13c}	43
Receiver														
Antenna gain (dBi)	18 {10a}	0 to 6 {10a}	15	0	12 or more	0 to 4	18 {10a}	0 to 6 {10a}	18	From 0 to 6 {10a}	17	0 to 6	17	0 to 6
Antenna height (AGL) (m)	15 to 30 {11a}	≤ 1.5	15 to 45	≤ 1.5	15 to 45	1.5	15 to 30 {11b}	≤ 1.5	15 to 30	≤ 1.5	15 to 30	≤ 1.5	15 to 30	≤ 1.5
Misc. losses (dB)	0 {12a}	0	1 {12b}	0	2 {12b}	0	0 {12a}	0	0 {12a}	0	0 {12a}	0	< 1	0
Noise figure (dB)	3	5	5	7	5	7	4	7	4	7	4	7	4	6
Thermal noise density (dBm/Hz)	–174		–174		–174		–174		–174		–174		–174	
Adjacent Channel Selectivity (ACS) (dB)	{14a}				{14b}									
ACS_1 (dB)	46	33	46	33	42	30	46	33	46	33	46	33	46	33
ACS_2 (dB)	56	47	46	43	42	30	56	43	56	43	56	43	56	43

TABLE 1 (*end*)

Parameter	IEEE 802.16 [1]		HC-SDMA[2]		XGP [3]		T1.716/717[4]		ATIS.0700001.2004[5]		T1.723[6]		SCDMA BWA[7]	
	BS	**MS**	**BS**	**MS**	**BS**	**MS**	**BS**	**MS**	**BS**	**MS**	**BS**	**MS**	**BS**	**MS**
Interference criterion, *I*/*N* (dB) {15}	–6 or –10	–6 or –10	{15a}	{15a}	–6 or –10	–6 or –10	–6 or –10	–6 or –10	–6 or –10	–6 or –10	–6 or –10	–6 or –10	–6 or –10	–6 or –10
Required SINR (dB) {16}	{16a}	{16a}	1-17	0-14	{16a}	{16a}	{16a}	{16a}	{16a}	{16a}	{16a}	{16a}	{16a}	{16a}
Max. tolerable interference power (dBm) {17}	–110 or –114	–108 or –112	{17a}	Not applicable	–105 or –109	–103 or –107	–108 or –112	–105 or –109	–108 or –112 {17b}	–105 or –109 {17b}	–108 or –112 {17b}	–105 or –109 {17b}	{17a}	Not applicable
Nominal reference sensitivity (dBm)	Not applicable	Not applicable	–109.8 {18a}	–108.5 {18b}	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable

NOTE 1 – Numbers in {} refer to the Notes below.

[1] IEEE Std 802.16 forms the basis of WiMAX™ for fixed and mobile applications. Parameters for IMT-2000 OFDMA TDD WMAN are contained in Report ITU-R M.2039. The values given in this Report belong to non-IMT mobile implementations of IEEE 802.16 even though there might be similarities in some of the performance values to those expressed in Report ITU-R M.2039. Parameters in this table are specified by the WiMAX Forum.

[2] ANSI ATIS 0700004-2005, High capacity – Spatial division multiple access (HC-SDMA) is commercially known as the iBurst™ system.

[3] A-GN4.00-01-TS, XGP Forum Technical specifications.

[4] T1.716/7-2000 (R2004) air interface standard for broadband direct sequence CDMA for fixed wireless PSTN access – layer 1/layer 2.

[5] ANSI ATIS-0700001.2004 MCSB physical, MAC/LLC, and network layer specification.

[6] T1.723-2002 I-CDMA spread spectrum systems air interface standard, operating up to 2 GHz.

[7] Air interface of SCDMA broadband wireless access system standard.

Notes relating to Table 1:

{1a} While other nominal channel bandwidths are allowed in the standard, 5 MHz is chosen as a typical configuration for the frequency band of interest.

{1b} The HC-SDMA standard uses a 625 kHz carrier bandwidth. For a 5 MHz channel bandwidth, deployment of multiple 625 kHz carriers is assumed.

{1c} While other nominal channel bandwidths are allowed in the standard, this marked value is chosen as a typical configuration for the frequency band of interest.

{3a} Number of sectors ranges from 1 (omnidirectional) to higher numbers such as 6. For the sake of sharing studies, three-sectored sites are being considered.

{3b} Number of sectors ranges from 1 (omnidirectional) to higher numbers such as 3. For the sake of sharing studies, three-sectored sites are being considered.

{4a} System can support reuse of less than 1 through spatial division multiple access wherein up to four users can simultaneously share the same carrier/time slot combination. Reuse 1 is considered in the sharing study.

{5a} The HC-SDMA system utilizes a multi-antenna architecture with multiple antennas per sector.

{6} For co-located base stations, this parameter captures the minimum coupling loss between two systems. *Note:* Higher values are achievable. For example, Report ITU-R M.2045 suggests that a coupling loss of up to 70 dB is achievable with a few metres of antenna separation. In real deployment conditions, a coupling loss of up to 45 dB may be achievable.

{7a} This is the typical pattern; however, it should be noted that the radiation pattern will depend on the operator's deployment scenarios and equipment suppliers.

{7b} HC-SDMA systems are deployed with adaptive multi-antenna arrays. Therefore, the BS antenna array radiation pattern varies in time and space depending on changes in the relative configuration of desired and interfering signals.

{7c} See 3GPP TR 25.892 v2.0.0 2004-06.

{7d} See Recommendations ITU-R M.1646 and ITU-R F.1336-2.

{8a} TX power reported is typical and higher values may be available based on region. TX power is the RF power averaged during the transmit burst, without considering traffic statistics or lowered-power operation or UL/DL ratio.

{8b} Average power per antenna per carrier. Equivalent isotropic radiated power for victim systems should be computed statistically based on the average power per antenna and array geometry.

{9} A function of UL/DL ratio of the TDD mode, this parameter is not applicable to FDD operation.

{9a} BS transmit duty cycle expressed in dB.

{9b} MS transmit duty cycle expressed in dB.

{10a} Base station antenna gains are typical of wide area terrestrial cellular deployments and are consistent with the values provided by ETSI. Mobile subscriber station antenna gain ranges from 0 dBi, for PDA and other handheld terminals, to 6 dBi, for laptops.

{11} Previous ITU-R studies on sharing of IMT-2000 systems (Reports ITU-R M.2030 and ITU-R M.2045) use 30 m as a base station antenna height.

{12a} Miscellaneous losses account for cable/connector losses in the TX path. In the RX path, these losses are assumed to be avoided by using tower-top LNA.

{12b} Miscellaneous losses account for cable/connector losses in the TX and RX path.

{13a} Defined as the ratio of the on-channel transmitted power to the power transmitted in adjacent channels as measured at the output of the receiver filter, ACLR represents the interference power into a receiver operating in the adjacent channel(s). ACLR_*n* in the table are ACLR values at *n* 5-MHz channels away calculated with a receiver filter bandwidth of 4.5 MHz. The IEEE 802.16 standard does not specify ACLR information. These are values provided by the WiMAX Forum.

{13b} Defined as the ratio of the on-channel transmitted power to the power transmitted in adjacent channels, ACLR represents the interference power into a receiver operating in the adjacent channel(s). ACLR_*n* in the table are ACLR values at *n* 5-MHz away. Values are quoted as dBc per 625 kHz.

{13c} ACLR values dependent on filter roll-off and number of carriers.

{13d} Defined as the ratio of the on-channel transmitted power to the power transmitted in adjacent channels, ACLR represents the interference power into a receiver operating in the adjacent channel(s). ACLR_*n* in the table are ACLR values at *n* 10-MHz away. Values are quoted as dBc per 1 MHz.

Notes relating to Table 1 (end):

{13e} Defined as the ratio of the on-channel transmitted power to the power transmitted in adjacent channels, ACLR represents the interference power into a receiver operating in the adjacent channel(s). ACLR_*n* in the table are ACLR values at *n* 5-MHz away.

{13f} Defined as the ratio of the on-channel transmitted power to the power transmitted in adjacent channels, ACLR represents the interference power into a receiver operating in the adjacent channel(s). ACLR_*n* in the table are ACLR values at *n* 1.25-MHz away.

{14a} The IEEE 802.16 standard does not specify ACS information. The values shown were submitted by the WiMAX Forum.

{14b} The ACS values are based on anticipated performance by some of the industry, as provided by the XGP Forum. These values are with the following conditions: modulation type BPSK and BER of 10^{-5}.

{15} The *I*/*N* of –10 dB, corresponding to about half a dB impact on the receiver sensitivity, is a stringent criterion which is recommended in certain cases including in some ITU-R Recommendations. The number of –6 dB, corresponding to 1 dB impact on the receiver sensitivity, however, is also recommended in Recommendation ITU-R F.758-3.

{15a} *I*/*N* is not required since the information is provided by the SINR.

{16} Required SINR (dB) measured after array processing/equalization dependent on modulation class.

{16a} Not required because maximum tolerable interference power is specified.

{17} Numbers are based on *I*/*N* of –6 dB or –10 dB respectively (see {16a}).

{17a} Active interference selectivity is used for this system instead of maximum tolerable interference power. Multi-antenna HC-SDMA systems can achieve 20-30 dB active interference rejection, which can be used to address both intra-system and inter-system interferers.

{17b} Assumes equal interference across all carriers.

{18a} The base station nominal reference sensitivity for Mod Class 0 = –109.8 dBm. The reference sensitivity level of the base station shall be no greater than 1.2 dB above the nominal limits specified for each Mod Class (i.e. Mod Class 0 through Mod Class 8) for FER = 10^{-2}.

{18b} This user terminal nominal reference sensitivity for Mod Class 0 = 108.5 dBm. The reference sensitivity level of the UT (user terminal) shall be no greater than 1 dB higher than the nominal limits specified for each Mod Class (i.e. Mod Class 0 through Mod Class 8) at FER = 10^{-2}.

TABLE 2a

Technical and operational characteristics of base stations for use in sharing studies in the 3.4-4.2 GHz band[1]

IEEE 802.16[2]			
System			
Deployment scenario	Specific cellular deployment rural with expected nomadic BWA use	Typical cellular deployment rural	Typical cellular deployment urban
Channel bandwidth (MHz)	7 (5, 10)[3]	7 (5, 10)[3]	7 (5, 10)[3]
Carrier frequency	3.5 GHz	3.5 GHz	3.5 GHz
Modulation type	QPSK, 16-QAM, 64-QAM	QPSK, 16-QAM, 64-QAM	QPSK, 16-QAM, 64-QAM
Duplex method	TDD/FDD	TDD/FDD	TDD/FDD
Access technique	TDMA/OFDMA	TDMA/OFDMA	TDMA/OFDMA
No. of sectors	3	3	3
Reuse factor	1:3 (1:1)[4]	1:3 (1:1)[4]	1:3 (1:1)[4]
Antennas per sector	Depending on deployment	Depending on deployment	Depending on deployment
Colocated antenna minimum coupling loss (dB)	50	50	50
Peak antenna gain (dBi)	17	17	9
Antenna 3 dB beamwidth (degrees)	60 and 90 (sectorized)	60 and 90 (sectorized)	Omnidirectional
Antenna downtilt (degrees)[5]	0-8 (1°)	0-8 (2°)	0-8 (4°)
Antenna height a.g.l. (m)	50	30	15
Antenna gain pattern	Recommendation ITU-R F.1336	Recommendation ITU-R F.1336	Recommendation ITU-R F.1336
Transmitter			
TX peak output power (dBm)	43	35	32
Feeder loss (dB)	3	3	3
Power control (dB)	> 10	> 10	> 10
e.i.r.p. (dBm)	57	49	38
Unwanted emissions[6]	ECC Recommendation (04)05[7]		
Adjacent channel leakage ratio (ACLR) (dB)			
ACLR_1 (dB)	37 (51)[8]	37 (51)[8]	37 (51)[8]
ACLR_2 (dB)	48 (87)[8]	48 (87)[8]	48 (87)[8]
Receiver			
Noise figure (dB)	5	5	5
Thermal noise density (dBm/Hz)	–174	–174	–174
Adjacent channel selectivity (ACS)/ Adjacent channel rejection (ACR) (dB)			
ACR_1 (dB)	20[9]	20[9]	20[9]
ACR_2 (dB)	39[9]	39[9]	39[9]
Interference criterion, I/N (dB)[10]	–6 or –10	–6 or –10	–6 or –10
Required SINR (dB)	2.9 (for CTC QPSK ½)	2.9 (for CTC QPSK ½)	2.9 (for CTC QPSK ½)
Nominal reference sensitivity (dBm)	Not applicable	Not applicable	Not applicable

Notes relating to Table 2a:

(1) The ATIS standards (T1.716/717, T1.723, ATIS.07000001, ATIS.07000004) do not specify operation above 3 GHz, therefore no parameters are available.

(2) The information in this table applies to non-IMT IEEE 802.16 systems operating in the range 3.3 GHz to 3.8 GHz.

(3) Other values of 5 and 10 MHz channel bandwidth in parenthesis are also supported.

(4) Other values of Reuse 3 (1:3) in parenthesis are also supported.

(5) A range of values is indicated, recognizing that the value for each situation depends on the actual deployment scenario taking into account the topology of the terrain. In parentheses, a typical value is given for use in the compatibility studies.

(6) Information on unwanted emissions, including out-of-band and/or spurious emissions, to use in the sharing studies is still under consideration. This information may be provided in the form felt to be most appropriate for use in the compatibility studies.

(7) BWA base stations may comply with a specific regional regulatory requirement to the lowermost and uppermost edges of an operator's block assignment. The regulatory requirement is detailed as a block edge mask. The block edge mask regulatory requirement imposes a more stringent out of block emission performance on the operator and therefore implies a correspondingly more stringent unwanted emission performance across the edges of the system operating block which can be deduced from analysis of the defined block edge mask. The block edge mask is as specified in Section 2 Annex 2 of ECC Recommendation (04)05.

(8) Additional ACLR values for the base station are provided in parentheses. These additional ACLR values result from the application of a specific regional regulatory requirement to the lowermost and uppermost edges of an operator's block assignment. The regulatory requirement is detailed as a block edge mask. The block edge mask regulatory requirement imposes a more stringent out of block emission performance on the operator and therefore implies a correspondingly more stringent ACLR performance across the edges of the system operating block which can be deduced from analysis of the defined Block Edge Mask.

(9) The numbers provided are for receiver adjacent channel rejection (ACR) that is a measure of the capability of the receiver to receive a wanted signal without exceeding a given degradation due to the presence of an unwanted signal (interferer) either in the first or second adjacent channel. Receiver adjacent channel rejection is expressed as the ratio, in dB, of the level of the unwanted signal to the level of the wanted signal, at the receiver input. The minimum receiver adjacent channel rejection is expressed for a bit error ratio (BER) $\leq 10^{-6}$. Adjacent channel selectivity (ACS) can be derived from ACR through ACS = ACR + SNR_min + 3dB.

(10) The I/N of –10 dB, corresponding to about half a dB impact on the receiver sensitivity, is a stringent criterion which is recommended in certain cases. The number of –6 dB, corresponding to 1 dB impact on the receiver sensitivity, however, is also recommended in Recommendation ITU-R F.758-4.

TABLE 2b

Technical and operational characteristics of terminal stations for use in sharing studies in the 3.4-4.2 GHz band[(1)]

IEEE 802.16[(2)]				
	Fixed-outdoor	**Fixed-indoor**	**Nomadic**	**Mobile**
System				
Channel bandwidth (MHz)	7 (5, 10)[(3)]	7 (5, 10)[(3)]	7 (5, 10)[(3)]	7 (5, 10)[(3)]
Carrier frequency	3.5 GHz	3.5 GHz	3.5 GHz	3.5 GHz
Modulation type	QPSK, 16-QAM, 64-QAM	QPSK, 16-QAM, 64-QAM	QPSK, 16-QAM, 64-QAM	QPSK, 16-QAM, 64-QAM
Duplex method	TDD/FDD	TDD/FDD	TDD/FDD	TDD/FDD
Access technique	TDMA/OFDMA	TDMA/OFDMA	TDMA/OFDMA	TDMA/OFDMA
No. of sectors	Not applicable	Not applicable	Not applicable	Not applicable
Reuse factor	1:3 (1:1)[(4)]	1:3 (1:1)[(4)]	1:3 (1:1)[(4)]	1:3 (1:1)[(4)]
Antennas per sector	Not specified	Not specified	Not specified	Not specified
Colocated antenna minimum coupling loss (dB)	Not applicable	Not applicable	Not applicable	Not applicable
Peak antenna gain (dBi)	17	5	5	0
Antenna gain pattern	Recommendation ITU-R F.1245	Omnidirectional	Omnidirectional	Omnidirectional
Antenna 3 dB beamwidth (degrees)	24°	n/a	n/a	n/a
Antenna height a.g.l. (m)	10	1.5	1.5	1.5
Number of co-channel TSs per BS	10 users for uplink activity factor[(5)] of 38% in a 5 msec frame	10 users for uplink activity factor[(5)] of 38% in a 5 msec frame	10 users for uplink activity factor[(5)] of 38% in a 5 msec frame	10 users for uplink activity factor[(5)] of 38% in a 5 msec frame
Transmitter				
TX peak output power (dBm)	26[(6)]	26[(6)]	22[(6)]	20[(6)]
Feeder loss (dB)	1	1	1	1
Power control (dB)[(7)]	0-45	0-45	0-45	0-45

TABLE 2b (*end*)

IEEE 802.16[2]				
	Fixed-outdoor	**Fixed-indoor**	**Nomadic**	**Mobile**
e.i.r.p. (dBm)	42	30	26	19
Unwanted emissions	See Attachment 1[8]			
Adjacent channel leakage ratio (ACLR) (dB)				
ACLR_1 (dB)	33	33	33	33
ACLR_2 (dB)	43	43	43	43
Receiver				
Noise figure (dB)	8	8	8	8
Thermal noise density (dBm/Hz)	–174	–174	–174	–174
Feeder loss (dB)	1	1	1	1
Adjacent channel selectivity (ACS) (dB)				
ACS_1 (dB)	28	28	28	28
ACS_2 (dB)	47	47	47	47
Interference criterion, *I*/*N* (dB)[9]	–6 or –10	–6 or –10	–6 or –10	–6 or –10
Required SINR (dB)	2.9 (for CTC QPSK ½)	2.9 (for CTC QPSK ½)	2.9 (for CTC QPSK ½)	2.9 (for CTC QPSK ½)
Nominal reference sensitivity (dBm)	Not applicable	Not applicable	Not applicable	Not applicable

(1) The ATIS standards (T1.716/717, T1.723, ATIS.07000001, ATIS.07000004) do not specify operation above 3 GHz, therefore no parameters are available.

(2) The information in this table applies to non-IMT IEEE 802.16 systems operating in the range 3.3 GHz to 3.8 GHz.

(3) Other values of 5 and 10 MHz channel bandwidth in parenthesis are also supported.

(4) Other values of Reuse 1 (1:1) in parenthesis are also supported.

(5) Uplink activity factor for TDD mode is defined by the ratio of uplink subframe over the entire frame, that is uplink plus downlink subframes.

(6) WiMAX Forum profile 5.A, 5.B and 5.C, in general, cover a range of power classes.

(7) The 45 dB is based on the minimum dynamic range requirements.

(8) The unwanted emission information in Attachment 1 is applicable to the 3.3-3.8 GHz range.

(9) The I/N of –10 dB, corresponding to about half a dB impact on the receiver sensitivity, is a stringent criterion which is recommended in certain cases including in some ITU-R Recommendations. The number of –6 dB, corresponding to 1 dB impact on the receiver sensitivity, however, is also recommended in Recommendation ITU-R F.758-4.

Acronyms and abbreviations

ACLR	Adjacent channel leakage ratio
ACR	Adjacent channel rejection
ACS	Adjacent channel selectivity
AGL	Above ground level
ATIS	Alliance for Telecommunications Industry Solutions
BPSK	Binary phase shift keying
BS	Base station
BWA	Broadband wireless access
DL	Downlink
FDD	Frequency division duplex
FER	Frame error ratio
HC-SDMA	High capacity-spatial division multiple access
IEEE	Institute of Electrical and Electronic Engineers
MS	Mobile station
PSK	Phase shift keying
QAM	Quadrature amplitude modulation
QPSK	Quadrature phase shift keying
SINR	Signal to interference-plus-noise ratio
TDD	Time division duplex
Tx	Transmitter
UL	Uplink
UT	User terminal
XGP	eXtended Global Platform

Attachment 1

Spectrum emission mask for terminal station equipment operating in the band 3 400-3 800 MHz

This is based on an extract from the WiMAX Forum mobile radio specification [1].

Emission mask for 5 MHz channel bandwidth

The spectrum emission mask of the MS applies to frequency offsets between 2.5 MHz and 12.5 MHz on both sides of the MS centre carrier frequency. The out-of-channel emission is specified as power level measured over the specified measurement bandwidth relative to the total mean power of the MS carrier measured in the 5 MHz channel.

1. The MS emission shall not exceed the levels specified in Table 3. Assuming specific power classes, the relative requirements of Table 3 can be converted to absolute values for testing purposes.
2. In addition, for centre carrier frequencies within the 3 650-3 700 MHz range, all emission levels shall not exceed –13 dBm/MHz.

TABLE 3

Spectrum emission mask requirement for 5 MHz channel bandwidth

Frequency offset Δf	Minimum requirement	Measurement bandwidth
2.5 MHz to 3.5 MHz	$\left\{-33.5-15\times\left(\frac{\Delta f}{\text{MHz}}-2.5\right)\right\}$ dBc	30 kHz
3.5 to 7.5 MHz	$\left\{-33.5-1\times\left(\frac{\Delta f}{\text{MHz}}-3.5\right)\right\}$ dBc	1 MHz
7.5 to 8.5 MHz	$\left\{-37.5-10\times\left(\frac{\Delta f}{\text{MHz}}-7.5\right)\right\}$ dBc	1 MHz
8.5 to 12.5 MHz	–47.5 dBc	1 MHz

NOTE 1 – Δf is the separation between the carrier frequency and the centre of the measuring filter.

NOTE 2 – The first measurement position with a 30 kHz filter is at Δf equals 2.515 MHz; the last is at Δf equals 3.485 MHz.

NOTE 3 – The first measurement position with a 1 MHz filter is at Δf equals 4 MHz; the last is at Δf equals 12 MHz. As a general rule, the resolution bandwidth of the measuring equipment should be equal to the measurement bandwidth. To improve measurement accuracy, sensitivity and efficiency, the resolution bandwidth can be different from the measurement bandwidth. When the resolution bandwidth is smaller than the measurement bandwidth, the result should be integrated over the measurement bandwidth in order to obtain the equivalent noise bandwidth of the measurement bandwidth.

NOTE 4 – Note that equivalent PSD type mask can be derived by applying 10*log ((5 MHz)/(30 kHz)) = 22.2 dB and 10*log((5 MHz)/(1 MHz)) = 7 dB scaling factor for 30 kHz and 1 MHz measurement bandwidth respectively.

Emission mask for 7 MHz channel bandwidth

The spectrum emission mask of the MS applies to frequency offsets between 3.5 MHz and 17.5 MHz on both sides of the MS centre carrier frequency. The out-of-channel emission is specified as power level measured over the specified measurement bandwidth relative to the total mean power of the MS carrier measured in the 7 MHz channel.

1. The MS emission shall not exceed the levels specified in Table 4. Assuming specific power classes, the relative requirements of Table 4 can be converted to absolute values for testing purposes.
2. In addition, for centre carrier frequencies within the 3 650-3 700 MHz range, all emission levels shall not exceed –13 dBm/MHz.

TABLE 4

Spectrum emission mask requirement for 7 MHz channel bandwidth

Frequency offset Δf	Minimum requirement	Measurement bandwidth
3.5 MHz to 4.75 MHz	$\left\{-33.5-13.5\times\left(\frac{\Delta f}{\text{MHz}}-3.5\right)\right\}$ dBc	30 kHz
4.75 to 10.5 MHz	$\left\{-35-0.7\times\left(\frac{\Delta f}{\text{MHz}}-4.75\right)\right\}$ dBc	1 MHz
10.5 to 11.9 MHz	$\left\{-39.0-7\times\left(\frac{\Delta f}{\text{MHz}}-10.5\right)\right\}$ dBc	1 MHz
11.9 to 17.5 MHz	–49.0 dBc	1 MHz

NOTE 1 – Δf is the separation between the carrier frequency and the centre of the measuring filter.

NOTE 2 – The first measurement position with a 30 kHz filter is at Δf equals 3.515 MHz; the last is at Δf equals 4.735 MHz.

NOTE 3 – The first measurement position with a 1 MHz filter is at Δf equals 5.25 MHz; the last is at Δf equals 17 MHz. As a general rule, the resolution bandwidth of the measuring equipment should be equal to the measurement bandwidth. To improve measurement accuracy, sensitivity and efficiency, the resolution bandwidth can be different from the measurement bandwidth. When the resolution bandwidth is smaller than the measurement bandwidth, the result should be integrated over the measurement bandwidth in order to obtain the equivalent noise bandwidth of the measurement bandwidth.

NOTE 4 – Note that equivalent PSD type mask can be derived by applying 10*log ((7 MHz)/(30 kHz)) = 23.7 dB and 10*log((7 MHz)/(1 MHz)) = 8.5 dB scaling factor for 30 kHz and 1 MHz measurement bandwidth respectively.

Emission mask for 10 MHz channel bandwidth

The spectrum emission mask of the MS applies to frequency offsets between 5.0 MHz and 25.0 MHz on both sides of the MS centre carrier frequency.

The out-of-channel emission is specified as power level measured over the specified measurement bandwidth relative to the total mean power of the MS carrier measured in the 10 MHz channel.

1. The MS emission shall not exceed the levels specified in Table 5. Assuming specific power classes, the relative requirements of Table 5 can be converted to absolute values for testing purposes.
2. In addition, for centre carrier frequencies within the 3 650-3 700 MHz range, all emission levels shall not exceed –13 dBm/MHz.

TABLE 5

Spectrum emission mask requirement for 10 MHz channel bandwidth

Frequency offset Δf	Minimum requirement	Measurement bandwidth
5.0 MHz to 7.0 MHz	$\left\{-33.5-9\times\left(\frac{\Delta f}{\text{MHz}}-5.0\right)\right\}$ dBc	30 kHz
7.0 to 15.0 MHz	$\left\{-36.5-0.5\times\left(\frac{\Delta f}{\text{MHz}}-7.0\right)\right\}$ dBc	1 MHz
15.0 to 17.0 MHz	$\left\{-40.5-5\times\left(\frac{\Delta f}{\text{MHz}}-15.0\right)\right\}$ dBc	1 MHz
17.0 to 25.0 MHz	–50.5 dBc	1 MHz

NOTE 1 – Δf is the separation between the carrier frequency and the centre of the measuring filter.

NOTE 2 – The first measurement position with a 30 kHz filter is at Δf equals 510.015 MHz; the last is at Δf equals 6.985 MHz.

NOTE 3 – The first measurement position with a 1 MHz filter is at Δf equals 7.5 MHz; the last is at Δf equals 24.5 MHz. As a general rule, the resolution bandwidth of the measuring equipment should be equal to the measurement bandwidth. To improve measurement accuracy, sensitivity and efficiency, the resolution bandwidth can be different from the measurement bandwidth. When the resolution bandwidth is smaller than the measurement bandwidth, the result should be integrated over the measurement bandwidth in order to obtain the equivalent noise bandwidth of the measurement bandwidth.

NOTE 4 – Equivalent PSD type mask can be derived by applying 10*log ((10 MHz)/(30 kHz)) = 25.2 dB and 10*log((10 MHz)/(1 MHz)) = 10 dB scaling factor for 30 kHz and 1 MHz measurement bandwidth respectively.

References

[1] WiMAX Forum® Mobile Radio Specifications, (WMF-T23-005-R015v04).