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Characteristics of terrestrial IMT-2000 systems for frequency sharing/ interference analyses

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REPORT ITU-R M.2039-1

Characteristics of terrestrial IMT-2000 systems for frequency sharing/interference analyses

(2004-2009)

1 Introduction

IMT-2000 is an advanced mobile communication application concept intended to provide telecommunication services on a worldwide scale regardless of location, network or terminal used. At WARC-92, spectrum was identified for IMT-2000 in the bands 1 885-2 025 MHz and 2 110-2 200 MHz, including the bands 1 980-2 010 MHz and 2 170-2 200 MHz for the satellite component of IMT-2000. At WRC-2000, additional spectrum was identified for IMT-2000 in the bands 806-960 MHz, 1 710-1 885 MHz and 2 500-2 690 MHz.

Frequency sharing studies and interference analyses involving IMT-2000 systems and other systems and services operating in bands identified for IMT-2000 may need to be undertaken within ITU-R. To perform the necessary sharing studies between IMT-2000 systems and systems in other services, characteristics of the terrestrial component of IMT-2000 systems are needed.

This Report provides the baseline characteristics of terrestrial IMT-2000 systems for use in frequency sharing and interference analysis studies involving IMT-2000 systems and between IMT-2000 systems and other systems.

2 Characteristics

Table 1 provides an explanation of the terminology used for the IMT-2000 terrestrial technologies. Tables 2 and 3 contain typical technical and operational characteristics of IMT-2000 mobile and base stations systems, respectively. The values of some characteristics, such as data rates, etc. may vary when considering technology enhancements (such as high-rate packet data (HRPD) or high-speed downlink packet access (HSDPA)).

Additional information is contained in the references following these Tables.

TABLE 1

IMT-2000 terrestrial radio interfaces

Full name	Common names
IMT-2000 CDMA Direct Spread	UTRA FDD WCDMA UMTS
IMT-2000 CDMA Multi-Carrier	CDMA2000 1X and 3X CDMA2000 1xEV-DO CDMA2000 1xEV-DV
IMT-2000 CDMA TDD (time-code)	UTRA TDD 3.84 Mchip/s high chip rate UTRA TDD 1.28 Mchip/s low chip rate (TD-SCDMA) UMTS
IMT-2000 TDMA Single-Carrier	UWC-136 EDGE
IMT-2000 FDMA/TDMA (frequency-time)	DECT
IMT-2000 OFDMA TDD WMAN	Mobile WiMAX

FDD: Frequency division duplex.

TDD: Time division duplex.

UTRA: Universal terrestrial radio access.

TABLE 2

Characteristics of IMT-2000 mobile stations

Parameter	IMT-2000 CDMA Direct Spread [1]	IMT-2000 CDMA Multi-Carrier[1]		IMT-2000 CDMA TDD (time-code)		IMT-2000 TDMA Single-Carrier		IMT-2000 FDMA/ TDMA (frequency-time) [5]	IMT-2000 OFDMA TDD WMAN[2]	
				1.28 Mchip/s low chip rate [2]	3.84 Mchip/s high chip rate [2]					
Carrier spacing	5 MHz ± *n* × 0.2 MHz	1.25 MHz (1X)	3.75 MHz (3X)	1.6 MHz ± *n* × 0.2 MHz	5 MHz ± *n* × 0.2 MHz	30 kHz [14]	200 kHz [7]	1.728 MHz	5 MHz	10 MHz
Duplex method	FDD	FDD	FDD	TDD	TDD	FDD	FDD	TDD	TDD	TDD
Transmitter power (dBm) (typical)[3]	20	20	20	20	20	20	20	10	20[4]	20[4]
TDD activity factor (dB)[5]									3 dB[5]	3 dB[5]
Transmitter power (dBm) (maximum)	24 or 21	24	24	24 or 21	24 or 21	30 [15]	30 [8]	24	24	24
Antenna gain (dBi)	0	0	0	0	0	0	0	0	0	0
Antenna height (m)	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	≤ 1.5	≤ 1.5
Access techniques	CDMA[6]	CDMA	CDMA	TDMA/ CDMA	TDMA/ CDMA	TDMA [15]	TDMA[7]	MC/TDMA[8]	TDMA/ OFDMA	TDMA/ OFDMA

TABLE 2 (*continued*)

Parameter	IMT-2000 CDMA Direct Spread [1]	IMT-2000 CDMA Multi-Carrier[1]		IMT-2000 CDMA TDD (time-code)		IMT-2000 TDMA Single-Carrier		IMT-2000 FDMA/ TDMA (frequency-time) [5]	IMT-2000 OFDMA TDD WMAN[2]	
				1.28 Mchip/s low chip rate [2]	3.84 Mchip/s high chip rate [2]					
Data rates supported	Pedestrian: 384 kbit/s, Vehicular: 144 kbit/s, Indoors: 2 Mbit/s Higher data rates up to 10 Mbit/s are supported by technology enhancements (HSDPA) [23]	Up to 625.35 kbit/s on forward link and up to 433.35 kbit/s on reverse link Higher data rates up to 2 457 kbit/s are supported by technology enhancements (HRPD) [22]	Up to 2 084.55 kbit/s on forward link and up to 1 354.95 kbit/s on reverse link	Pedestrian: 384 kbit/s, Vehicular: 144 kbit/s, Indoors: 2 Mbit/s Higher data rates up to 2.8 Mbit/s are supported by technology enhancements (HSDPA) [23]	Pedestrian: 384 kbit/s, Vehicular: 144 kbit/s, Indoors: 2 Mbit/s Higher data rates up to 10.2 Mbit/s are supported by technology enhancements (HSDPA) [23]	13.0 kbit/s (π/4 DQPSK) 19.95 kbit/s (8-PSK downlink) 18.6 kbit/s (8-PSK uplink)	144 kbit/s [9] 384 kbit/s	1.152 Mbit/s 32 kbit/s/ timeslot (> 2 Mbit/s with aggregated time slots and 8 level modulation)	Max per user (Mbit/s)[9]: SIMO (1x2): DL=10.08, UL=2.52 MIMO (2x2): DL=20.16, UL=2.52 [24]	Max per user (Mbit/s)[9]: SIMO (1x2): DL=20.16, UL=5.04 MIMO (2x2): DL=40.32, UL=5.04 [24]
Modulation type	HPSK[10]	QPSK/BPSK	QPSK/BPSK	QPSK/ 8-PSK	QPSK	π/4-DQPSK 8-PSK	GMSK 8-PSK	GMSK (BT = 0.5) (+ multi-level modulation options)	QPSK 16-QAM 64-QAM (64-QAM optional), Repetition factor (*R*) 2, 4, 6	QPSK 16-QAM 64-QAM, (64-QAM optional), Repetition factor (*R*) 2, 4, 6
Emission bandwidth	[1]	[20]	[20]	[2]	[2]	[16]		[5]	4.75 MHz as defined by –1 dB bandwidth[11]	9.5 MHz as defined by –1 dB bandwidth[11]

TABLE 2 (*continued*)

Parameter	IMT-2000 CDMA Direct Spread [1]	IMT-2000 CDMA Multi-Carrier[(1)]		IMT-2000 CDMA TDD (time-code)		IMT-2000 TDMA Single-Carrier		IMT-2000 FDMA/ TDMA (frequency-time) [5]	IMT-2000 OFDMA TDD WMAN[(2)]	
				1.28 Mchip/s low chip rate [2]	3.84 Mchip/s high chip rate [2]					
–3 dB							0.12 MHz [10], 0.12 MHz [11]			
–20 dB							0.18 MHz [10], 0.18 MHz [11]			
–60 dB							0.40 MHz [10], 0.60 MHz [11]			
Receiver NF (worst case)	9 dB	9 dB	9 dB	9 dB	9 dB	9 dB	9 dB	10 dB	5 dB for single band and 8 dB for multi-band designs	5 dB for single band and 8 dB for multi-band designs
Thermal noise in specified bandwidth[(12)]	–108 dBm in 3.84 MHz	–113 dBm	–108 dBm	–113 dBm in 1.28 MHz	–108 dBm in 3.84 MHz	–128 dBm[(13)]	–121 dBm[(14)]	–113 dBm in 1.152 MHz	–107 dBm in 4.75 MHz	–104 dBm in 9.5 MHz
Receiver thermal noise level	–99 dBm in 3.84 MHz	–125 dBm[(15)] –113 dBm –104 dBm[(16)]	–125 dBm[(17)] –113 dBm –99 dBm[(18)]	–104 dBm in 1.28 MHz	–99 dBm in 3.84 MHz	–119 dBm	–112 dBm	–102 dBm in 1.728 MHz	–102 dBm in 4.75 MHz for 5 dB NF and –99 for 8 dB NF	–99 dBm in 9.5 MHz for 5 dB NF and –96 for 8 dB NF
Receiver bandwidth	[1]	[20]	[20]	[2]	[2]	[17]	[12]	[5]	4.75 MHz as defined by –1 dB bandwidth[(11)]	9.5 MHz as defined by –1 dB bandwidth[(11)]

TABLE 2 (*continued*)

Parameter	IMT-2000 CDMA Direct Spread [1]	IMT-2000 CDMA Multi-Carrier[1]		IMT-2000 CDMA TDD (time-code)		IMT-2000 TDMA Single-Carrier		IMT-2000 FDMA/ TDMA (frequency-time) [5]	IMT-2000 OFDMA TDD WMAN[2]	
				1.28 Mchip/s low chip rate [2]	3.84 Mchip/s high chip rate [2]					
–3 dB										
–20 dB										
–60 dB										
E_b/N_0 for $P_e = 10^{-3}$		[20]	Performance not available			7.8 dB	8.4 dB	11 dB (non-coherent detection)	n/a	n/a
SNR_{min} for $P_e = 10^{-6}$ (19)									2.9 (QPSK 1/2 rate convolutional turbo code in AWGN)	2.9 (QPSK 1/2 rate convolutional turbo code in AWGN)
SNR including implementation loss and pilot boosting offset, SNR_{IL} (20)									8.4 dB (QPSK 1/2 rate convolutional turbo code in AWGN)	8.4 dB (QPSK 1/2 rate convolutional turbo code in AWGN)
Receiver reference sensitivity(21), $\hat{I}_{or}$	–117 dBm in 3.84 MHz(21)	–104 dBm total received power in fully loaded system. Single 9 600 bit/s traffic channel is at –119.6 dBm in AWGN for 0.5% FER(21)	–99 dBm total received power in fully loaded system. Single 9 600 bit/s traffic channel is at –119.6 dBm in AWGN for 0.5% FER(21)	–108 dBm in 1.28 MHz(21)	–105 dBm in 3.84 MHz(21)	–113 dBm(21) [18]	–102 dBm(21) [9]	–94 dBm typical (spec.: –86 dBm for speech and generally –83 dBm)(21)	–91.0 dBm (QPSK 1/2 rate convolutional turbo code in AWGN)(22)	–88.0 dBm (QPSK 1/2 rate convolutional turbo code in AWGN)(22)

TABLE 2 (*end*)

Parameter	IMT-2000 CDMA Direct Spread [1]	IMT-2000 CDMA Multi-Carrier[1]		IMT-2000 CDMA TDD (time-code)		IMT-2000 TDMA Single-Carrier		IMT-2000 FDMA/ TDMA (frequency-time) [5]	IMT-2000 OFDMA TDD WMAN[2]	
				1.28 Mchip/s low chip rate [2]	3.84 Mchip/s high chip rate [2]					
Interference criterion, *I*/*N* (dB)[23]									–6 dB	–6 dB
Interference threshold[23]	–105 dBm in 3.84 MHz	–110 dBm in 1.25 MHz	–105 dBm in 3.75 MHz	–110 dBm in 1.28 MHz	–105 dBm in 3.84 MHz	No equivalent	[13]	–105 dBm typical (–97 dBm for specification speech)	–108 dBm or in 4.75 MHz for single band and –105 dBm for multi-band devices	–105 dBm in 9.5 MHz for single band and –102 dBm for multi-band devices
Transmitter ACLR	[1]	[20][24]	[20][25]	[2]	[2]			[5]	[26]	[26]
1st adjacent channel	33 dB @ ± 5 MHz	31.6 dB @ ± 3.75 MHz	–33 dBc in 3.84 MHz @ ± 3.08 MHz	33 dB @ ± 1.6 MHz	33 dB @ ± 5 MHz				33 dB (3.84 MHz Rx) 30 dB (4.75 MHz Rx) @ ± 5 MHz	33 dB (7.68 MHz Rx) 30 dB (9.5 MHz Rx) @ ± 10 MHz
2nd adjacent channel	43 dB @ ± 10 MHz	48.2 dB @ ± 8.75 MHz	–43 dBc in 3.84 MHz @ ± 8.08 MHz	43 dB @ ± 3.2 MHz	43 dB @ ± 10 MHz				43 dB (3.84 MHz Rx) 44 dB (4.75 MHz Rx) @ ± 10 MHz	43 dB (7.68 MHz Rx) 44 dB (9.5 MHz Rx) @ ± 20 MHz
Transmitter spurious emissions	[1]	[20]	[20]	[2]	[2]			[5]	[11]	[11]
Receiver ACS	33 dB	64 dB[27]	50 dB	33 dB	33 dB				33 dB[28]	33 dB
Receiver ACS_2									47 dB[28]	47 dB
Receiver blocking levels	[1]	[20]	[20]	[2]	[2]			[5]		

Notes relatives to Table 2:

ACS: Adjacent channel selectivity.

ACLR: Adjacent channel leakage power ratio.

AWGN: Additive white Gaussian noise.

FER: Frame error rate.

GMSK: Gaussian filtered minimum shift keying.

NF: Noise figure.

(1) The IMT-2000 minimum performance requirements recorded here for IMT-2000 CDMA multicarrier are defined in the band class 6 (i.e. 2 GHz band) requirements in [20]. This is also relevant to the technology enhancements (HRPD) requirements contained in [22].

(2) The OFDMA TDD WMAN parameters are for the 2 500 to 2 690 MHz band.

(3) May not be appropriate for all scenarios, for example when calculating aggregate interference from all users in a cell.

(4) 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.

(5) A function of UL/DL ratio of the TDD mode; this parameter is not applicable to FDD operation.

(6) Desired signal at sensitivity, $I/N = -6$ dB for a 10% loss in range applicable to cases where interference effects a limited number of cells. In other cases, e.g. international coordination with BSS sound in the 2.5 GHz band a trigger value of $I/N = -10$ dB is appropriate.

(7) TDMA, comprising 8 timeslots (577 μs) per single TDMA frame (4.615 ms). For user packet data service, 1-4 timeslots per frame may be used by mobile stations having multi-slot classes that do not require simultaneous transmission and reception, i.e. classes for which a duplexer is not required.

(8) Ten frequency channels with 24 time slots (32 kbit/s) per frame. The frame length is 10 ms.

(9) The rates provided are for the case of DL:UL ratio of 2:1. For more information, please refer to [24].

(10) Hybrid phase shift keying: a method peculiar to IMT-2000 CDMA Direct Spread in which the peak to average ratio is reduced in comparison to a QPSK signal by mixing the orthogonal variable spreading factor (OSVF) with both information sources as real signals, i.e. those destined for I and Q modulation components, and then shifting one component by 90° to produce an equivalent imaginary signal and then utilizing gain control on the Q channel to preserve orthogonality.

(11) Please refer to Recommendation ITU-R M.1581, Annex 6 for more information.

(12) $10 \log (k\ T\ b) + 30$ (dBm)

where:

k: Boltzman's constant = 1.38×10^{-23}, T: reference temperature = average Earth temperature = 277 K, b: noise equivalent bandwidth (Hz).

(13) In the receiver bandwidth.

(14) In the receiver bandwidth.

Notes relatives to Table 2 (end):

(15) In bandwidth equal to data rate: for IMT-2000 CDMA multicarrier, values are given for 9 600 bit/s speech services and nominal supported rate (153.6 kbit/s) for data services.

(16) In the receiver bandwidth.

(17) In bandwidth equal to data rate: for IMT-2000 CDMA multicarrier, values are given for 9 600 bit/s speech services and nominal supported rate (153.6 kbit/s) for data services.

(18) In the receiver bandwidth.

(19) SNR_{min} is minimum required signal to noise ratio for BER probability of 1×10^{-6}.

(20) $SNR_{IL} = SNR_{min}$ + implementation loss + pilot boosting offset. Implementation loss is 5 dB and pilot boosting offset is 0.46 dB for mandatory PUSC on the downlink.

(21) For a 10^{-3} raw bit error rate, $\hat{I}_{or}$, the received power spectral density (integrated in a bandwidth of $(1 + \alpha)$ times the chip rate and normalized to the chip rate) of the downlink signal as measured at the UE antenna connector.

(22) Receiver sensitivity = $-114 + SNR_{min} - 10 \log_{10}(R) + 10 \log_{10}$ (receiver bandwidth (MHz)) + implementation loss + pilot boosting offset + receiver NF. The sensitivity value given in the Table is calculated with a NF of 8 dB and a repetition factor, R, of 1.

(23) $I/N = -6$ dB for a 10% loss in range applicable to cases where interference effects a limited number of cells. In other cases, e.g. sharing with BSS (sound) in the 2 630-2 655 MHz band, a value of $I/N = -10$ dB is appropriate. 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 –6 dB, corresponding to 1 dB impact on the receiver sensitivity, however, is also recommended in Recommendation ITU-R F.758-3.

(24) Currently [20], [21] and [22] do not contain explicit 1X mobile station or base station ACLR requirements. Nevertheless, the 1X spectrum emission limits described in [20] already provide protection of adjacent channels. A lower bound for the effective ACLR can be calculated by integrating the maximum allowed 1X emissions over a 3.84 MHz integration bandwidth centred at the specified frequency offset are considered. Results summarized in this Table are calculated by assuming a 24 dBm mobile station output power, and a one 43 dBm output power base station. The actual 1X ACLR value in practical implementations will be considerably better since the emission limits (i.e. flat mask, no slope) in the region of the second adjacent channel do not realistically model a power amplifier emissions roll-off.

(25) The requirements at offsets of 3.08 and 8.08 MHz are equivalent to ACLR requirements of 33 and 43 dB from a 3X mobile station transmitter into a 3X or IMT-DS mobile station receiver offset by 5 and 10 MHz respectively. With regard to base stations, [19] currently does not contain an explicit ACLR requirement for base stations. Nevertheless, the 1X spectrum emission limits described in [19] already provide protection of adjacent channels. A lower bound for the effective ACLR can be calculated by integrating the maximum allowed emissions of three neighbouring IMT-MC 1X channels over a 3.84 MHz integration bandwidth centred at the specified frequency offset. Results summarized in this Table are produced assuming three adjacent 38 dBm output power 1X base stations; the aggregate output power over the 5 MHz of assigned channels is 43 dBm.

(26) ACLR values are specified in Recommendation ITU-R M.1581, Annex 6.

(27) The test equipment ACLR (i.e. in-band emissions contributions) effectively limits the mobile station ACS that can be tested.

(28) ACS = SNR_{min} + implementation loss + pilot boosting offset + M $-10 \log_{10}(10^{M/10} - 1)$ + ACR, where the test margin, M , is given in IEEE802.16 as 3 dB, and the ACR values are contained in the global core specification (WiMAX Forum Mobile Radio Specification version 0.3.1).

TABLE 3

Characteristics of IMT-2000 base stations

Parameter	IMT-2000 CDMA Direct Spread [3], [6]			IMT-2000 CDMA Multi-Carrier[1]						IMT-2000 CDMA TDD (time-code)						IMT-2000 TDMA Single-Carrier[2]			IMT-2000 FDMA/ TDMA (frequency-time) [5]	IMT-2000 OFDMA TDD WMAN	
										1.28 Mchip/s low chip rate [4]			3.84 Mchip/s high chip rate [4]								
Carrier spacing	5 MHz ± n × 0.2 MHz			1.25 MHz (1X)			3.75 MHz (3X)			1.6 MHz ± n × 0.2 MHz			5 MHz ± n × 0.2 MHz			30 kHz		200 kHz	1.728 MHz	5 MHz	10 MHz
Duplex method	FDD			FDD			FDD			TDD			TDD			FDD		FDD	TDD	TDD	TDD
Reuse factor																				1:1; 1:3	1:1; 1:3
TDD activity factor (dB)[3]																				3 dB[4]	3 dB[4]
Cell type	Macro	Micro	Pico	Macro	Micro	Pico	Macro	Micro	Pico	Macro	Micro	Pico	Macro	Micro	Pico	Macro	Micro	Pico	Omni	Macro	Macro
Transmitter power dBm[4]	43	38	24	40	tbd	tbd	40	tbd	tbd	43	tbd	tbd	43	tbd	tbd	40	tbd	tbd	24	36[5]	36[5]
Antenna gain[6, 7] (dBi/120° sector)	17	5	0	17	tbd	tbd	17	tbd	tbd	17	5	0	17	5	0	17	tbd	tbd	Maximum 12 Normal 0	18[8, 9]	18[8, 9]
Antenna height (m)[4]	30	5	1.5	30	tbd	tbd	30	tbd	tbd	30	5	1.5	30	5	1.5	30	tbd	tbd	1.5-10 (typical 2.5)	15-30	15-30
Tilt of antenna (degrees down)[4]	2.5	0	0	2.5	tbd	tbd	2.5	tbd	tbd	2.5	0	0	2.5	0	0	2.5	tbd	tbd	tbd	2.5	2.5
Access techniques	CDMA			CDMA			CDMA			TDMA/CDMA			TDMA/CDMA			TDMA		TDMA	MC/ TDMA	TDMA/ OFDMA	TDMA/ OFDMA
Data rates supported	Pedestrian: 384 kbit/s, Vehicular: 144 kbit/s, Indoors: 2 Mbit/s Higher data rates up to 10 Mbit/s are supported by technology enhancements (HSDPA) [23]			Up to 625.35 kbit/s on forward link and up to 433.35 kbit/s on reverse link Higher data rates up to 2 457 kbit/s are supported by technology enhancements (HRPD) [21]			Up to 2 084.55 kbit/s on forward link and up to 1 354.95 kbit/s on reverse link			Pedestrian: 384 kbit/s, Vehicular: 144 kbit/s, Indoors: 2 Mbit/s Higher data rates up to 2.8 Mbit/s are supported by technology enhancements (HSDPA) [23]			Pedestrian: 384 kbit/s, Vehicular: 144 kbit/s, Indoors: 2 Mbit/s Higher data rates up to 10.2 Mbit/s are supported by technology enhancements (HSDPA) [23]			30 kbit/s 44 kbit/s		384 kbit/s	1.152 Mbit/s 32 kbit/s/ timeslot (> 2 Mbit/s with aggregated time slots and 8 level modulation)	Max per user (Mbit/s)[10]: SIMO (1x2): DL=10.08, UL=2.52 MIMO (2x2): DL=20.16, UL=2.52 [24]	Max per user (Mbit/s)[10]: SIMO (1x2): DL=20.16, UL=5.04 MIMO (2x2): DL=40.32, UL=5.04 [24]

TABLE 3 (*continued*)

Parameter	IMT-2000 CDMA Direct Spread [3], [6]	IMT-2000 CDMA Multi-Carrier[1]		IMT-2000 CDMA TDD (time-code)		IMT-2000 TDMA Single-Carrier[2]		IMT-2000 FDMA/ TDMA (frequency-time) [5]	IMT-2000 OFDMA TDD WMAN	
				1.28 Mchip/s low chip rate [4]	3.84 Mchip/s high chip rate [4]					
Modulation type	QPSK	QPSK/BPSK 8-PSK/ 16-QAM[11]	QPSK/BPSK	QPSK/ 8-PSK	QPSK	π/4-DQPSK 8-PSK	GMSK 8-PSK	GMSK (BT = 0.5) (+ multi-level modulation options)	QPSK 16-QAM 64-QAM, Repetition factor (*R*) 2, 4, 6	QPSK 16-QAM 64-QAM, Repetition factor (*R*) 2, 4, 6
Emission bandwidth	[3]	[19]	[19]	[4]	[4]			[5]	4.75 MHz as defined by –1 dB bandwidth [12]	9.5 MHz as defined by –1 dB bandwidth [12]
–3 dB						0.03 MHz	0.18 MHz			
–20 dB						0.03 MHz	0.22 MHz			
–60 dB						0.04 MHz	0.24 MHz			
Thermal noise density (dBm/Hz)									–174 dBm/Hz	–174 dBm/Hz
Receiver NF (worst case)	5 dB for macro BS	5 dB	5 dB	7 dB for macro BS	5 dB for macro BS	5 dB	5 dB	10 dB	3 dB with tower top LNA, 5 dB otherwise	3 dB with tower top LNA, 5 dB otherwise
Receiver thermal noise level[12]	–103 dBm in 3.84 MHz for macro BS	–129 dBm –117 dBm[13] –108 dBm[14]	–129 dBm –117 dBm[15] –103 dBm[16]	–106 dBm in 1.28 MHz for macro BS	–103 dBm in 3.84 MHz for macro BS	–125 dBm [17]	–117 dBm [18]	–103 dBm in 1.152 MHz	–104 dBm for tower top LNA case and –102 dBm for other cases in 4.75 MHz	–101 dBm for tower top LNA case and –99 dBm for other cases in 9.5 MHz
Receiver bandwidth	< 5 MHz [3]	[19]	[19]	< 1.6 MHz [4]	< 5 MHz [4]			[5]	4.75 MHz as defined by –1 dB bandwidth [19]	9.5 MHz as defined by –1 dB bandwidth [22]
–3 dB						0.03 MHz	0.18 MHz			
–20 dB						0.04 MHz	0.25 MHz			
–60 dB						0.09 MHz	0.58 MHz			

TABLE 3 (*continued*)

Parameter	IMT-2000 CDMA Direct Spread [3], [6]	IMT-2000 CDMA Multi-Carrier[1]		IMT-2000 CDMA TDD (time-code)		IMT-2000 TDMA Single-Carrier[2]		IMT-2000 FDMA/ TDMA (frequency-time) [5]	IMT-2000 OFDMA TDD WMAN	
				1.28 Mchip/s low chip rate [4]	3.84 Mchip/s high chip rate [4]					
E_b/N_0 for $P_e = 10^{-3}$	[3]	[19]	Performance not available			7.8 dB	8.4 dB	11 dB (non-coherent detection)		
SNR_{min} for $P_e = 10^{-6}$ [20]									2.9 dB (QPSK 1/2 rate convolutional turbo code in AWGN)	2.9 dB (QPSK 1/2 rate convolutional turbo code in AWGN)
SNR including implementation loss, SNR_{IL}[21]									7.9 dB (QPSK 1/2 rate convolutional turbo code in AWGN)	7.9 dB (QPSK 1/2 rate convolutional turbo code in AWGN)
Receiver reference sensitivity[22]	–121 dBm[23] for macro BS –111 dBm for micro BS –107 dBm for pico BS	–119 dBm for fundamental channel in AWGN	–119 dBm for fundamental channel in AWGN	–110 dBm for macro and micro BS –96 dBm for pico BS	–109 dBm for macro and micro BS –95 dBm for pico BS	–117 dBm	–108 dBm	–94 typical (specification: –86 dBm for speech and generally –83 dBm)	–94.5 dBm [24]	–91.5 dBm [24]
Interference criterion, I/N (dB)[25]									–6 dB	–6 dB
Interference threshold for macro BS 1[25]	–109 dBm in 3.84 MHz[26]	–114 dBm in 1.25 MHz	–109 dBm in 3.75 MHz	–112 dBm in 1.28 MHz	–109 dBm in 3.84 MHz	–131 dBm	–123 dBm	–105 dBm typical (–97 dBm for speech specification)	–110 dBm with 3 dB NF and –108 dBm with 5 dB NF in 4.75 MHz	–107 dBm with 3 dB NF and –105 dBm with 5 dB NF in 9.5 MHz
Transmitter ACLR for macro/micro/ pico BS	[3], [6]	[19][27]	[19][28]	[4]	[4]				[29]	[30]

TABLE 3 (*continued*)

Parameter	IMT-2000 CDMA Direct Spread [3], [6]	IMT-2000 CDMA Multi-Carrier[1]		IMT-2000 CDMA TDD (time-code)		IMT-2000 TDMA Single-Carrier[2]		IMT-2000 FDMA/ TDMA (frequency-time) [5]	IMT-2000 OFDMA TDD WMAN	
				1.28 Mchip/s low chip rate [4]	3.84 Mchip/s high chip rate [4]					
1st adjacent	45 dB @ ± 5 MHz	50.8 dB @ ± 3.75 MHz	49.3 dB @ ± 5 MHz	40 dB @ ± 1.6 MHz	45 dB @ ± 5 MHz				53.5 dB (3.84 MHz Rx) @ ± 5 MHz Inter-system case 45 dB (4.75 MHz Rx) @ ± 5 MHz Intra-system case	53.5 dB (7.68 MHz Rx) @ ± 10 MHz Inter-system case 45 dB (9.5 MHz Rx) @ ± 10 MHz Intra-system case
2nd adjacent	50 dB @ ± 10 MHz	67.2 dB @ ± 8.75 MHz	62.2 dB @ ± 10 MHz	45 dB @ ± 3.2 MHz	55 dB @ ± 10 MHz				66 dB (3.84 MHz Rx) @ ± 10 MHz Inter-system case 55 dB (4.75 MHz Rx) @ ± 10 MHz Intra-system case	66 dB (7.68 MHz Rx) @ ± 20 MHz Inter-system case 55 dB (9.5 MHz Rx) @ ± 20 MHz Intra-system case
Transmitter spurious emissions	[3], [6]	[19]	[19]	[4]	[4]				[19]	[19]
Macro BS receiver ACS (relative ACS)	–52 dBm (46 dB)[26]	–53 dBm	–49 dBm	–55 dBm (46 dB)[26]	–52 dBm (46 dB)[26]				46 dB[30]	46 dB[30]
Macro BS receiver ACS_2									56 dB[30]	56 dB[30]
Micro BS receiver ACS (relative ACS)	–42 dBm (46 dB)[26]	tbd	tbd	–41 dBm (46 dB)[26]	–38 dBm (46 dB)[31]					

TABLE 3 (*end*)

Parameter	IMT-2000 CDMA Direct Spread [3], [6]	IMT-2000 CDMA Multi-Carrier[1]		IMT-2000 CDMA TDD (time-code)		IMT-2000 TDMA Single-Carrier[2]		IMT-2000 FDMA/ TDMA (frequency-time) [5]	IMT-2000 OFDMA TDD WMAN	
				1.28 Mchip/s low chip rate [4]	3.84 Mchip/s high chip rate [4]					
Pico BS receiver ACS (relative ACS)	–38 dBm (46 dB)[26]	tbd	tbd	–41 dBm (46 dB)[26]	–38 dBm (46 dB)[26]					
Receiver blocking levels	[3], [6]	[19]	[19]	[4]	[4]					
Co-located antenna minimum coupling loss (dB)[32]									30 dB	30 dB

tbd: To be determined.

(1) The IMT-2000 minimum performance requirements recorded here for IMT-2000 CDMA multicarrier are defined in the band class 6 (i.e. 2 GHz band) requirements in [19]. This is also relevant to the technology enhancements (HRPD) requirements contained in [21].

(2) IMT-2000 TDMA single carrier consists of three components: enhancements to the 30 kHz channels (designated as 136+) for advanced voice and data capabilities, a 200 kHz carrier component for high speed data (384 kbit/s) accommodating high mobility (designated as 136HS outdoor), and a 1.6 MHz carrier component for very high speed data (2 Mbit/s) in low mobility applications (designated as 136HS indoor). The combined result constitutes the IMT-2000 radio interface referred to as IMT-2000 TDMA single carrier.

(3) A function of UL/DL ratio of the TDD mode, this parameter is not applicable to FDD operation.

(4) May not be appropriate for all scenarios.

(5) 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.

(6) Feeder losses are not included in the values and should be considered in the sharing/compatibility issues. In the case of using a tower top LNA, this loss is negligible and does not need to be included in the sharing/compatibility studies.

(7) The reference pattern is specified in Recommendation ITU-R F.1336 with (k = 0.2).

(8) See 3GPP TR 25.892 v2.0.0 2004-06.

(9) See Recommendation ITU-R M.1646/Recommendation ITU-R F.1336-1.

(10) The rates provided are for the case of DL:UL ratio of 2:1. For more information, please refer to [24].

(11) Both HRPD and IMT-2000 CDMA multicarrier revision C support 8-PSK and 16-QAM on the forward packet channel.

Notes relatives to Table 3 (cont):

(12) Receiver thermal noise level as defined by thermal noise in specified bandwidth + receiver NF.

(13) In bandwidth equal to data rate: for IMT-2000 CDMA multicarrier, values are given for 9 600 bit/s speech services and nominal supported rate for data services.

(14) In the receiver bandwidth.

(15) In bandwidth equal to data rate: for IMT-2000 CDMA multicarrier, values are given for 9 600 bit/s speech services and nominal supported rate for data services.

(16) In the receiver bandwidth.

(17) In bandwidth equal to data rate: for IMT-2000 CDMA multicarrier, values are given for 9 600 bit/s speech services and nominal supported rate for data services.

(18) In bandwidth equal to data rate: for IMT-2000 CDMA multicarrier, values are given for 9 600 bit/s speech services and nominal supported rate for data services.

(19) Please refer to Recommendation ITU-R M.1580, Annex 6 for more information.

(20) SNR_{min} is minimum required signal to noise ratio for BER probability of 1×10^{-6}.

(21) SNR_{IL} = SNR_{min} + implementation loss. Implementation loss is 5 dB. Note that pilots are not boosted in mandatory PUSC on the uplink.

(22) For a 10^{-3} raw bit error rate, theoretical E_b/N_0.

(23) The thermal noise figure for a WCDMA receiver is –108 dBm based on $k\ T\ f$ where k is Boltzmann's constant (1.38×10^{-23}), T is the temperature (K), and f is the bandwidth (Hz). For a noise figure of 4 dB (typical value for a base station receiver), the thermal noise becomes –104 dBm. However, receiver sensitivity depends on the service (i.e. voice, packet, etc.). For example, the voice (DTCH 32) sensitivity for the base station receiver is –121 dBm for BER < 0.001.

(24) Receiver sensitivity = $-114 + SNR_{min} - 10 \log_{10}(R) + 10 \log_{10}$ (receiver bandwidth (MHz)) + implementation loss + receiver NF. The sensitivity value given in the Table is calculated with a NF of 5 dB and a repetition factor, R, of 1.

(25) I/N = –6 dB for a 10% loss in range applicable to cases where interference effects a limited number of cells. In other cases, e.g. sharing with BSS (sound) in the 2 630-2 655 MHz band a value of I/N = –10 dB is appropriate. 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 –6 dB, corresponding to 1 dB impact on the receiver sensitivity, however, is also recommended in Recommendation ITU-R F.758-3.

(26) The tolerable I/N thresholds are as follows: coordinated use (–6 dB), agreement trigger (–10 dB), licence exempt (–20 dB).

(27) Currently [20], [21] and [22] do not contain explicit 1X mobile station or base station ACLR requirements. Nevertheless, the 1X spectrum emission limits described in [20] already provide protection of adjacent channels. A lower bound for the effective ACLR can be calculated by integrating the maximum allowed 1X emissions over a 3.84 MHz integration bandwidth centred at the specified frequency offset are considered. Results summarized in this Table are calculated by assuming a 24 dBm mobile station output power, and a one 43 dBm output power base station. The actual 1X ACLR value in practical implementations will be considerably better since the emission limits (i.e. flat mask, no slope) in the region of the second adjacent channel do not realistically model a power amplifier emissions roll-off.

(28) The requirements at offsets of 3.08 and 8.08 MHz are equivalent to ACLR requirements of 33 and 43 dB from a 3X mobile station transmitter into a 3X or IMT-DS mobile station receiver offset by 5 and 10 MHz respectively. With regard to base stations, [19] currently does not contain an explicit ACLR requirement for base stations. Nevertheless, the 1X spectrum emission limits described in [19] already provide protection of adjacent channels. A lower bound for the effective ACLR can be calculated by integrating the maximum allowed emissions of three neighbouring IMT-MC 1X channels over a 3.84 MHz integration bandwidth centred at the specified frequency offset. Results summarized in this Table are produced assuming three adjacent 38 dBm output power 1X base stations; the aggregate output power over the 5 MHz of assigned channels is 43 dBm.

Notes relatives to Table 3 (end):

(29) ACLR values are specified in Recommendation ITU-R M.1580, Annex 6.

(30) ACS = SNR_{min} + implementation loss + M –10 $\log_{10}$ ($10^{M/10}$ – 1) + ACR, where the test margin, M, and the ACR are contained in the global core specification (WiMAX Forum Mobile Radio Specification version 0.3.1).

(31) The absolute ACS values are the test values as specified in 3GPP TS25.104 and TS 25.105. The following conversion formula:

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

can be used to derive relative ACS values, where M is the margin (dB) used in the ACS test, which is the useful signal level above the reference sensitivity level. For both IMT-2000 CDMA direct spread and IMT-2000 CDMA TDD (time code), M = 6 dB. ACS relative values are often used in sharing studies.

(32) 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.

TABLE 4

An example of IMT-2000 assumed traffic model characteristics for a mature network[(1)]

Parameter	Value
Traffic environments	Rural Vehicular Pedestrian In-building (central business district)
Maximum data rates	Rural – 9.6 kbit/s Vehicular – 144 kbit/s Pedestrian – 384 kbit/s In-building – 2 Mbit/s
Cell size	Rural – 10 km radius Vehicular – 1 000 m radius Pedestrian – 315 m radius In-building – 40 m radius
Users per cell during busy hour	Rural – not significant Vehicular – 4 700 Pedestrian – 42 300 In-building – 1 275
Percent of total uplink traffic > 64 kbit/s during busy hour	Rural – not significant Vehicular – 34% Pedestrian – 30% In-building – 28%
Percent of total downlink traffic > 64 kbit/s during busy hour	Rural – not significant Vehicular – 78% Pedestrian – 74% In-building – 73%
Average number of users per cell per MHz during busy hour assuming frequency duplex operation	Rural – not significant Vehicular < 64 kbit/s – 16 > 64 kbit/s – 4 Pedestrian < 64 kbit/s – 150 > 64 kbit/s – 64 In-building < 64 kbit/s – 4 > 64 kbit/s – 2

(1) Values in Table 4 were derived from Report ITU-R M.2023.

References

[1] 3GPP TS 25.101 v5.5.0 (2002-12): 3rd Generation Partnership Project; Technical Specification Group Radio Access Networks; UE Radio Transmission and Reception (FDD) (Release 5).

[2] 3GPP TS 25.102 v5.3.0 (2002-12): 3rd Generation Partnership Project; Technical Specification Group Radio Access Networks; UE Radio Transmission and Reception (TDD) (Release 5).

[3] 3GPP TS 25.104 v6.0.0 (2002-12): 3rd Generation Partnership Project; Technical Specification Group Radio Access Networks; BS Radio Transmission and Reception (FDD) (Release 6).

[4] 3GPP TS 25.105 v5.3.0 (2002-12): 3rd Generation Partnership Project; Technical Specification Group Radio Access Networks; BS Radio Transmission and Reception (TDD) (Release 5).

[5] Final Draft ETSI EN 300 175-2 v1.6.0 (2001-04): Digital Enhanced Telecommunications (DECT) Common Interface (CI) part 2: Physical Layer.

[6] 3GPP TR 25.951 v1.5.0 (2003-02): 3rd Generation Partnership Project; Technical Specification Group Radio Access Networks, FDD Base Station Classification (Release 6).

[7] TR45 technical specification, TIA/EIA-136-290); RF Minimum performance requirements 136HS Outdoor and 136HS Indoor Bearers, clause 2.

[8] TR45 technical specification, TIA/EIA-136-290; RF Minimum performance requirements 136HS Outdoor and 136HS Indoor Bearers, clause 4.1.1.2 refers to Power Class II mobile station.

[9] TR45 technical specification, TIA/EIA-136-290; RF Minimum performance requirements 136HS Outdoor and 136HS Indoor Bearers, clause 6.2 specifies data rates and reference sensitivity. Reference sensitivity listed for 144 kbit/s at a 10% block erasure rate (BLER).

[10] TR45 technical specification, TIA/EIA-136-290; RF Minimum performance requirements 136HS Outdoor and 136HS Indoor Bearers, Table A3a: Modulation and noise spectrum mask due to GMSK modulation. Measurement bandwidth is 30 kHz.

[11] TR45 technical specification, TIA/EIA-136-290; RF Minimum performance requirements 136HS Outdoor and 136HS Indoor Bearers, Table A3b: Modulation and noise spectrum mask due to 8-PSK modulation. Measurement bandwidth is 30 kHz.

[12] TR45 technical specification, TIA/EIA-136-290; RF Minimum performance requirements 136HS Outdoor and 136HS Indoor Bearers, clause 5.1:

The mobile station shall meet the requirements set forth in clause 6.2 in the presence of an unmodulated carrier at the following frequencies and amplitudes:

TABLE 5

Requirements of clause 6.2

Frequency of blocking signal	**Amplitude of blocking signal (dBm)**
600 kHz <= $\|f - f_0\|$ < 800 kHz	–43
800 kHz <= $\|f - f_0\|$ < 1.6 MHz	–43
1.6 MHz <= $\|f - f_0\|$ < 3 MHz	–33
3 MHz = $\|f - f_0\|$	–26

[13] TR45 technical specification, TIA/EIA-136-290; RF Minimum performance requirements 136HS Outdoor and 136HS Indoor Bearers, clause 6.3:

In Table 6 the reference co-channel interference (*C*/*Ic*), block error rate (BLER) performance is defined for each of the channel conditions. The actual interference ratio is defined as the interference ratio for which this performance is met. The actual interference ratio shall be less than a specified limit, called the reference interference ratio. For 200 kHz bearers the reference interference ratio shall be, for BTS and all types of MS:

TABLE 6

Input signal level and interference ratio for outdoor BTS at reference performance

Bearer	Environment	Speed (km/h)	Coding scheme	Error rate	*C/I* (dB)
136HS Outdoor	Pedestrian A	3	GCS-1	10% BLER	7
136HS Outdoor	Pedestrian A	3	GCS-2	10% BLER	8.5
136HS Outdoor	Pedestrian A	3	GCS-3	10% BLER	9.5
136HS Outdoor	Pedestrian A	3	GCS-4	10% BLER	13.5
136HS Outdoor	Pedestrian A	3	PCS-1	10% BLER	13
136HS Outdoor	Pedestrian A	3	PCS-2	10% BLER	16
136HS Outdoor	Pedestrian A	3	PCS-3	10% BLER	18
136HS Outdoor	Pedestrian A	3	PCS-4	10% BLER	19.5
136HS Outdoor	Pedestrian A	3	PCS-5	10% BLER	21
136HS Outdoor	Pedestrian A	3	PCS-6	10% BLER	24.5
136HS Outdoor	Vehicular A	50	GCS-1	10% BLER	3.5
136HS Outdoor	Vehicular A	50	GCS-2	10% BLER	7
136HS Outdoor	Vehicular A	50	GCS-3	10% BLER	8.5
136HS Outdoor	Vehicular A	50	GCS-4	10% BLER	17
136HS Outdoor	Vehicular A	50	PCS-1	10% BLER	9
136HS Outdoor	Vehicular A	50	PCS-2	10% BLER	13
136HS Outdoor	Vehicular A	50	PCS-3	10% BLER	14.5
136HS Outdoor	Vehicular A	50	PCS-4	10% BLER	18
136HS Outdoor	Vehicular A	50	PCS-5	10% BLER	21
136HS Outdoor	Vehicular A	50	PCS-6	10% BLER	(see Note 1)
136HS Outdoor	Vehicular A	120	GCS-1	10% BLER	7
136HS Outdoor	Vehicular A	120	GCS-2	10% BLER	8.5
136HS Outdoor	Vehicular A	120	GCS-3	10% BLER	9.5
136HS Outdoor	Vehicular A	120	GCS-4	10% BLER	13.5
136HS Outdoor	Vehicular A	120	PCS-1	10% BLER	13
136HS Outdoor	Vehicular A	120	PCS-2	10% BLER	16
136HS Outdoor	Vehicular A	120	PCS-3	10% BLER	18
136HS Outdoor	Vehicular A	120	PCS-4	10% BLER	19.5
136HS Outdoor	Vehicular A	120	PCS-5	10% BLER	21
136HS Outdoor	Vehicular A	120	PCS-6	10% BLER	24.5

NOTE 1 – This is the GMSK interfering channel. The channel models in the above Table are taken directly from Recommendation ITU-R M.1225.

[14] TR45 technical specification, SP-4027-270b); Mobile Station Minimum Performance, clause 2.3.1.3.1.

[15] TR45 technical specification, SP-4027-270b); Mobile Station Minimum Performance, clause 1.4 and clause 3.2.2. Refers To Power Class Ii Mobile Station.

[16] TR45 technical specification, SP-4027-270b); Mobile Station Minimum Performance, clause 3.4.1.1.3.

[17] TR45 technical specification, SP-4027-270b); Mobile Station Minimum Performance, clause 2.3.2.4.3:

TABLE 7

Blocking and spurious response rejection

Frequency band	Desired signal (frequency, F_c)	Blocking signal (frequency, F_0)	Spurious response limit (frequency, F_0)	Error rate (%)
$\lvert f_c - f_0 \rvert > 3$ MHz ($\pi/4$ DQPSK)	–102	–30	–45	3
3 MHz $> \lvert f_c - f_0 \rvert > 90$ kHz ($\pi/4$ DQPSK)	–102	–45	–45	3
$\lvert f_c - f_0 \rvert > 3$ MHz (8-PSK)	–99	–30	–45	3
3 MHz $> \lvert f_c - f_0 \rvert > 90$ kHz (8-PSK)	–99	–45	–45	3

[18] TR45 technical specification, SP-4027-270b); Mobile Station Minimum Performance, clause 2.3.1.1.3.

[19] TR45 technical specification, TIA-97-E; Recommended minimum performance Standards for cdma2000® spread spectrum base stations.

[20] TR45 technical specification, TIA-98-E; Recommended minimum performance Standards for cdma2000® spread spectrum mobile stations.

[21] TR45 technical specification, TIA-864-E; Recommended minimum performance Standards for cdma2000® High Rate Packet Data Access Network.

[22] TR45 technical specification, TIA-866-E; Recommended minimum performance Standards for cdma2000® High Rate Packet Data Access Terminal.

[23] 3GPP TS 25.308 v5.4.0 (2003-03); 3rd Generation Partnership Project; Technical Specification Group Radio Access Network; High Speed Downlink Packet Access (HSDPA); Overall description; Stage 2 (Release 5).

[24] Mobile WiMAX – Part I: A Technical Overview and Performance Evaluation, August, 2006, WiMAX Forum®.

Bibliography

TR45 technical specification, TIA/EIA 136-131; Digital Traffic Channel Layer 1, clause 1.3.

3GPP TS 25.942; 3rd Generation Partnership Project; Technical Specification Group Radio Access Networks; RF System Scenarios, clause 4.1.1.2. Body loss expectation is that values are similar for all technologies. Footnote retained for information purposes.