



Recommendation ITU-R M.1801-2
(02/2013)

**Radio interface standards for broadband
wireless access systems, including mobile
and nomadic applications, in the mobile
service operating below 6 GHz**

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SF	Frequency sharing and coordination between fixed-satellite and fixed service systems
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SNG	Satellite news gathering
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V	Vocabulary and related subjects

Note: This ITU-R Recommendation was approved in English under the procedure detailed in Resolution ITU-R 1.

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RECOMMENDATION ITU-R M.1801-2*

**Radio interface standards for broadband wireless access systems,
including mobile and nomadic applications, in the mobile
service operating below 6 GHz**

(Questions ITU-R 212-4/5 and ITU-R 238-2/5)

(2007-2010-2013)

1 Introduction

This Recommendation recommends specific standards for broadband wireless access¹ 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.1399².

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 – Vocabulary of terms for wireless access.

Recommendation ITU-R F.1763 – Radio interface standards for broadband wireless access systems in the fixed service operating below 66 GHz.

Recommendation ITU-R M.1678 – Adaptive antennas for mobile systems.

* This Recommendation should be brought to the attention of ITU-T Study Groups 2 and 15.

¹ “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.

² *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.

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
CQI	Channel quality indicator
CS-OFDMA	Code spread OFDMA
CTC	Convolutional turbo code
DECT	Digital enhanced cordless telecommunications
DFT	Discrete Fourier transform
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
FSTD	Frequency switched transmit diversity
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
ICIC	Inter-cell interference coordination
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
LTE	Long term evolution
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
PAPR	Peak-to-average power ratio

PDCP	Packet data convergence protocol
PHS	Personal handyphone system
PHY	Physical layer
PLP	Physical layer protocol
PMI	Preferred matrix index
PT	Portable termination
QAM	Quadrature amplitude modulation
QoS	Quality-of-service
RAC	Reverse access channel
RF	Radio frequency
RIT	Ratio Interface Technologies
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
SFBC	Space frequency block coding
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
TTI	Transmission time interval
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

that the radio interface standards in Annexes 1 to 8 should be used for BWA systems in the mobile service operating below 6 GHz.

NOTE 1 – Annex 9 provides a summary of the characteristics of the standards found in Annexes 1 to 8.

Annex 1

Broadband radio local area networks

Radio local area networks (RLANs) 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, and can be grouped as follows:

- IEEE 802.11
- ETSI BRAN HIPERLAN
- ARIB HiSWANa.

1 IEEE 802.11

The IEEE 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), and Robust Audio Video Streaming (IEEE 802.11aa).

The URL for the IEEE 802.11 Working Group is <http://www.ieee802.org/11>. IEEE Std 802.11-2012 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 MMAC³ HSWA⁴

MMAC HSWA has developed and ARIB⁵ 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

³ Multimedia Mobile Access Communication Systems Promotion Council (now called “Multimedia Mobile Access Communication Systems Forum” or “MMAC Forum”).

⁴ High Speed Wireless Access Committee.

⁵ Association of Radio Industries and Businesses.

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

IMT-2000 terrestrial radio interfaces

The section titles are taken from § 5 of Recommendation ITU-R M.1457, additional updated information can be found there.

1 IMT-2000 CDMA Direct Spread⁶

The UTRAN radio-access scheme is direct-sequence CDMA (DS-SS) with information spread over approximately 5 MHz bandwidth using a chip rate of 3.84 Mchip/s. Higher order modulation (64-QAM in downlink and 16-QAM in uplink), multiple input multiple output antennas (MIMO), improved L2 support for high data rates and coding techniques (turbo codes) are used to provide high-speed packet access.

A 10 ms radio frame is divided into 15 slots (2 560 chip/slot at the chip rate of 3.84 Mchip/s). A physical channel is therefore defined as a code (or number of codes). For HS-SSCH (high-speed downlink packet access – HSDPA), E-DCH (high-speed uplink packet access – HSUPA) and associated signalling channels, 2 ms subframes consisting of 3 slots are defined. This technology achieves peak data rates approaching 42 Mbit/s for downlink and up to 11 Mbit/s for uplink. In the downlink, further enhancements of DC-HSDPA in combination with the MIMO feature support peak data rates reaching up to 84 Mbit/s. In the uplink, the dual cell feature is also applicable to two adjacent frequencies in the same band with enhanced uplink in order to support peak data rates reaching up to 23 Mbit/s. Large cell ranges (up to 180 km) can be achieved in good propagation conditions (e.g. desert, grassy and plain fields, coastal areas, etc.).

For efficient support of always-on connectivity whilst enabling battery saving in the UE and further increasing the air interface capacity, the specifications also include the continuous packet connectivity feature (CPC). The CS voice services are supported over HSPA.

The radio interface is defined to carry a wide range of services to efficiently support both circuit-switched services (e.g. PSTN- and ISDN-based networks) as well as packet-switched services (e.g. IP-based networks). A flexible radio protocol has been designed where several different services such as speech, data and multimedia can simultaneously be used by a user and multiplexed on a single carrier. The defined radio-bearer services provide support for both real-time and non-real-time services by employing transparent and/or non-transparent data transport. The QoS can be adjusted in terms such as delay, bit-error probability, and frame error ratio (FER).

⁶ See § 5.1 of Recommendation ITU-R M.1457.

The radio access network architecture also provides support for multimedia broadcast and multicast services, i.e. allowing for multimedia content distribution to groups of users over a point-to-multipoint bearer.

Evolved UTRA (E-UTRA) has been introduced for the evolution of the radio-access technology towards a high-data-rate, low-latency and packet-optimized radio-access technology.

The downlink transmission scheme is based on conventional OFDM to provide a high degree of robustness against channel frequency selectivity while still allowing for low-complexity receiver implementations also at very large bandwidths. The uplink transmission scheme is based on SC-FDMA (Single Carrier-FDMA), more specifically DFT-spread OFDM (DFTS-OFDM). It also supports multi-cluster assignment of DFTS-OFDM. The use of DFTS-OFDM transmission for the uplink is motivated by the lower Peak-to-Average Power Ratio (PAPR) of the transmitted signal compared to conventional OFDM.

E-UTRA supports bandwidths from approximately 1.4 MHz to 100 MHz, yielding peak data rates up to roughly 3 Gbit/s in the downlink and 1.5 Gbit/s in the uplink. Carrier aggregation, i.e. the simultaneous transmission of multiple component carriers in parallel to/from the same terminal, is used to support bandwidths larger than 20 MHz.

2 IMT-2000 CDMA Multi-Carrier⁷

The CDMA multi-carrier radio interface provides two options: cdma2000 operation where one or three RF carriers are utilized or cdma2000 high rate packet data (HRPD) where one to fifteen RF carriers are utilized.

The cdma2000 operation option supports one or three 1.2288 Mc/s RF carriers. The radio interface is defined to carry a wide range of services to support both circuit-switched services (e.g. PSTN- and ISDN-based networks) as well as packet-switched services (e.g. IP-based networks). The radio protocol has been designed where several different services such as speech, data and multimedia can simultaneously be used in a flexible manner by a user and multiplexed on a single carrier. The defined radio-bearer services provide support for both real-time and non-real-time services by employing transparent and/or non-transparent data transport. The QoS can be adjusted in terms such as delay, bit-error probability and FER.

The radio-interface specification includes enhanced features for simultaneous high-speed packet data and other services such as speech on the single carrier. In particular, features for enhanced reverse link have been introduced, allowing for improved capacity and coverage, higher data rates than the current uplink maximum, and reduced delay and delay variance for the reverse link.

The radio access network architecture also provides support for multimedia broadcast and multicast services, i.e. allowing for multimedia content distribution to groups of users over a point-to-multipoint bearer.

For cdma2000 HRPD, the forward link, deployed on one to fifteen RF carriers, consists of the following time-multiplexed channels: the pilot channel, the forward MAC channel, the control channel and the forward traffic channel. The forward traffic channel carries user data packets. The control channel carries control messages, and it may also carry user traffic. Each channel is further decomposed into code-division-multiplexed quadrature Walsh channels.

⁷ See § 5.2 of Recommendation ITU-R M.1457.

The cdma2000 HRPD MAC channel consists of two sub-channels: the reverse power control (RPC) channel and the reverse activity (RA) channel. The RA channel transmits a reverse link activity bit (RAB) stream. Each MAC channel symbol is BPSK-modulated on one of (sixty-four) 64-ary Walsh codewords.

The cdma2000 HRPD forward traffic channel is a packet-based, variable-rate channel. The user data for an access terminal is transmitted at a data rate that varies from 38.4 kbit/s to 4.9 Mbit/s per 1.2288 Mchip/s carrier. The forward traffic channel and control channel data are encoded, scrambled and interleaved. The outputs of the channel interleaver are fed into a QPSK/8-PSK/16-QAM/64-QAM modulator. The modulated symbol sequences are repeated and punctured, as necessary. Then, the resulting sequences of modulation symbols are demultiplexed to form 16 pairs (in-phase and quadrature) of parallel streams. Each of the parallel streams are covered with a distinct 16-ary Walsh function at a chip rate to yield Walsh symbols at 76.8 ksymbol/s. The Walsh-coded symbols of all the streams are summed together to form a single in-phase stream and a single quadrature stream at a chip rate of 1.2288 Mchip/s. The resulting chips are time-division multiplexed with the preamble, pilot channel, and MAC channel chips to form the resultant sequence of chips for the quadrature spreading operation.

The cdma2000 HRPD forward traffic channel physical layer packets can be transmitted in 1 to 16 slots. When more than one slot is allocated, the transmitted slots use 4-slot interlacing. That is, the transmitted slots of a packet are separated by three intervening slots, and slots of other packets are transmitted in the slots between those transmit slots. If a positive acknowledgement is received on the reverse link ACK channel that the physical layer packet has been received on the forward traffic channel before all of the allocated slots have been transmitted, the remaining untransmitted slots are not transmitted and the next allocated slot is used for the first slot of the next physical layer packet transmission.

The cdma2000 HRPD reverse link, deployed on one to fifteen RF carriers, consists of the access channel and the reverse traffic channel. The access channel is used by the access terminal to initiate communication with the access network or to respond to an access terminal directed message. The access channel consists of a pilot channel and a data channel. The reverse traffic channel is used by the mobile station to transmit user-specific traffic or signalling information to the access network. The cdma2000 HRPD reverse link traffic channel comprises a pilot channel, a reverse rate indicator (RRI) channel, a data rate control (DRC) channel, an acknowledgement (ACK) channel, and a data channel. The user data for an access terminal is transmitted at a data rate that varies from 4.8 kbits/s to 1.8 Mbits/s per 1.2288 Mchips/s carrier. The RRI channel is used to indicate the data rate transmitted on the reverse traffic channel. The RRI channel is time-multiplexed with the pilot channel. The DRC channel is used by the mobile station to indicate to the access network the supportable forward traffic channel data rate and the best serving sector on the forward CDMA channel. The ACK channel is used by the access terminal to inform the access network whether or not the data packet transmitted on the forward traffic channel has been received successfully.

For the enhanced HRPD access, physical layer H-ARQ (hybrid automatic repeat request), shorter frame sizes, fast scheduling/rate-control, and adaptive modulation and coding are implemented to increase the peak data rate and system throughput of the reverse link.

2.1 Ultra mobile broadband system

The ultra-mobile broadband (UMB) system provides a unified design for full- and half-duplex FDD and TDD modes of operation with support for scalable bandwidths between 1.25 MHz and 20 MHz. The system is designed for robust mobile broadband access, and is optimized for high spectral efficiency and short latencies using advanced modulation, link adaptation, and multi-antenna transmission techniques. Fast handoff, fast power control, and inter-sector interference management

are used. Adaptive coding and modulation with synchronous H-ARQ and turbo coding (LDPC optional) are used for achieving high spectral efficiencies. Sub-band scheduling provides enhanced performance on forward and the reverse link by exploiting multi-user diversity gains for latency-sensitive traffic.

The forward link is based on orthogonal frequency division multiple access (OFDMA) enhanced by multi-antenna transmission techniques including MIMO, closed loop beamforming, and space division multiple access (SDMA), with the maximum total spatial multiplexing order 4. Minimum forward link retransmission latency is approximately 5.5 ms and peak rate over 288 Mbit/s is achieved with 4th order MIMO in 20 MHz.

The reverse link is quasi-orthogonal. That is, it employs orthogonal transmission based on OFDMA, together with non-orthogonal user multiplexing with layered superposition or multiple receive antennas (SDMA). The reverse link also includes optional CDMA transmission for low-rate traffic. Interference management is obtained through fractional frequency reuse. An optimized throughput/fairness trade-off is obtained through distributed power control based on other-cell interference. The reverse link employs a CDMA control segment and OFDMA control segment. The system employs fast access with reduced overhead and fast requests. The reverse link employs a broadband reference signal for power control, handoff decisions, and sub-band scheduling. UMB MAC design allows for a power efficient reverse link transmission by power limited terminals through scheduling. The reverse link retransmission latency is approximately 7.3 ms and the peak data rate is over 75 Mbit/s in a 20 MHz bandwidth (with single codeword quasi-orthogonal coding).

UMB is designed to operate in partly or fully asynchronous deployments, however, air interface is optimized to take advantage of inter-cell synchronization. Low overhead pilot channels (beacons) are introduced to enable low-complexity neighbour search and facilitate same frequency handoff as well as inter-frequency handoff with minimum interruption.

UMB also features power efficient operation modes to improve terminal battery life. Specifically, selected interlace mode is optimized for low-rate latency sensitive applications such as VoIP while a semi-connected state is designed to provide efficient DTX/DRX with a low duty cycle latency tolerant traffic.

3 IMT-2000 CDMA TDD⁸

The universal terrestrial radio access (UTRA) time-division duplex (TDD) radio interface is defined where three options, called 1.28 Mchip/s TDD (TD-SCDMA), 3.84 Mchip/s TDD and 7.68 Mchip/s TDD can be distinguished.

The UTRA TDD radio interface has been developed with the strong objective of harmonization with the FDD component (see § 1) to achieve maximum commonality. This was achieved by harmonization of important parameters of the physical layer, and a common set of protocols in the higher layers are specified for both FDD and TDD, where 1.28 Mchip/s TDD has significant commonality with 3.84 Mchip/s TDD and 7.68 Mchip/s TDD. UTRA TDD with the three options accommodates the various needs of the different Regions in a flexible way and is specified in a common set of specifications.

The radio access scheme is direct-sequence code division multiple access. There are three chip-rate options: the 3.84 Mchip/s TDD option, with information spread over approximately 5 MHz bandwidth and a chip rate of 3.84 Mchip/s, the 7.68 Mchip/s TDD option with information spread over approximately 10 MHz bandwidth and a chip rate of 7.68 Mchip/s and the 1.28 Mchip/s TDD option, with information spread over approximately 1.6 MHz bandwidth and a chip rate of

⁸ See § 5.3 of Recommendation ITU-R M.1457.

1.28 Mchip/s. The radio interface is defined to carry a wide range of services to efficiently support both circuit-switched services (e.g. PSTN- and ISDN-based networks) as well as packet-switched services (e.g. IP-based networks). A flexible radio protocol has been designed where several different services such as speech, data and multimedia can simultaneously be used by a user and multiplexed on a single carrier. The defined radio bearer services provide support for both real-time and non-real-time services by employing transparent and/or non-transparent data transport. The QoS can be adjusted in terms such as delay, BER and FER.

The radio-interface specification includes enhanced features for high-speed downlink packet access (HSDPA) and improved L2 support for high data rates, allowing for downlink packet-data transmission with peak data rates of 2.8 Mbit/s, 10.2 Mbit/s and 20.4 Mbit/s for the 1.28 Mchip/s, 3.84 Mchip/s and 7.68 Mchip/s modes respectively, and for simultaneous high-speed packet data and other services such as speech on the single carrier. Features for enhanced uplink have been introduced, allowing for improved capacity and coverage, higher data rates, and reduced delay and delay variance for the uplink.

The addition of higher order modulation (16-QAM) for the enhanced uplink, allows for peak data rates up to 2.2 Mbit/s, 9.2 Mbit/s and 17.7 Mbit/s for the 1.28 Mchip/s, 3.84 Mchip/s and 7.68 Mchip/s modes, respectively. Support has been added for multi-frequency operation for the 1.28 Mchip/s UTRA TDD mode.

The radio access network architecture also provides support for multimedia broadcast and multicast services, i.e. allowing for multimedia content distribution to groups of users over a point-to-multipoint bearer.

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E-UTRA supports bandwidths from approximately 1.4 MHz to 100 MHz, yielding peak data rates up to roughly 3 Gbit/s in the downlink and 1.5 Gbit/s in the uplink. Carrier aggregation, i.e. the simultaneous transmission of multiple component carriers in parallel to/from the same terminal, is used to support bandwidths larger than 20 MHz.

4 IMT-2000 TDMA Single-Carrier⁹

This radio interface provides three bandwidth options for high-speed data, all using TDMA technology. The 200 kHz carrier bandwidth option (EDGE) utilizes 8-PSK or 32-QAM modulation with increased symbol rate with hybrid ARQ and achieves a channel transmission rate in dual-carrier mode of 1.625 Mbit/s or 3.25 Mbit/s while supporting high mobility. A 1.6 MHz bandwidth is provided for lower mobility environments which utilizes binary and quaternary offset QAM modulation with hybrid ARQ. This 1.6 MHz bandwidth option supports flexible slot allocation and achieves a channel transmission rate of 5.2 Mbit/s.

A rich broadcast or point-to-multipoint service known as multimedia broadcast/multicast service (MBMS) is provided. Point-to-multipoint services exist today which allow data from a single source

⁹ See § 5.4 of Recommendation ITU-R M.1457.