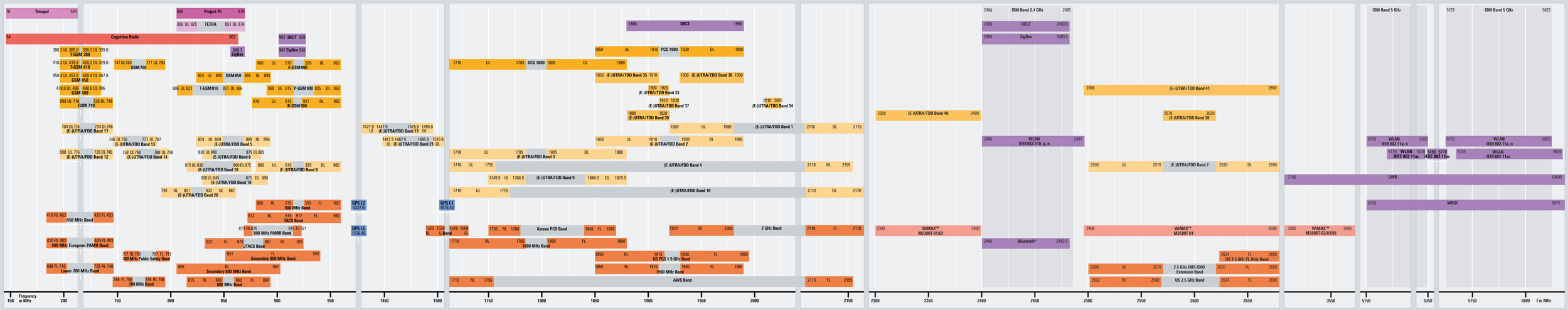
Wireless Communications Standards



	DIGITAL CELLULAR STANDARDS										PUBLIC SAFETY STANDARDS			WIRELESS CONNECTIVITY											NAVIGATION				
	LTE/LTE-Advanced*	WCDMA/HSPA/HSPA+	TD-SCDMA LCR TDD	TD-CDMA HCR TDD	GSM/GPRS/EDGE/ EDGE Evolution/VAMOS	CDMA2000® EV-DO DO Advanced	CDMA2000® EV-DO Revision B	CDMA2000® 1xEV-DO Release 0/Revision A	CDMA2000® 1xRTT	WiMAX™ Release 2 IEEE 802.16m*	WiMAX™ Release 1 IEEE 802.16-2009	Cognitive Radio IEEE802.22	TETRA TETRA 2 (TEDS)	Tetrapol	Project 25	WLAN IEEE802.11a, b, g	WLAN IEEE802.11n	WLAN IEEE802.11ac*	Wireless Gigabit IEEE802.11ad*	WHDI	WirelessHD	Bluetooth®	UWB WiMedia (MB-OFDM) ECMA-0368	ZigBee IEEE802.15.4	RFID, NFC ISO/IEC18000, NFC Analogue Specification	DECT	GPS	Galileo	GLONASS	COMPASS BeiDou-2
Frequency range	**(E-)UTRA/FDD Bands** (in MHz) **1)** UL: 1920 to 1980 DL: 2110 to 2170 **2)** UL: 1850 to 1910 DL: 1930 to 1990 **3)** UL: 1710 to 1785 DL: 1805 to 1880 **4)** UL: 1710 to 1755 DL: 2110 to 2155 **5)** UL: 824 to 849 DL: 869 to 894 **6)** UL: 830 to 840 DL: 875 to 885 **7)** UL: 2500 to 2570 DL: 2620 to 2690 **8)** UL: 880 to 915 DL: 925 to 960 **9)** UL: 1749.9 to 1784.9 DL: 1844.9 to 1879.9 **10)** UL: 1710 to 1770 DL: 2110 to 2170 **11)** UL: 1427.9 to 1447.9 DL: 1475.9 to 1495.9 **12)** UL: 698 to 716 DL: 728 to 746 **13)** UL: 777 to 787 DL: 746 to 756 **14)** UL: 788 to 798 DL: 758 to 768 **17)** UL: 704 to 716 DL: 734 to 746 **18)** UL: 815 to 830 DL: 860 to 875 **19)** UL: 830 to 845 DL: 875 to 890 **20)** UL: 832 to 862 DL: 791 to 821 **21)** UL: 1447.9 to 1462.9 DL: 1495.9 to 1510.9	**(E-)UTRA/TDD Bands** (in MHz) **33)** 1900 to 1920 **34)** 2010 to 2025 **35)** 1850 to 1910 **36)** 1930 to 1990 **37)** 1910 to 1930 **38)** 2570 to 2620 **39)** 1880 to 1920 **40)** 2300 to 2400 **41)** 2496 to 2690	**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 429.8 **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: 698 to 716 DL: 728 to 746 **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 **R-GSM 900** UL: 876 to 915 DL: 921 to 960 **DCS 1800** UL: 1710 to 1785 DL: 1805 to 1880 **PCS 1900** UL: 1850 to 1910 DL: 1930 to 1990	**Band Classes** (in MHz) **BC0) 800 MHz Band** **BC1) 1900 MHz Band** **BC2) TACS Band** **BC3) JTACS Band** **BC4) Korean PCS Band** **BC5) 450 MHz Band** **BC6) 2 GHz Band** **BC7) 700 MHz Band** **BC8) 1800 MHz Band** **BC9) 900 MHz Band** **BC10) Secondary 800 MHz Band** **BC11) 400 MHz European PAMR Band** **BC12) 800 MHz PAMR Band** **BC13) 2.5 GHz IMT-2000 Extension Band** **BC14) US PCS 1.9 GHz Band** **BC15) AWS Band** **BC16) US 2.5 GHz Band** **BC17) US 2.5 GHz Forward Link Only Band** **BC18) 700 MHz Public Safety Band** **BC19) Lower 700 MHz Band** **BC20) L-Band**			**Profiles for Release 1** (in MHz) **M2300T-01/02)** 2300 to 2400 **M2500T-01)** 2496 to 2690 **M3500T-02/03/05)** 3400 to 3600 Targeted for 16-2009, 16m: **UTRA/TDD Bands** Targeted for 16m: **UTRA/FDD Bands**		**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	**Bands** (in MHz) UL: 351 to 356 DL: 361 to 366 UL: 380 to 390 DL: 390 to 400 UL: 410 to 420 DL: 420 to 430 UL: 450 to 460 DL: 460 to 470 UL: 806 to 825 DL: 851 to 870	**Band** (in MHz) 70 to 520	**Bands** (in MHz) 136 to 174 403 to 512 806 to 870	**Bands** (in MHz) 2400 to 2497 (b, g, n) 5150 to 5350 (a, n) 5725 to 5825 (a, n)	**WLAN** IEEE802.11n	**Bands** (in MHz) 5170 to 5330 5490 to 5710 5735 to 5835	**Band** (in GHz) 56.16 to 64.80	**Bands** (in MHz) **Europe/North America:** 5150 to 5875 **Japan:** 5150 to 5725 **Korea:** 5150 to 5825	**Band** (in GHz) 57.24 to 65.88	**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	125 kHz to 134 kHz 6.7 MHz 7.4 MHz to 8.8 MHz 13.56 MHz (NFC) 27 MHz 433 MHz 865 MHz to 868 MHz 902 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	**L1:** 1575.42 MHz **L2:** 1227.60 MHz **L5:** 1176.45 MHz	**E5a:** 1176.45 MHz **E5b:** 1207.14 MHz **E6:** 1278.75 MHz **E1:** 1575.42 MHz	**L1:** 1602 MHz **L2:** 1246 MHz	**E1:** 1589.74 MHz **E2:** 1561.10 MHz **E6:** 1268.52 MHz **E5b:** 1207.14 MHz
Modulation type	OPSK, 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 BPSK (EDGE) QPSK, 16QAM, 32QAM (EDGE Evo) AQPSK (VAMOS)	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)	BPSK, QPSK, 16QAM, 64QAM	BPSK, QPSK, 16QAM, 64QAM	QPSK, 16QAM, 64QAM	n/4-DQPSK π/8-D8PSK 4QAM, 16QAM, 64QAM (TEDS)	GMSK	C4FM, CQPSK	BPSK, DQPSK, QPSK, 16QAM, 64QAM, CCK, PBCC	BPSK, QPSK, 16QAM, 64QAM	BPSK, QPSK, 16QAM, 64QAM, 256QAM	DBPSK, SQPSK, (π/2) BPSK, (π/2) QPSK, (π/2) 16QAM, 64QAM	BPSK, 16QAM, OOK	QPSK, 16QAM (HRP) BPSK (LRP)	GFSK GFSK (EDR, Header) π/4-DQPSK, 8DPSK (EDR, Data)	OPSK, DCM	BPSK (868/915 MHz) OQPSK (2.4 GHz)	FSK, ASK, PSK, PJM, BPSK dependent on standard	GFSK	BPSK	BOC	BPSK	BPSK, QPSK
Transmission method/ multiple access	OFDMA (DL) SC-FDMA (UL)	WCDMA	TD-SCDMA, FDMA	TD-CDMA, FDMA	TDMA, FDMA	OFDMA (180)	TDMA (FL) CDMA (RL)	TDMA (FL) CDMA (RL)	CDMA	SOFDMA (128, 256, 512, 1024, 2048)	SOFDMA (128, 256, 512, 1024, 2048), OFDM (256)	OFDM, OFDMA typ. 2k, optionally 1k, 4k (2k, 4k, 6k for channel bonding)	TDMA	FDMA	TDMA, FDMA	OFDM, CSMA/CA	OFDM, CSMA/CA	OFDM	OFDM, CSMA/CA	OFDM	OFDM, TDMA	FHSS	TFI-OFDM, FFI-OFDM	DSSS, CSMA/CA	TDMA, FDMA	FDMA, TDMA				
Duplex	FDD, TDD	FDD	TDD	TDD	FDD	FDD	FDD	FDD	FDD	TDD, FDD/HFDD	TDD, FDD/HFDD	TDD, FDD	FDD	FDD	FDD	FDD	FDD	TDD	TDD	TDD	TDD	TDD	TDD	TDD	TDD	TDD				
Channel bandwidth	Scalable to 20 MHz up to 100 MHz (LTE-A)	5 MHz	1.6 MHz	5 MHz	200 kHz	1.25 MHz × N (N = number of channels, max. 15)	1.25 MHz × N (N = number of channels, max. 15)	1.25 MHz	1.25 MHz	5 MHz to 20 MHz up to 100 MHz	5 MHz, 7 MHz, 8.75 MHz, 10 MHz	6 MHz, 7 MHz, 8 MHz	25 kHz; 25 kHz, 50 kHz; 100 kHz, 150 kHz (TEDS)	10 kHz, 12.5 kHz	6.25 kHz, 12.5 kHz	20 MHz	20 MHz, 40 MHz	80 MHz, 160 MHz	2.16 GHz	20 MHz, 40 MHz	1.5 GHz	1.160 GHz (HRP) 415.25 MHz (LRP)	1 MHz	528 MHz	5 MHz	typ. 200 kHz / 500 kHz	1.728 MHz	20.46 MHz	24 MHz (E5a) 24 MHz (E5b) 40 MHz (E6) 32.736 MHz (E1)	562.5 kHz (L1) 473.5 kHz (L2)	20 MHz (E6) 4 MHz (E2, E5b)
Peak data rate	300 Mbit/s (DL, 20 MHz, 4x4 MIMO) 75 Mbit/s (UL, 20 MHz) LTE-A requirements: 1 Gbit/s (DL) 500 Mbit/s (UL)	384 kbit/s (DL, UL) 14 Mbit/s (DL, HSDPA) 5.76 Mbit/s (UL, HSUPA) 84.4 Mbit/s (DL, HSPA+) 23 Mbit/s (UL, HSPA+)	2.8 Mbit/s (DL, HSDPA) 2.2 Mbit/s (UL, HSUPA) 8.4 Mbit/s (DL, HSPA+) 2.2 Mbit/s (UL, HSPA+)	384 kbit/s (DL, UL) 10.2 Mbit/s (DL, HSPA) 9.2 Mbit/s (UL, HSPA)	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)	18.7 Mbit/s × N (FL) 4.3 Mbit/s × N (RL) (N = number of channels, max. 15)	4.9 Mbit/s × N (FL, 64QAM) 1.8 Mbit/s × 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	300 Mbit/s (DL, 20 MHz, 4x4 MIMO) 135 Mbit/s (UL, 20 MHz, 2x4 MIMO) 16m requirements: 1 Gbit/s (DL) 500 Mbit/s (UL)	128 Mbit/s (DL, 20 MHz, 2x2 MIMO) 56 Mbit/s (UL, 20 MHz, 2x2 MIMO)	72 Mbit/s (3 × 6 MHz)	36 kbit/s 691 kbit/s (TEDS)	7.2 kbit/s	9.4 kbit/s	54 Mbit/s	< 600 Mbit/s	Requirement: > 1 Gbit/s	6.757 Gbit/s (OFDM) 4.62 Gbit/s (SC)	1.5 Gbit/s (20 MHz) 3.0 Gbit/s (40 MHz)	4 Gbit/s (HRP) 10 Mbit/s (LRP) 40 Mbit/s (LRP, beam formed mode)	1 Mbit/s 3 Mbit/s (EDR)	typ. 480 Mbit/s	20 kbit/s (868 MHz) 40 kbit/s (915 MHz) 250 kbit/s (2.4 GHz)	106 kbit/s 212 kbit/s 424 kbit/s 848 kbit/s dependent on standard	1 Mbit/s	50 bit/s	50 sps (E5a) 250 sps (E5b) 1000 sps (E6) 250 sps (E1)	50 bit/s	50 bit/s
Standardization forums	www.3gpp.org www.globalcertificationforum.org www.ptcrb.com					www.3gpp2.org www.globalccf.org				www.ieee802.org/16 www.wimaxforum.org		www.ieee802.org/22	www.etsi.org www.tetra-association.com	www.tetrapol.com	www.project25.org	www.ieee802.org/11				www.whdi.org	www.wirelesshd.org	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	www.gps.gov	www.gsa.europa.eu	www.glonass-ianc.rsa.ru	www.beidou.gov.cn

Glossary: 1xEV-DO = Single Carrier Evolution – Data Optimized; **1xRTT** = Single Carrier Radio Transmission Technology; **AQPSK** = Adaptive QPSK; **ASK** = Amplitude Shift Keying; **AWS** = Advanced Wireless Services; **BOC** = Binary Offset Carrier; **BPSK** = Binary PSK; **C4FM** = Continuous 4 Level FM; **CCK** = Complementary Code Keying; **CDMA** = Code Division Multiple Access; **CQPSK** = Compatible QPSK; **CSMA/CA** = Carrier Sense Multiple Access with Collision Avoidance; **D8PSK** = Differential 8PSK; **DBPSK** = Differential BPSK; **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; **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; **GLONASS** = Global Navigation Satellite System; **GMSK** = Gaussian Minimum Shift Keying; **GPRS** = General Packet Radio Service; **GPS** = Global Positioning System; **GSM** = Global System for Mobile Communications; **HCR** = High Chip Rate; **HD** = High Definition; **HFDD** = Hybrid FDD; **HPSK** = Hybrid PSK; **HRP** = High Rate Physical Layer; **HSUPA/HSPA** = High Speed (Downlink/Uplink) Packet Access; **IEEE** = Institute of Electrical and Electronics Engineers; **IMT** = International Mobile Telecommunications; **ISO** = International Organization for Standardization; **JTACS** = Japan TACS; **LCR** = Low Chip Rate; **LRP** = Low Rate Physical Layer; **LTE** = Long Term Evolution; **MB-OFDM** = Multiband OFDM; **MIMO** = Multiple Input Multiple Output; **NFC** = Near Field Communication; **OFDM** = Orthogonal Frequency Division Multiplex; **OFDMA** = Orthogonal Frequency Division Multiple Access; **OOK** = On-Off Keying; **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; **R-GSM** = Railway GSM; **RL** = Reverse Link; **SC** = Single Carrier; **SOFDMA** = Scalable OFDMA; **SPS** = Samples per Second; **SQPSK** = Spread QPSK; **T-GSM** = Trunking GSM; **TACS** = Total Access Communications Systems; **TD-(S)CDMA** = Time Division (Synchronous) CDMA; **TDD** = Time Division Duplex; **TDMA** = Time Division Multiple Access; **TEDS** = TETRA Enhanced Data Service; **TETRA** = Terrestrial Trunked Radio; **TFI-OFDM** = Time Frequency Interleaving OFDM; **UL** = Uplink; **UTRA** = Universal Terrestrial Radio Access; **UWB** = Ultra Wideband; **VAMOS** = Voice Services Over Adaptive Multi-User Channels on One Slot; **WCDMA** = Wideband CDMA; **WHDI** = Wireless Home Digital Interface; **WiMAX** = Worldwide Interoperability for Microwave Access; **WLAN** = Wireless Local Area Network

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***) Standard not yet final.**

Sources: 3GPP, 3GPP2, IEEE, WiMAX Forum®, ETSI, Bluetooth® SIG, WiMedia Alliance, UWB Forum, ZigBee Alliance, Tetrapol, ISO, GLONASS, GSA.

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