Wireless Communications Standards

DIGITAL CELLULAR STANDARDS

	3GPP LTE	3GPP WCDMA/HSPA/HSPA+	3GPP TD-SCDMA	3GPP TD-CDMA	GSM/GPRS/EDGE/EDGE Evolution
Frequency range	**(E-)UTRA/FDD Bands** (in MHz) **I)** UL: 1920 to 1980 DL: 2110 to 2170 **II)** UL: 1850 to 1910 DL: 1930 to 1990 **III)** UL: 1710 to 1785 DL: 1805 to 1880 **IV)** UL: 1710 to 1755 DL: 2110 to 2155 **V)** UL: 824 to 849 DL: 869 to 894 **VI)** UL: 830 to 840 DL: 875 to 885 **VII)** UL: 2500 to 2570 DL: 2620 to 2690 **VIII)** UL: 880 to 915 DL: 925 to 960 **IX)** UL: 1749.9 to 1784.9 DL: 1844.9 to 1879.9 **X)** UL: 1710 to 1770 DL: 2110 to 2170 **XI)** UL: 1427.9 to 1452.9 DL: 1475.9 to 1500.9 **XII)** UL: 698 to 716 DL: 728 to 746 **XIII)** UL: 777 to 787 DL: 746 to 756 **XIV)** UL: 788 to 798 DL: 758 to 768 **XVII)** UL: 704 to 716 DL: 734 to 746		**(E-)UTRA/TDD Bands** (in MHz) **a)** 1900 to 1920 2010 to 2025 **b)** 1850 to 1910 1930 to 1990 **c)** 1910 to 1930 **d)** 2570 to 2620 **e)** 2300 to 2400 **f)** 1880 to 1920		**Bands** (in MHz) **T-GSM 380** UL: 380.2 to 389.8 DL: 390.2 to 399.8 **T-GSM 410** UL: 410.2 to 419.8 DL: 420.2 to 429.2 **GSM 450** UL: 450.4 to 457.6 DL: 460.4 to 467.6 **GSM 480** UL: 478.8 to 486 DL: 488.8 to 496 **GSM 710** UL: 728 to 746 DL: 698 to 716 **GSM 750** UL: 777 to 793 DL: 747 to 763 **T-GSM 810** UL: 806 to 821 DL: 851 to 866 **GSM 850** UL: 824 to 849 DL: 869 to 894 **P-GSM 900** UL: 890 to 915 DL: 935 to 960 **E-GSM 900** UL: 880 to 915 DL: 925 to 960 **T-GSM 900** UL: 870.4 to 876 DL: 915.4 to 921 **DCS 1800** UL: 1710 to 1785 DL: 1805 to 1880 **PCS 1900** UL: 1850 to 1910 DL: 1930 to 1990
Modulation type	QPSK, 16QAM, 64QAM (DL) QPSK, 16QAM, 64QAM (UL)	QPSK (DL) 16QAM (DL, HSDPA) 64QAM (DL, HSPA+) Dual BPSK (UL) 16QAM (UL, HSPA+)	QPSK, 8PSK 16QAM (HSPA) 64QAM (HSPA+)	QPSK (DL) 16QAM (DL, HSDPA) QPSK (UL)	GMSK 8PSK (EDGE) QPSK, 16QAM, 32QAM (EDGE Evo)
Transmission method/multiple access	OFDMA (DL) SC-FDMA (UL)	WCDMA	TD-SCDMA, FDMA	TD-CDMA, FDMA	TDMA, FDMA
Duplex	FDD / TDD	FDD	TDD	TDD	FDD
Channel bandwidth	Scalable to 20 MHz	5 MHz	1.6 MHz	5 MHz	200 kHz
Peak data rate	300 Mbit/s (DL, 20 MHz, 4x4 MIMO) 75 Mbit/s (UL, 20 MHz)	2.0 Mbit/s (DL, UL) 14.4 Mbit/s (DL, HSDPA) 5.76 Mbit/s (UL, HSUPA) 42.2 Mbit/s (DL, HSPA+) 11.5 Mbit/s (UL, HSPA+)	2.0 Mbit/s (DL, UL) 2.8 Mbit/s (DL, HSDPA) 2.0 Mbit/s (UL, HSUPA) 8.4 Mbit/s (DL, HSPA+) 5.0 Mbit/s (UL, HSPA+)	2.0 Mbit/s (DL, UL) 10 Mbit/s (DL, HSDPA)	14.4 kbit/s (GSM) 171 kbit/s (DL, GPRS) 128 kbit/s (UL, GPRS) 473.6 kbit/s (DL, EDGE) 355.2 kbit/s (UL, EDGE) 1.89 Mbit/s (DL, EDGE Evo) 1.42 Mbit/s (UL, EDGE Evo)
Standardization forums	www.3gpp.org www.globalcertificationforum.org www.ptcrb.com				

	CDMA2000® 1xEV-DO Revision C*	CDMA2000® 1xEV-DO Revision B	CDMA2000® 1xEV-DO Release 0/Revision A	CDMA2000® 1xRTT	cdmaOne IS-95	D-AMPS IS-136
Frequency range	**Band Classes** (in MHz) **BC0) 800 MHz Band** RL: 815 to 849 FL: 860 to 894 **BC1) 1900 MHz Band** RL: 1850 to 1910 FL: 1930 to 1990 **BC2) TACS Band** RL: 872 to 915 FL: 917 to 960 **BC3) JTACS Band** RL: 887 to 925 FL: 832 to 870 **BC4) Korean PCS Band** RL:1750 to 1780 FL: 1840 to 1870 **BC5) 450 MHz Band** RL: 410 to 483 FL: 420 to 493 **BC6) 2 GHz Band** RL: 1920 to 1980 FL: 2110 to 2170 **BC7) 700 MHz Band** RL: 776 to 794 FL: 746 to 764 **BC8) 1800 MHz Band** RL: 1710 to 1785 FL: 1805 to 1880 **BC9) 900 MHz Band** RL: 880 to 915 FL: 925 to 960 **BC10) Secondary 800 MHz Band** RL: 806 to 901 FL: 851 to 940 **BC11) 400 MHz European PAMR Band** RL: 410 to 483 FL: 420 to 493 **BC12) 800 MHz PAMR Band** RL: 870 to 876 FL: 915 to 921 **BC13) 2.5 GHz IMT-2000 Extension Band** RL: 2500 to 2570 FL: 2620 to 2690 **BC14) US PCS 1.9 GHz Band** RL: 1850 to 1915 FL: 1930 to 1995 **BC15) AWS Band** RL: 1710 to 1755 FL: 2110 to 2155 **BC16) US 2.5 GHz Band** RL: 2502 to 2568 FL: 2624 to 2690 **BC17) US 2.5 GHz Forward Link Only Band** FL: 2624 to 2690 **BC18) 700 MHz Public Safety Band** RL: 757 to 769 FL: 787 to 799 **BC19) Lower 700 MHz Band** RL: 728 to 746 FL: 698 to 716				**Bands** (in MHz) RL: 824 to 849 FL: 869 to 894 RL: 1850 to 1910 FL: 1930 to 1990	**Bands** (in MHz) RL: 824 to 849 FL: 869 to 894 RL: 1850 to 1910 FL: 1930 to 1990
Modulation type	BPSK, QPSK, 16QAM, 64QAM (FL) BPSK, QPSK, 16QAM, 64QAM (RL)	QPSK, 8PSK, 16QAM, 64QAM (FL) BPSK, QPSK, 8PSK (RL)	QPSK, 8PSK, 16QAM (FL) BPSK, QPSK, 8PSK (RL)	QPSK (FL) HPSK, OQPSK (RL)	QPSK, OQPSK	π/4 DQPSK
Transmission method/multiple access	OFDMA (180)	TDMA (FL) CDMA (RL)	TDMA (FL) CDMA (RL)	CDMA	CDMA, FDMA	TDMA, FDMA
Duplex	FDD	FDD	FDD	FDD	FDD	FDD
Channel bandwidth	1.25 MHz x N (N = number of channels, max. 15)	1.25 MHz x N (N = number of channels, max. 15)	1.25 MHz	1.25 MHz	1.25 MHz	30 kHz
Peak data rate	18.7 Mbit/s x N (FL) 4.3 Mbit/s x N (RL) (N = number of channels, max. 15)	4.9 Mbit/s x N (FL, 64QAM) 1.9 Mbit/s x N (RL) (N = number of channels, max. 15)	2.4 Mbit/s (FL, Rel. 0) 153 kbit/s (RL, Rel. 0) 3.1 Mbit/s (FL, Rev. A) 1.8 Mbit/s (RL, Rev. A)	307.7 kbit/s	14.4 kbit/s (IS-95-A) 115.2 kbit/s (IS-95-B)	48.6 kbit/s
Standardization forums	www.3gpp2.org www.globalccf.org				www.tiaonline.org	www.tiaonline.org

	WiMAX™ IEEE 802.16m*	WiMAX™ IEEE 802.16e-2005 IEEE 802.16-2004	TETRA TETRA 2 (TEDS)	MBWA IEEE 802.20*	Cognitive Radio IEEE 802.22*
Frequency range	**Bands for 16-2004** (in MHz) 3400 to 3600 5725 to 5850 **Profiles for 16e, 16m** (in MHz) **M2300T-01/02)** 2300 to 2400 **M2300T-04/05)** 2305 to 2360 **M2500T-01)** 2496 to 2690 **M3300T-01/02)** 3300 to 3400 **M3500T-01/04)** 3400 to 3800 **M3500T-02/03/05)** 3400 to 3600 Targeted for 16e, 16m: **UTRA/TDD Bands** Targeted for 16e (Rel. 1.5), 16m: **UTRA/FDD Bands**		300 MHz to 921 MHz	**CDMA2000® Band Classes** BC0 to BC16 and BC18 to BC19	**Max. Range** (in MHz) 54 to 862 **Bands** (in MHz) North America: 54 to 746 Europe: 48 to 798 China: 48 to 798 Japan: 54 to 746
Modulation type	BPSK, QPSK, 16QAM, 64QAM, SC	BPSK, QPSK, 16QAM, 64QAM, SC	π/4 DQPSK π/8 DQPSK (TEDS)	BPSK, QPSK, 8PSK, 12QAM, 16QAM, 24QAM, 32QAM, 64QAM	QPSK, 16QAM, 64QAM
Transmission method/multiple access	SOFDMA (128, 256, 512, 1024, 2048)	SOFDMA (128, 256, 512, 1024, 2048), OFDM (256), SC	TDMA, FDMA	OFDMA (512, 1024, 2048)	OFDM, OFDMA typically 2k, optionally 1k, 4k (2k, 4k, 6k for channel bonding)
Duplex	TDD, FDD / HFDD	TDD, FDD / HFDD	FDD	TDD / FDD	TDD / FDD
Channel bandwidth	5 MHz to 20 MHz optionally 40 MHz	3.5 MHz, 7 MHz, 10 MHz (16-2004) 5 MHz, 7 MHz, 8.75 MHz, 10 MHz (16e)	25 kHz 25 kHz, 50 kHz, 100 kHz, 150 kHz (TEDS)	5 MHz, 10 MHz, 20 MHz in wideband mode 625 kHz/carrier in MC mode	6 MHz, 7 MHz, 8 MHz
Peak data rate	300 Mbit/s (DL, 20 MHz, 4x4 MIMO) 135 Mbit/s (UL, 20 MHz, 2x4 MIMO)	128 Mbit/s (DL, 20 MHz, 2x2 MIMO, 16e) 56 Mbit/s (UL, 20 MHz, 2x2 MIMO, 16e)	7.2 kbit/s 28.8 kbit/s using timeslot bundling 690 kbit/s (TEDS)	12 Mbit/s (5 MHz) 41.5 Mbit/s (20 MHz)	72 Mbit/s (3 x 6 MHz)
Standardization forums	www.ieee802.org/16 www.wimaxforum.org		www.etsi.org www.tetramou.com	www.ieee802.org/20	www.ieee802.org/22

WIRELESS CONNECTIVITY

	WLAN IEEE 802.11a, b, g	WLAN IEEE 802.11n*	Bluetooth® Basic Rate + EDR	UWB WiMedia (MB-OFDM) ECMA-0368	ZigBee IEEE 802.15.4	RFID, NFC ISO 14443 (NFC), ISO 15693, ISO 18000 (EPC)	DECT
Frequency range	**Bands** (in MHz) 2400 to 2497 (b, g, n) 5150 to 5350 (a, n) 5725 to 5825 (a, n)		**Band** (in MHz) 2400 to 2483.5	**Max. Range** (in MHz) 3100 to 10600 **Band Groups** (in MHz) **BG1)** 3432 to 4488 **BG2)** 5016 to 6072 **BG3)** 6600 to 7656 **BG4)** 8184 to 9240 **BG5)** 9768 to 10296 **BG6)** 7656 to 8712	**Bands** (in MHz) Worldwide: 2400 to 2483.5 North America: 902 to 928 Europe: 868.3	0 MHz to 30 MHz 125 kHz to 134 kHz 6.7 MHz 7.4 MHz to 8.8 MHz 13.56 MHz 27 MHz 125 MHz 433 MHz 868 MHz to 928 MHz 2.45 GHz 5.8 GHz 24.125 GHz	**Bands** (in MHz) Worldwide: 1880 to 1990 North America: 902 to 928 2400 to 2483.5
Modulation type	BPSK, DQPSK, QPSK, 16QAM, 64QAM, CCK, PBCC	BPSK, QPSK, 16QAM, 64QAM	GFSK GFSK (EDR, Header) π/4 DQPSK, 8DPSK (EDR, Data)	QPSK, DCM	BPSK (868/915 MHz) OQPSK (2.4 GHz)	FSK, ASK, PSK, PJM, BPSK dependent on standard	GFSK
Transmission method/multiple access	OFDM, CSMA/CA	OFDM, CSMA/CA	FHSS	TFI-OFDM, FFI-OFDM	DSSS, CSMA/CA	TDMA, FDMA	FDMA, TDMA
Duplex	TDD	TDD	TDD	TDD	TDD	TDD	TDD
Channel bandwidth	20 MHz	20 MHz, 40 MHz	1 MHz	528 MHz	5 MHz	typically 200 kHz / 500 kHz	1.728 MHz
Peak data rate	54 Mbit/s	<600 Mbit/s	1 Mbit/s 3 Mbit/s (EDR)	typically 480 Mbit/s	20 kbit/s (868 MHz) 40 kbit/s (915 MHz) 250 kbit/s (2.4 GHz)	848 kbit/s	1 Mbit/s
Standardization forums	www.ieee802.org/11		www.bluetooth.org	www.ecma-international.org www.wimedia.org	www.ieee802.org/15 www.zigbee.org	www.iso.org www.nfc-forum.org	www.dect.org www.etsi.org

MOBILE BROADCASTING

	DVB-SH	CMMB	ATSC Mobile DTV	MediaFLO™	DVB-H	T-DMB	ISDB-T 1Seg
Frequency range	**Bands** (in MHz) **L Band:** 1452 to 1492 **S Band:** 2170 to 2200	**Bands** (in MHz) **UHF:** 470 to 798 **S Band:** 2635 to 2660	**Bands** (in MHz) **VHF:** 54 to 216 **UHF:** 470 to 482 632 to 770	**Bands** (in MHz) **VHF:** 174 to 230 **UHF:** 698 to 746 USA: UHF channel 55	**Bands** (in MHz) **VHF:** 174 to 230 **UHF:** 470 to 862 **L Band:** 1452 to 1492 Austria: VHF channels 36, 37, 47 Finland: VHF channel 38 Italy: VHF channels 21 to 25 UHF channels	**Bands** (in MHz) **VHF:** 174 to 240 **L Band:** 1452 to 1492 Korea: VHF channels 8 and 12	**Band** (in MHz) **UHF:** 470 to 770 Japan: UHF channel 32
Modulation type	QPSK, 8PSK, 16APSK (TDM) QPSK, 16QAM (OFDM)	BPSK, QPSK, 16QAM	8VSB	QPSK, 16QAM	QPSK, 16QAM, (64QAM)	DQPSK	DQPSK, QPSK, 16QAM, 64QAM
Transmission method/multiple access	TDM, OFDM (1k, 2k, 4k, 8k)	OFDM (1k, 4k)	SC	OFDM (1k, 2k, 4k, 8k)	OFDM	OFDM	OFDM
Duplex							
Channel bandwidth	1.7 MHz, 5 MHz, 6 MHz, 7 MHz, 8 MHz	8 MHz (4k) 2 MHz (1k)	6 MHz	5 MHz, 6 MHz, 7 MHz, 8 MHz	5 MHz, 6 MHz, 7 MHz, 8 MHz	1.536 MHz	6 MHz (13 segments) 428 kHz (1 segment)
Peak data rate	17 Mbit/s	3 Mbit/s (2 MHz) 16 Mbit/s (8 MHz)	4 Mbit/s to 6 Mbit/s max. 19.39 Mbit/s	2.8 Mbit/s to 11.2 Mbit/s (6 MHz channel)	typ. 200 kbit/s max. 384 kbit/s per segment	max. 64 channels with typically 0.2 Mbit/s to 0.384 Mbit/s max. 1.5 Mbit/s	0.28 Mbit/s to 1.787 Mbit/s per segment, (13 segments in total)
Standardization forums	www.dvb.org	www.cmmb.org.cn	www.atsc.org	www.mediaflo.com	www.dvb.org	www.worlddab.org	www.dibeg.org

NAVIGATION

	GPS	Galileo
Frequency range	**L1:** 1575.42 MHz **L2:** 1227.60 MHz **L5:** 1176.45 MHz	**E5a:** 1176.45 MHz **E5b:** 1207.14 MHz **E6:** 1278.75 MHz **L1:** 1575.42 MHz
Modulation type	BPSK	BOC
Transmission method/multiple access		
Duplex		
Channel bandwidth	20.46 MHz	24 MHz (E5a) 24 MHz (E5b) 40 MHz (E6) 32.736 MHz (L1)
Peak data rate	50 bit/s	50 sps (E5a) 250 sps (E5b) 1000 sps (E6) 250 sps (L1)
Standardization forums		www.gsa.europa.eu

Glossary: 1xEV-DO = 1x Evolution – Data Optimized; **1xRTT** = 1x Radio Transmission Technology; **3GPP** = 3rd Generation Partnership Project; **8VSB** = 8-Level Vestigial Sideband Modulation; **APSK** = Asymmetric PSK; **ASK** = Amplitude Shift Keying; **ATSC Mobile DTV** = Advanced Television Systems Committee – Mobile Digital Television; **AWS** = Advanced Wireless Services; **BOC** = Binary Offset Carrier; **BPSK** = Binary PSK; **CCK** = Complementary Code Keying; **CDMA** = Code Division Multiple Access; **CMMB** = China Multimedia Mobile Broadcasting; **CSMA/CS** = Carrier Sense Multiple Access with Collision Avoidance; **D-AMPS** = Digital Advanced Mobile Phone System; **DCM** = Dual Code Modulation; **DCS** = Digital Cellular System; **DECT** = Digital Enhanced Cordless Telecommunication; **DL** = Downlink; **DPSK** = Differential PSK; **DQPSK** = Differential QPSK; **DSSS** = Direct Sequence Spread Spectrum; **DVB-(S)H** = Digital Video Broadcasting – (Satellite/)Handheld; **E-GSM** = Extended GSM; **E-UTRA** = Evolved UTRA; **ECMA** = European Computer Manufacturers Association; **EDGE** = Enhanced Data Rates for GSM Evolution; **EDR** = Enhanced Data Rate; **EPC** = Electronic Product Code; **FDD** = Frequency Division Duplex; **FDMA** = Frequency Division Multiple Access; **FFI-OFDM** = Fixed-Frequency Interleaving OFDM; **FHSS** = Frequency Hopping Spread Spectrum; **FL** = Forward Link; **FSK** = Frequency Shift Keying; **GFSK** = Gaussian FSK; **GMSK** = Gaussian Minimum Shift Keying; **GPRS** = General Packet Radio Service; **GPS** = Global Positioning System; **GSM** = Global System for Mobile Communications; **HFDD** = Hybrid FDD; **HPSK** = Hybrid PSK; **HS(D/U)PA** = High Speed (Downlink/Uplink) Packet Access; **IEEE** = Institute of Electrical and Electronics Engineers; **IMT** = International Mobile Telecommunications; **IS** = Interim Standard; **ISDB-T 1Seg** = Integrated Services Digital Broadcasting – Terrestrial One Segment; **ISO** = International Organization for Standardization; **JTACS** = Japan TACS; **LTE** = Long Term Evolution; **MB-OFDM** = Multiband OFDM; **MBWA** = Mobile Broadband Wireless Access; **MC** = Multicarrier; **MediaFLO** = Media Forward Link Only; **MIMO** = Multiple Input Multiple Output; **NFC** = Near Field Communication; **OFDM** = Orthogonal Frequency Division Multiplex; **OFDMA** = Orthogonal Frequency Division Multiple Access; **OQPSK** = Offset QPSK; **P-GSM** = Standard or Primary GSM; **PAMR** = Public Access Mobile Radio; **PBCC** = Packet Binary Convolutional Coding; **PCS** = Personal Communications System; **PJM** = Phase Jitter Modulation; **PSK** = Phase Shift Keying; **QAM** = Quadrature Amplitude Modulation; **QPSK** = Quadrature PSK; **RFID** = Radio Frequency Identification; **RL** = Reverse Link; **SC** = Single Carrier; **SOFDMA** = Scalable OFDMA; **SPS** = Samples per Second; **T-DMB** = Terrestrial Digital Multimedia Broadcasting; **T-GSM** = Trunking GSM; **TACS** = Total Access Communications Systems; **TD-(S)CDMA** = Time Division (Synchronous) CDMA; **TDD** = Time Division Duplex; **TDM** = Time Division Multiplex; **TDMA** = Time Division Multiple Access; **TEDS** = TETRA Enhanced Data Service; **TETRA** = Terrestrial Trunked Radio; **TFI-OFDM** = Time Frequency Interleaving OFDM; **UHF** = Ultra High Frequency; **UL** = Uplink; **UMTS** = Universal Mobile Telecommunications System; **UTRA** = UMTS Terrestrial Radio Access; **UWB** = Ultra Wideband; **VHF** = Very High Frequency; **WCDMA** = Wideband CDMA; **WiMAX** = Worldwide Interoperability for Microwave Access; **WLAN** = Wireless Local Area Network

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Sources: 3GPP, 3GPP2, TIA®, IEEE, WiMAX Forum®, ETSI, Bluetooth® SIG, WiMedia Alliance, UWB Forum, ZigBee Alliance, ISO, DVB Project, CMMB, ATSC, MediaFLO, World DAB, DiBEG, GSA.

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*) Standard not yet final.

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