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| **Radiocommunication Study Groups** |  |
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| Source: Document 5A/TEMP/9  Submission of IEEE to WP 5A, Edits to ITU-R M.1801-1  Sections edited address updates to IEEE 802.11 standards | **Annex 15 to**  **Document 5A/79-E** |
| **1 June 2012** |
| **English only** |
| Annex 15 to Working Party 5A Chairman’s Report | |
| working document to a Preliminary DRAFT REVISION  OF RECOMMENDATION ITU-R M.1801-1[[1]](#footnote-1)\* | |
| Radio interface standards for broadband wireless access systems,  including mobile and nomadic applications, in the  mobile service operating below 6 GHz | |

(Questions ITU‑R 212/5 and ITU‑R 238/5)

(2007-2010)

# 1 Introduction

This Recommendation recommends specific standards for broadband wireless access[[2]](#footnote-2) in the mobile service. These specific standards are composed of common specifications developed by standards development organizations (SDOs). Using this Recommendation, manufacturers and operators should be able to determine the most suitable standards for their needs.

These standards support a wide range of applications in urban, suburban and rural areas for both generic broadband internet data and real-time data, including applications such as voice and videoconferencing.

# 2 Scope

This Recommendation identifies specific radio interface standards for BWA systems in the mobile service operating below 6 GHz. The standards included in this Recommendation are capable of supporting users at broadband data rates, taking into account the ITU‑R definitions of “wireless access” and “broadband wireless access” found in Recommendation ITU‑R F.1399[[3]](#footnote-3).

This Recommendation is not intended to deal with the identification of suitable frequency bands for BWA systems, nor with any regulatory issues.

# 3 Related ITU Recommendations

The existing Recommendations that are considered to be of importance in the development of this particular Recommendation are as follows:

[Recommendation ITU-R F.1399](http://www.itu.int/rec/R-REC-F.1399/en) – Vocabulary of terms for wireless access.

[Recommendation ITU-R F.1763](http://www.itu.int/rec/R-REC-F.1763/en) – Radio interface standards for broadband wireless access systems in the fixed service operating below 66 GHz.

[Recommendation ITU-R M.1678](http://www.itu.int/rec/R-REC-M.1678/en) – Adaptive antennas for mobile systems.

# 4 Acronyms and abbreviations

AA Adaptive antenna

ACK Acknowledgement (channel)

AN Access network

ARIB Association of Radio Industries and Businesses

ARQ Automatic repeat request

AT Access terminal

ATIS Alliance for Telecommunications Industry Solutions

ATM Asynchronous transfer mode

BCCH Broadcast control channel

BER Bit-error ratio

BRAN Broadband radio access network

BS Base station

BSR Base station router

BTC Block turbo code

BWA Broadband wireless access

CC Convolutional coding

CDMA Code division multiple access

CDMA-MC Code division multiple access – multi carrier

CL Connection layer

C-plane Control plane

CS-OFDMA Code spread OFDMA

CTC Convolutional turbo code

DECT Digital enhanced cordless telecommunications

DLC Data link control

DS-CDMA Direct-sequence code division multiple access

DSSS Direct sequence spread spectrum

E-DCH Enhanced dedicated channel

EGPRS Enhanced general packet radio service

EPC Evolved packet core

ETSI European Telecommunication Standards Institute

EV-DO Evolution data optimized

FC Forward channel

FCC Forward control channel

FDD Frequency division duplex

FEC Forward-error correction

FER Frame error rate

FHSS Frequency hopping spread spectrum

FT Fixed termination

GERAN GSM edge radio access network

GoS Grade of service

GPRS General packet radio service

GPS Global positioning system

HC-SDMA High capacity-spatial division multiple access

HiperLAN High performance RLAN

HiperMAN High performance metropolitan area network

HRPD High rate packet data

HSDPA High speed downlink packet access

HS-DSCH High speed downlink shared channel

HSUPA High speed uplink packet access

IEEE Institute of Electrical and Electronics Engineers

IETF Internet Engineering Task force

IP Internet protocol

LAC Link access control

LAN Local area network

LDPC Low density parity check

LLC Logic link control

MAC Medium access control

MAN Metropolitan area network

MCSB Multi-carrier synchronous beamforming

MIMO Multiple input multiple output

MS Mobile station

NLoS Non-line-of-sight

OFDM Orthogonal frequency-division multiplexing

OFDMA Orthogonal frequency-division multiple access

OSI Open systems interconnection

PDCP Packet data convergence protocol

PHS Personal handyphone system

PHY Physical layer

PLP Physical layer protocol

PT Portable termination

QAM Quadrature amplitude modulation

QoS Quality-of-service

RAC Reverse access channel

RF Radio frequency

RLAN Radio local area network

RLC Radio link control

RLP Radio link protocol

RTC Reverse traffic channel

SC Single carrier

SC-FDMA Single carrier-frequency division multiple access

SCG Subcarrier group

SDMA Spatial division multiple access

SDO Standards development organization

SISO Single input single output

SL Security/session/stream layer

SM Spatial multiplexing

SNP Signalling network protocol

TCC Traffic code channels

TDD Time-division duplex

TDMA Time-division multiple access

TDMA-SC TDMA-single carrier

TD-SCDMA Time-division-synchronized CDMA

TTA Telecommunications Technology Association

U-plane User plane

WiBro Wireless broadband

WirelessMAN Wireless metropolitan area network

WTSC Wireless Technologies and Systems Committee

WWINA Wireless wideband Internet access

XGP eXtended Global Platform

# 5 Noting

Recommendation ITU‑R F.1763 recommends radio interface standards for broadband wireless access systems in the fixed service operating below 66 GHz.

The ITU Radiocommunication Assembly,

*recommends*

**1** that the radio interface standards in Annexes 1 to 7 should be used for BWA systems in the mobile service operating below 6 GHz.

NOTE 1 – Annex 8 provides a summary of the characteristics of the standards found in Annexes 1 to 7.

**Annex 1**

**Broadband radio local area networks**

Radio local area networks (RLAN) offer an extension to wired LANs utilizing radio as the connective media. They have applications in commercial environments where there may be considerable savings in both cost and time to install a network; in domestic environments where they provide cheap, flexible, connectivity to multiple computers used in the home; and in campus and public environments where the increasing use of portable computers, for both business and personal use, while travelling and due to the increase in flexible working practices, e.g., nomadic workers using laptop personal computers not just in the office and at home, but in hotels, conference centres, airports, trains, planes and automobiles. In summary, they are intended mainly for nomadic wireless access applications, with respect to the access point (i.e., when the user is in a moving vehicle, the access point is also in the vehicle).

Broadband radio local area network standards are included in [Recommendation ITU‑R M.1450](http://www.itu.int/rec/R-REC-M.1450/en), and can be grouped as follows:

– IEEE 802.11

– ETSI BRAN HIPERLAN

– ARIB HiSWANa

**1 IEEE 802.11**

TheIEEE 802.11™ Working Group has developed a standard for RLANs, IEEE Std 802.11‑2012, which is part of the IEEE 802 series of standards for local and metropolitan area networks. The medium access control (MAC) unit in IEEE Std 802.11 is designed to support physical layer units as they may be adopted dependent on the availability of spectrum. IEEE Std 802.11 operates in the 2 400-2 500 MHz band and in the bands comprising 3 650‑3 700 MHz, 4.94-4.99 GHz, 5.03‑5.091 GHz, 5.15‑5.25 GHz, 5.25-5.35 GHz, 5.47‑5.725 GHz and 5.725‑5.850 GHz. IEEE Std 802.11 employs the frequency hopping spread spectrum (FHSS) technique, direct sequence spread spectrum (DSSS) technique, orthogonal frequency division multiplexing (OFDM) technique, and multiple input and multiple output (MIMO) technique.

Approved amendments to the IEEE 802.11-2012 base standard include Prioritization of Management Frames (IEEE 802.11ae), Video Transport Streams (IEEE 802.11aa). PHY and MAC amendments with available drafts include Very High Throughput below 6 GHz (IEEE 802.11ac

The URL for the IEEE 802.11 Working Group is <http://www.ieee802.org/11>. The IEEE Std 802.11‑2012 standard and some amendments are available at no cost through the Get IEEE 802™ program at <http://standards.ieee.org/about/get>, and future amendments will become available for no cost six months after publication. Approved amendments and some draft amendments are available for purchase at <http://www.techstreet.com/ieeegate.html>.

**2 ETSI BRAN HIPERLAN**

The HiperLAN 2 specifications were developed by ETSI TC (Technical Committee) BRAN (broadband radio access networks). HiperLAN 2 is a flexible RLAN standard, designed to provide high-speed access up to 54 Mbit/s at physical layer (PHY) to a variety of networks including internet protocol (IP) based networks typically used for RLAN systems. Convergence layers are specified which provide interworking with Ethernet, IEEE 1394 and ATM. Basic applications include data, voice and video, with specific quality-of-service parameters taken into account. HiperLAN 2 systems can be deployed in offices, classrooms, homes, factories, hot spot areas such as exhibition halls and, more generally, where radio transmission is an efficient alternative or complements wired technology.

HiperLAN 2 is designed to operate in the bands 5.15-5.25 GHz, 5.25-5.35 GHz and 5.47‑5.725 GHz. The core specifications are TS 101 475 (physical layer), TS 101 761 (data link control layer), and TS 101 493 (convergence layers). All ETSI standards are available in electronic form at: <http://pda.etsi.org/pda/queryform.asp>, by specifying the standard number in the search box.

ETSI TC BRAN has also developed conformance test specifications for the core HIPERLAN 2 standards, to assure the interoperability of devices and products produced by different vendors. The test specifications include both radio and protocol testing.

ETSI TC BRAN has worked closely with IEEE-SA (Working Group 802.11) and with MMAC in Japan (Working Group High Speed Wireless Access Networks) to harmonize the systems developed by these three fora for the 5 GHz bands.

**3 MMAC[[4]](#footnote-4) HSWA[[5]](#footnote-5)**

MMAC HSWA has developed and **ARIB[[6]](#footnote-6)** has approved and published, a standard for broadband mobile access communication systems. It is called HiSWANa (ARIB STD-T70). The scope of the technical specifications is limited to the air interface, the service interfaces of the wireless subsystem, the convergence layer functions and supporting capabilities required to realize the services.

The technical specifications describe the PHY and MAC/DLC layers, which are core network independent, and the core network-specific convergence layer. The typical data rate is from 6 to 36 Mbit/s. The OFDM technique and TDMA-TDD scheme are used. It is capable of supporting multimedia applications by providing mechanisms to handle the quality-of-service (QoS). Restricted user mobility is supported within the local service area. Currently, only Ethernet service is supported.

The HiSWANa system is operated in the 5 GHz bands (4.9-5.0 GHz and 5.15-5.25 GHz).

**Annex 2  
  
(no change)**

**Annex 3  
  
(no change)**

**Annex 4  
  
ATIS WTSC radio interface standard for BWA systems  
in the mobile service**

# 1 ATIS WTSC wireless wideband internet access standard

The Wireless Technologies and Systems Committee (WTSC) of the Alliance of Telecommunications Industry Solutions (ATIS), an American National Standards Institute (ANSI)‑accredited standards development organization, has developed an American National Standard that adheres to its adopted requirements for wireless wideband internet access (WWINA) systems. The WWINA air interface standard enables wireless portability and nomadic roaming subscriber services that complement the DSL and cable modem markets. This system is optimized for high-speed packet data services that operate on a separate, data-optimized channel. The WWINA requirements specify a non-line-of-sight wireless internet air interface for full-screen, full-performance multimedia devices.

This air interface provides for portable access terminal (AT) devices with improved performance when compared to other systems that are targeted for high-mobility user devices. More specifically, the WWINA air interface optimizes the following performance attributes:

– system data speeds;

– system coverage/range;

– network capacity;

– minimum network complexity;

– grade-of-service and quality-of-service management.



# 42 ATIS-0700004.2005 high capacity-spatial division multiple access (HC-SDMA)

## 42.1 Overview of the radio interface

The HC-SDMA standard specifies the radio interface for a wide-area mobile broadband system. HC-SDMA uses TDD and adaptive antenna (AA) technologies, along with multi-antenna spatial processing algorithms to produce a spectrally efficient mobile communications system that can provide a mobile broadband service deployed in as little as a single (unpaired) 5 MHz band of spectrum licensed for mobile services. HC-SDMA systems are designed to operate in licensed spectrum below 3 GHz, which is the best suited for mobile applications offering full mobility and wide area coverage. Because it is based on TDD technology and does not require symmetrical paired bands separated by an appropriate band gap or duplexer spacing, systems based on the HC‑SDMA standard can easily be re-banded for operation in different frequency bands. The HC‑SDMA technology achieves a channel transmission rate of 20 Mbit/s in a 5 MHz licensed band. With its frequency re-use factor of *N* = 1/2, in a deployment using 10 MHz of licensed spectrum the 40 Mbit/s transmission rate is fully available in every cell in an HC-SDMA network, which is a spectral efficiency of 4 bits/s/Hz/cell.

## 42.2 Detailed specifications of the radio interface

The HC-SDMA air interface has a TDD/TDMA structure whose physical and logical characteristics have been chosen for the efficient transport of end-user IP data and to extract maximum benefit from adaptive antenna processing. The physical aspects of the protocol are arranged to provide spatial training data, and correlated uplink and downlink interference environments, for logical channels amenable to directive transmission and reception such as traffic channels. Conversely, channels not amenable to directive processing, such as paging and broadcast channels have smaller payloads and receive a greater degree of error protection to balance their links with those of the directively processed channels. Adaptive modulation and channel coding, along with uplink and downlink power control, are incorporated to provide reliable transmission across a wide range of link conditions. Modulation, coding and power control are complemented by a fast ARQ to provide a reliable link. Fast, low-overhead make-before-break inter-cell handover is also supported. Authentication, authorization, and privacy for the radio access link is provided by mutual authentication of the terminals and access network, and by encryption.

The HC-SDMA air interface has three layers designated as L1, L2, and L3.

Table 1 describes the air interface functionality embodied in each layer. Each layer’s features are briefly described below; more detailed overviews of key aspects are described in subsequent sections of this document.

TABLE 1

**Air interface layers**

|  |  |
| --- | --- |
| **Layer** | **Defined properties** |
| L1 | Frame and burst structures, modulation and channel coding, timing advance |
| L2 | Reliable transmission, logical to physical channel mapping, bulk encryption |
| L3 | Session management, resource management, mobility management, fragmentation, power control, link adaptation, authentication |

Table 2 summarizes the key elements of the HC-SDMA air interface.

TABLE 2

**Summary of the basic elements of the HC-SDMA air interface**

|  |  |
| --- | --- |
| **Quantity** | **Value** |
| Duplex method | TDD |
| Multiple access method | FDMA/TDMA/SDMA |
| Access scheme | Collision sense/avoidance, centrally scheduled |
| Carrier spacing | 625 kHz |
| Frame period | 5 ms |
| User data rate asymmetry | 3:1 down:up asymmetry at peak rates |
| Uplink time-slots | 3 |
| Downlink time-slots | 3 |
| Range | > 15 km |
| Symbol rate | 500 kbaud/sec |
| Pulse shaping | Root raised cosine |
| Excess channel bandwidth | 25% |
| Modulation and coding | – Independent frame-by-frame selection of uplink and downlink constellation + coding  – 8 uplink constellation + coding classes  – 9 downlink constellation + coding classes  – Constant modulus and rectangular constellations |
| Power control | Frame-by-frame uplink and downlink open and closed loop |
| Fast ARQ | Yes |
| Carrier and time-slot aggregation | Yes |
| QoS | DiffServ (Differentiated services) policy specification, supporting rate limiting, priority, partitioning, etc. |
| Security | Mutual AT and BSR authentication, encryption for privacy |
| Handover | AT directed, make-before-break |
| Resource allocation | Dynamic, bandwidth on demand |



The standard referenced in this annex is available in electronic form at: <https://www.atis.org/docstore/default.aspx>.

**Annex 5  
  
(no change)**

**Annex 6   
  
(no change)**

**Annex 7   
  
(no change)**

**Annex 8  
  
Key characteristics of standards**

Table 7 provides a summary of key characteristics of each standard.

TABLE 7

**Key technical parameters**

| Standard | Nominal RF channel bandwidth | Modulation/ coding rate(1)  – upstream  – downstream | Coding support | Peak channel transmission rate per 5 MHz channel (except as noted) | Beam-forming support (yes/no) | Support for MIMO (yes/no) | Duplex method | Multiple access method | Frame duration | Mobility capabilities (nomadic/ mobile) |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| IEEE 802.16 WirelessMAN/ ETSI HiperMAN (Annex 3) | Flexible from 1.25 MHz up to 28 MHz.  Typical bandwidths are: 3.5,  5,  7,  8.75,  10 and 20 MHz | Up: – QPSK-1/2, 3/4 – 16-QAM-1/2, 3/4  – 64-QAM-1/2, 2/3,   3/4, 5/6  Down: – QPSK-1/2, 3/4 – 16-QAM-1/2, 3/4  – 64-QAM-1/2, 2/3,   3/4, 5/6 | CC/CTC Other options: BTC/ LDPC | Up to 17.5 Mbit/s with SISO  Up to 35 Mbit/s with (2 × 2) MIMO  Up to 70 Mbit/s with (4 × 4) MIMO | Yes | Yes | TDD/ FDD/ HFDD | OFDMA TDMA | 5 ms  Other options: 2, 2.5, 4, 8, 10, 12.5 and 20 ms | Mobile |
|  |  |  |  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |  |  |

TABLE 7 (*continued*)

| Standard | Nominal RF channel bandwidth | Modulation/ coding rate(1)  – upstream  – downstream | Coding support | Peak channel transmission rate per 5 MHz channel (except as noted) | Beam-forming support (yes/no) | Support for MIMO (yes/no) | Duplex method | Multiple access method | Frame duration | Mobility capabilities (nomadic/ mobile) |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| ATIS-0700004.2005 high capacity-spatial division multiple access (HC-SDMA)  (Annex 4) | 0.625 MHz | Up: – BPSK, QPSK,   8-PSK, 12-QAM,   16-QAM 3/4  Down: – BPSK, QPSK,   8-PSK, 12-QAM,   16-QAM,   24-QAM 8/9 | Convolu- tional and block code | Up: 2.866 Mbit/s × 8 sub-channels ×  4 spatial channels = 91.7 Mbit/s  Down: 2.5 Mbit/s ×  8 sub-channels × 4 spatial channels =  80 Mbit/s | Yes | Yes | TDD | TDMA/FDMA/ SDMA | 5 ms | Mobile |
|  |  |  |  |  |  |  |  |  |  |  |
| eXtended Global Platform : XGP (Annex 5) | 1.25 MHz 2.5 MHz 5 MHz 10 MHz 20 MHz | Up and down: BPSK 1/2, 2/3 QPSK 1/2, 3/4 16-QAM 1/2, 3/4 64-QAM 4/6, 5/6 256-QAM 6/8, 7/8 | Convolu- tional code Turbo code (option) | Up: 9.85 Mbit/s  Down: 10.7 Mbit/s (in case of SISO, symmetry) | Yes (option) | Yes (option) | TDD | OFDMA SC-FDMA  TDMA | 5 ms | Mobile |
| IEEE 802.11-2012 Subclause 17  (Formerly 802.11b)  (Annex 1) | 22 MHz | Up and down: DQPSK CCK BPSK PBCC – 1/2 QPSK PBCC – 1/2 | Uncoded/ CC | 2.5 Mbit/s | No | No | TDD | CSMA/  CA | Variable frame duration | Nomadic |

TABLE 7 (*continued*)

| Standard | Nominal RF channel bandwidth | Modulation/ coding rate(1)  – upstream  – downstream | Coding support | Peak channel transmission rate per 5 MHz channel (except as noted) | Beam-forming support (yes/no) | Support for MIMO (yes/no) | Duplex method | Multiple access method | Frame duration | Mobility capabilities (nomadic/ mobile) |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| IEEE 802.11-2012  Subclause 18 (Formerly 802.11a)  (Annex 1) | 5 MHz  10 MHz  20 MHz | Up and down:  64-QAM OFDM 2/3, 3/4  16-QAM OFDM –1/2, 3/4  QPSK OFDM – 1/2, 3/4  BPSK OFDM – 1/2, 3/4 | CC | 13.5 Mbit/s | No | No | TDD | CSMA/ CA | Variable frame duration | Nomadic |
| IEEE 802.11-2012 Subclause 19  (Formerly 802.11g) (Annex 1) | 20 MHz | Up and down: 64-QAM OFDM 2/3, 3/4 16-QAM OFDM – 1/2, 3/4 QPSK OFDM – 1/2, 3/4 BPSK OFDM – 1/2, 3/4 8-PSK PBCC – 2/3 64-QAM DSSS-OFDM – 2/3, 3/4 16-QAM DSSS-OFDM – 1/2, 3/4 QPSK DSSS-OFDM – 1/2, 3/4 BPSK DSSS-OFDM – 1/2, 3/4 | CC | 13.5 Mbit/s | No | No | TDD | CSMA/ CA | Variable frame duration | Nomadic |

TABLE 7 (*continued*)

| Standard | Nominal RF channel bandwidth | Modulation/ coding rate(1)  – upstream  – downstream | Coding support | Peak channel transmission rate per 5 MHz channel (except as noted) | Beam-forming support (yes/no) | Support for MIMO (yes/no) | Duplex method | Multiple access method | Frame duration | Mobility capabilities (nomadic/ mobile) |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| IEEE 802.11-2012 Subclause 20  (Formerly 802.11n) (Annex 1) | 20 MHz  40 MHz | Up and down :  64-QAM OFDM – 2/3, 3/4, 5/6 16-QAM OFDM –1/2, 3/4 QPSK OFDM – 1/2, 3/4 BPSK OFDM – 1/2 | CC and LDPC | 75 Mbit/s | Yes | Yes | TDD | CSMA/ CA | Variable frame duration | Nomadic |
| IEEE P802.11ac | 20 MHz  40 MHz  80 MHz  160 MHz  80+80 MHz | Up and down,  256-QAM OFDM 2/3, 3/4, 5/6  64-QAM OFDM – 2/3, 3/4, 5/6 16-QAM OFDM –1/2, 3/4 QPSK OFDM – 1/2, 3/4 BPSK OFDM – 1/2 | CC and LDPC | 216 Mbit/s | Yes | Yes | TDD | CSMA/CA | Variable frame duration | Nomadic |
| ETSI BRAN HiperLAN 2 (Annex 1) | 20 MHz | 64-QAM-OFDM 16-QAM-OFDM QPSK-OFDM BPSK-OFDM  both upstream and downstream | CC | 6, 9, 12, 18, 27, 36 and 54 Mbit/s in 20 MHz channel (only 20 MHz channels supported) | No | No | TDD | TDMA | 2 ms | Nomadic |
| ARIB HiSWANa (Annex 1) | 4 × 20 MHz (5.15-5.25 GHz)  4 × 20 MHz (4.9-5.0 GHz) | – BPSK 1/2 – BPSK 3/4 – QPSK 1/2 – QPSK 3/4 – 16-QAM 9/16 – 16-QAM 3/4 – 64-QAM 3/4 | Convolu-tional | 6-54 Mbit/s in 20 MHz | No | No | TDD | TDMA | 2 ms | Nomadic |
| IMT-2000 CDMA Direct Spread (Annex 2) | 5 MHz  (E-UTRAN)  1.4 MHz, 3 MHz,  5 MHz, 10 MHz, 15 MHz, 20 MHz | Up:  QPSK,  16-QAM  Down:  16-QAM, QPSK, 64-QAM  (E-UTRAN) QPSK, 16-QAM, 64-QAM | Convolu-tional turbo | Up: 11.5 Mbit/s  Down: 42 Mbit/s  (E-UTRAN)  Up:  75.3 Mbit/s /  20 MHz(3)  Down:  302.7 Mbit/s /  20 MHz(3) | Yes | Yes | FDD | CDMA  (E-UTRAN) OFDM in DL  SC-FDMA in UL | 2 ms and 10 ms  (E-UTRAN) 10 ms  Sub-frame length  1 ms | Mobile |

TABLE 7 (*continued*)

| Standard | Nominal RF channel bandwidth | Modulation/ coding rate(1)  – upstream  – downstream | Coding support | Peak channel transmission rate per 5 MHz channel (except as noted) | Beam-forming support (yes/no) | Support for MIMO (yes/no) | Duplex method | Multiple access method | Frame duration | Mobility capabilities (nomadic/ mobile) |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| IMT-2000 CDMA Multi-Carrier  (Annex 2) | 1.25 MHz and 3.75 MHz (cdma2000)  1.25-20 MHz (cdma2000 HRPD) 1.25‑20 MHz, 153.6 kHz granularity  (UMB) | Up:  BPSK, QPSK, 8-PSK  Down:  QPSK, 8-PSK, 16‑QAM, (cdma2000)  QPSK, 8-PSK, 16‑QAM, 64-QAM (cdma2000 HRPD)  QPSK, 8-PSK, 16‑QAM, 64-QAM  (UMB) | Convolu-tional/ turbo  (cdma2000 and cdma2000 HRPD) Convolu-tional/ turbo/ LDPC (optional)  (UMB) | Up: 1.8 Mbit/s per 1.25 MHz channel  Down  3.1 Mbit/s Per 1.25 MHz (cdma2000)  Up: 1.8 Mbit/s per 1.25 MHz channel  Down:  4.9 Mbit/s  Per 1.25 MHz channel  (cdma2000 HRPD)Up: 75 Mbit/s for 20 MHz  Down:  228 Mbit/s for 20 MHz (UMB) | No  (cdma2000 and cdma2000 HRPD)  Yes (UMB) | No  (cdma2000 and cdma2000 HRPD)  Yes (UMB) | FDD  (cdma2000 and cdma2000 HRPD)  FDD/TDD (UMB) | CDMA  (cdma2000 and cdma2000 HRPD)  CDMA and  OFDMA  (UMB) | Down: 1.25, 1.67 2.5, 5, 10, 20, 40, 80 ms  Up: 6.66, 10, 20, 26.67, 40, 80 ms (cdma2000)  Down: 1.67, 3.33, 6,66,13.33,26.67  Up: 1.67, 6.66, 13.33, 20, 26.67 (cdma2000 HRPD)  Down: 0.911 ms  Up: 0.911 ms  (UMB) | Mobile |

TABLE 7 (*continued*)

| Standard | Nominal RF channel bandwidth | Modulation/ coding rate(1)  – upstream  – downstream | Coding support | Peak channel transmission rate per 5 MHz channel (except as noted) | Beam-forming support (yes/no) | Support for MIMO (yes/no) | Duplex method | Multiple access method | Frame duration | Mobility capabilities (nomadic/ mobile) |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| IMT-2000 CDMA TDD (Annex 2) | 1.28 Mchip/sTDD option: Less than  1.6 MHz  3.84 Mchip/sTDD option: Less than  5 MHz  7.68 Mchip/s TDD option:  Less than 10 MHz  (E-UTRAN) 1.4 MHz, 3 MHz, 5 MHz,  10 MHz, 15 MHz and  20 MHz | 1.28 Mchip/s TDD option:  Up: 8‑PSK, QPSK,  16-QAM, Down: 8-PSK,  16-QAM, QPSK  3.84 Mchip/sTDD option:  Up: 16-QAM, QPSK  Down: 16-QAM, QPSK  7.68 Mchip/s TDD option:  Up: 16-QAM, QPSK  Down: 16-QAM, QPSK  (E-UTRAN) QPSK, 16-QAM,  64-QAM | Convolu- tional turbo | 1.28 Mchip/s TDD option:  Up: 2.2 Mbit/s /  1.6 MHz(2)  Down:  2.8 Mbit/s /  1.6 MHz(2)  3.84 Mchip/s TDD option:  Up: 9.2 Mbit/s Down: 10.2 Mbit/s  7.68 Mchip/s TDD option:  Up: 17.7 Mbit/s / 10 MHz Down:  20.4 Mbit/s /  10 MHz  (E-UTRAN)  Up: 75.3 Mbit/s / 20 MHz(3)  Down: 302.7 Mbit/s / 20 MHz(3) | Yes | No  (E-UTRAN)  Yes | TDD | TDMA/ CDMA  (E-UTRAN) OFDM in DL. SC-FDMA in UL | 1.28 Mchip/s TDD option:  10 ms  Sub-frame length: 5 ms  3.84 Mchip/s TDD option:  10 ms  7.68 Mchip/s TDD option:  10 ms  (E-UTRAN)  10 ms  Sub-frame length: 1 ms | Mobile |

TABLE 7 (*continued*)

| Standard | Nominal RF channel bandwidth | Modulation/ coding rate(1)  – upstream  – downstream | Coding support | Peak channel transmission rate per 5 MHz channel (except as noted) | Beam-forming support (yes/no) | Support for MIMO (yes/no) | Duplex method | Multiple access method | Frame duration | Mobility capabilities (nomadic/ mobile) |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| IMT-2000 TDMA Single-Carrier (Annex 2) | 2 × 200 kHz 2 × Dual 200 kHz 2 × 1.6 MHz | Up: – GMSK – 8-PSK – QPSK, – 16-QAM,  – 32-QAM – B-OQAM – Q-OQAM 0.329 –   1/1  Down: – GMSK – 8-PSK – QPSK, – 16-QAM,  – 32-QAM  – B-OQAM – Q-OQAM 0.329 –   1/1 | Punctured convolu- tional code  Turbo code | Up: 16.25 Mbit/s 20.312 Mbit/s 40.625 Mbit/s  Down: 16.25 Mbit/s 20.312 Mbit/s 40.625 Mbit/s | Not explicit but not precluded | Not explicit but not precluded | FDD | TDMA | 4.6 ms 4.615 ms | Mobile |
| IMT-2000 FDMA/TDMA (Annex 2) | 1.728 MHz | Up and down: GFSK π/2-DBPSK π/4-DQPSK π/8-D8-PSK 16-QAM, 64-QAM | Depends on service: CRC, BCH, Reed-Solomon, Turbo | 20 Mbit/s | Partial | Partial | TDD | TDMA | 10 ms | Mobile |
| IMT-2000 OFDMA TDD WMAN (Annex 2) | 5 MHz,  7 MHz,  8.75 MHz, 10 MHz | Up: – QPSK-1/2, 3/4 – 16-QAM-1/2, 3/4 – 64-QAM-1/2, 2/3,   3/4, 5/6  Down: – QPSK-1/2, 3/4 – 16-QAM-1/2, 3/4  – 64-QAM-1/2, 2/3,   3/4, 5/6 | CC/CTC Other options: BTC/ LDPC | Up to 17.5 Mbit/s with SISO  Up to 35 Mbit/s with (2 × 2) MIMO  Up to 70 Mbit/s with (4 × 4) MIMO | Yes | Yes | TDD  FDD | OFDMA | 5 ms | Mobile |

TABLE 7 (*end*)

| Standard | Nominal RF channel bandwidth | Modulation/ coding rate(1)  – upstream  – downstream | Coding support | Peak channel transmission rate per 5 MHz channel (except as noted) | Beam-forming support (yes/no) | Support for MIMO (yes/no) | Duplex method | Multiple access method | Frame duration | Mobility capabilities (nomadic/ mobile) |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| IEEE 802.20  (Annex 6) | Flexible from 625 kHz, up to 20 MHz | Wideband mode:  Up: QPSK, 8-PSK, 16-QAM, 64-QAM  Down: QPSK, 8‑PSK, 16-QAM, 64-QAM  625 kHz mode:  Pi/2 BPSK, QPSK, 8‑PSK, 12‑QAM, 16‑QAM, 24‑QAM, 32‑QAM, 64‑QAM | Convolu-tional, Turbo, LDPC Code, parity check code, extended Hamming code | Peak rates of 288 Mbit/s DL and 75 Mbit/s UL in 20 MHz | Yes: SDMA, and beam-forming support on forward and reverse links | Yes: Single codeword and multi codeword MIMO support | TDD FDD  HFDD | OFDMA TDMA/ FDMA/ SDMA | Wideband mode: 0.911 ms    625 kHz mode: 5 ms | Mobile |
| YD/T 1956-2009  Air interface of SCDMA broadband wireless access system standard (Annex 7) | Multiple of 1 MHz up to 5 MHz | QPSK, 8-PSK, 16‑QAM, 64‑QAM | Reed-Solomon | 15 Mbit/s in 5 MHz | Yes | Yes | TDD | CS-OFDMA | 10 ms | Mobile |
| (1) Including all applicable modes, or at least the maximum and the minimum.  (2) In 5 MHz three 1.28 Mchip/s TDD carriers can be deployed.  (3) E-UTRAN supports scalable bandwidth operation up to 20 MHz in both the uplink and downlink. | | | | | | | | | | |

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1. \* This Recommendation should be brought to the attention of ITU-T Study Groups 2 and 15. [↑](#footnote-ref-1)
2. “Wireless access” and “BWA” are defined in Recommendation ITU‑R F.1399, which also provides definitions of the terms “fixed”, “mobile” and “nomadic” wireless access. [↑](#footnote-ref-2)
3. *Broadband wireless access* is defined as wireless access in which the connection(s) capabilities are higher than the *primary rate*, which is defined as the transmission bit rate of 1.544 Mbit/s (T1) or 2.048 Mbit/s (E1). *Wireless access* is defined as end-user radio connection(s) to core networks. [↑](#footnote-ref-3)
4. Multimedia Mobile Access Communication Systems Promotion Council (now called “Multimedia Mobile Access Communication Systems Forum” or “MMAC Forum”). [↑](#footnote-ref-4)
5. High Speed Wireless Access Committee. [↑](#footnote-ref-5)
6. Association of Radio Industries and Businesses. [↑](#footnote-ref-6)