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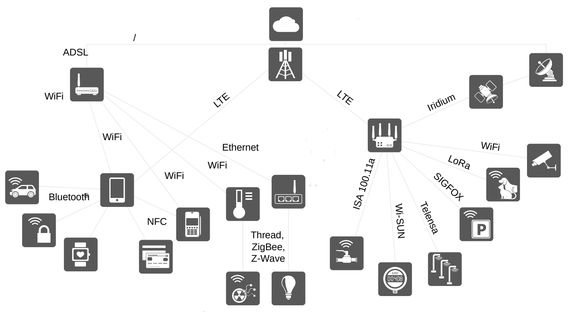

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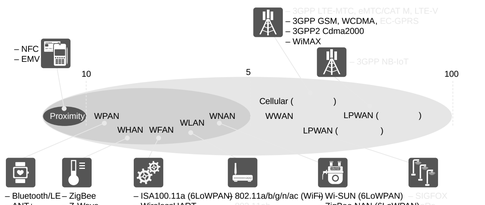

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WPAN: Wireless Personal Area Network
WHAN: Wireless Home Area Network
WFAN: Wireless Field (or Factory) Area Network
WLAN: Wireless Local Area Network
WNAN: Wireless Neighborhood Area Network
WWAN: Wireless Wide Area Network
LPWAN: Low Power Wide Area Network

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	54-698 (TVWS)														
	13.56	169	220	315	426	433	470	779	868	915	920	2400	5800	5900	
NFC/EMV	X														ISO14443
Wireless M-Bus		X	X	X	X	X	X	X	X	X	X				EN13757
China WMRNET		X	X	X	X	X	X	X	X	X	X				WMRNET-1, II, III, IV
LoRa		X	X	X	X	X	X	X	X	X	X				
SIGFOX		X	X	X	X	X	X	X	X	X	X				
Telensa		X	X	X	X	X	X	X	X	X	X				
OnRamp		X	X	X	X	X	X	X	X	X	X	X			802.15.4k
Wi-SUN		X	X	X	X	X	X	X	X	X	X	X			802.15.4g/e/6LoWPAN
ZigBee												X			802.15.4 2003, c d
Thread												X			802.15.4 2003/6LoWPAN
WirelessHART												X			802.15.4e
ISA100.11a												X			802.15.4e/6LoWPAN
Z-Wave						X	X	X							ITU G9959
EnOcean			X				X	X	X						ISO14543-3-10
ANT+											X				
Bluetooth											X				802.15.1
802.11a/b/g/n/ac											X	X			WiFi
802.11ah (HaLow)						X	X	X	X	X					WiFi HaLow
802.11p													X		V2X
802.11af			X												White Space
Positive Train Ctrl		X													802.15.4p

W S ub-GHz IC V 8 0215.4

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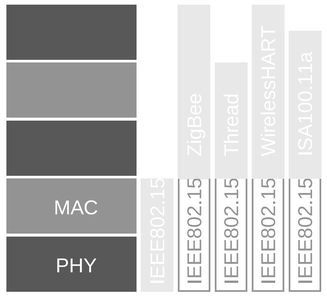
IEEE 802.15.4 PHY MAC



	Cellular Wireless Wide Area Network (WWAN)			Low Power Wide Area Network (LPWAN)									Wireless Neighborhood Area Network (WNAN)			Wireless Neighborhood Area Network (WNAN)					Wireless Field (Factory) Area Network (WFAN)		Wireless Home Area Network (WHAN)				Wireless Personal Area Network (WPAN)				Proximity[3]
	LTE MTC Cat 0	LTE eMTC Cat M	EC-GPRS	NB-IoT	LoRaWAN	SIGFOX	Telensa	OnRamp / Ingenu	Positive Train Control (PTC)	Weightless-W	Weightless-N	Weightless-P	ZigBee NAN	Wi-SUN	Wireless M-Bus	WiFi	WiGig	WiFi HaLow	WiFi WAVE	TV White Space	Wireless HART	ISA100.11a	ZigBee	Thread	Z-Wave	EnOcean	*Bluetooth* 4.0/4.1/4.2 Low Energy	ANT+	MiWi	NFC
/	3GPP Rel 12	3GPP Rel 13	3GPP Rel 13	3GPP Rel 13	LoRa Alliance	SIGFOX	Wireless Internet of Things Forum (WIoTF)	Ingenu (OnRamp)	IEEE 802.15.4p	Weightless Special Interest Group (SIG)	Weightless SIG	Weightless SIG	ZigBee Alliance IEEE 802.15.4g	Wi-SUN Alliance IEEE 802.15.4g	iP 13757	WiFi Alliance IEEE 802.11a/b/g/n/ac	WiFi Alliance IEEE 802.11ad	WiFi Alliance IEEE 802.11ah	WiFi Alliance IEEE 802.11p	WiFi Alliance IEEE 802.11af	FieldComm Group IEEE 802.15.4e	ISA100 Committee IEEE 802.15.4e	ZigBee Alliance IEEE 802.15.4	Thread Group IEEE 802.15.4	Z-Wave Alliance ITU G.9959	EnOcean Alliance ISO/IEC 14543-3-1x	Bluetooth special interest group (SIG)	ANT+ Alliance	IEEE 802.15.4 Microchip Technology	NFC Forum, ISO/IEC 14443 & 18000-3
( )	LTE		GSM	LTE, LTE GSM					220	TV White Space (TVWS)																	2,4 5,8	2,4	2,4	13,56
DL	20	1,4	200	180 (15)	125 , 500			1	12,5 25	5	200	12,5	600 , 1,2 , 2	200 1,2	5,5–6 , 12,5 , 40–80	20, 21, 22, 23, 24, 40, 80 160	2,16	1, 2, 4, 8 16	10	54–790	3	5	600 , 1,2 , 2	5	200	62,5	2	1		1
UL	20	1,4	200	180 (3,75 15) 180 (15)	125, 250 500	200 100 UL DL 600														6 8										
DL	OFDMA	OFDMA	TDMA	OFDMA	Chirp Spread Spectrum (CSS)	UNB/FHSS	UNB/FHSS	Random Phase Multiple Access (RPMA)	TDMA	FDMA + TDMA	UNB	FDMA + TDMA	Carrier Sense Multiple Access with Collision Avoidance (CSMA/CA)	Carrier Sense Multiple Access with Collision Avoidance (CSMA/CA)	Carrier Sense Multiple Access with Collision Avoidance (CSMA/CA)	OFDM, DSSS OFDMA	-	OFDM	OFDM	OFDM	TDMA	TDMA €	Carrier Sense Multiple Access with Collision Avoidance (CSMA/CA)	Carrier Sense Multiple Access with Collision Avoidance (CSMA/CA)	TDMA	TDMA	TDMA	TDMA	TDMA	·
UL	SC-FDMA	SC-FDMA	TDMA	- FDMA SC-FDMA																										
DL	QPSK, 16QAM 64QAM	QPSK, 16QAM 64QAM	GMSK, — 8PSK	BPSK, QPSK, — 16QAM	LoRa; (G)FSK	GFSK	2FSK	BPSK, OQPSK,FSK, GFSK, P-FSK, P-GFSK	GMSK, C4FM, QPSK, /4 DQPSK, DPSK	BPSK/QPSK/16QAM	DBPSK	GMSK, OQPSK	DSSS (Direct Sequence Spread Spectrum), BPSK, O-QPSK	MR-FSK/MR-OFDM/ MR-O-QPSK	FSK/GFSK/GMSK/4GFSK	GCK, BPSK, QPSK, 16-QAM 64-QAM, 256-QAM	2-BPSK, QPSK, QAM16 SQPSK, QAM64	BPSK, QPSK, 16-QAM, 64-QAM, 256-QAM	BPSK, QPSK, 16QAM, 64QAM	BPSK, QPSK, 16-QAM, 64-QAM, 256-QAM	O-QPSK DSSS	O-QPSK DSSS	BPSK, O-QPSK DSSS	O-QPSK DSSS	FSK, GFSK	ASK, FSK	GFSK FHSS	GFSK	GFSK	ASK, FSK
UL	QPSK, 16QAM	QPSK, 16QAM	GMSK, — 8PSK	BPSK, QPSK, — 8PSK 16QAM		DBPSK																								
	1 • /	1 • /	10–240 • /	DL: 250 • / ; UL: 20 • / , : 250 • /	0,3–50 • /	: 100 / , : 600 /	: 62,5 / , : 500 /	20 • /	9,6/16/19,2/ 32/36/38,4 • /	1 • / 10 • /	100 /	200 / 240 • /	250 • /	50 • / 1 • /	2,4 • /	b: 11 • / a/g/n/j: 54 • / n: 600 • / ac: 86,7 • / 6,9 • /	6,76 • /	100 • / 40 • /	6–54 • /	26,7–568,9 • /	250 • /	250 • /	20, 40 250 • /	40–250 • /	9,6, 40 100 • /	125 • /	1 • /	1 • /	250 • /	106, 212, 424 848 • /
(• /)	~141	~156	~164	~164	~150–157	~146-162	~3	~4		~5	~3	~2		~1	~1	~200	~10	~1	~1	~1	~200	~200	~100	~30	~30	~300	~50	~50	~20–50	~20
•	LTE MTC	LTE MTC, Cat-0, LTE MTC Cat-0.	GPRS/GSM	LTE-slate lean- eMTC Cat M.		‰ Š	« » —	‡ Š €	† †	€ — †- TVWS	(UL).	.	ZigBee NAN « », WAN	« « —	…	• € •	802.11 ‡€€	Wi-Fi €	/ (Wireless Access in Vehicular Environment, WAVE)	WLAN TVWS	—		802.14.4 PHY/ MAC.	802.15.4 IETF IPv6 6LoWPAN		‡ ‡	‡	, †	Microchip Technology Š	NFC/SPCM
•		Œ † Cat M1		Œ † Cat M2	LoRa LoRaWAN: MAC. LoRa Semtech.	SIGFOX — ‡ LPWAN Iol.		2015 . OnRamp Ingenu.	PTC — ‡ GPS,				ZigBee IP 802.15.4g	6LoWPAN		802.11ax (‡€€ WLAN) — ‡ WiFi, 5–10 . 1 6 2019 .	802.11ay — ‡ 60 (NG60) 20 • / † 45 2019 .	2 † 2016 .			HART (Highway Addressable Remote Transducer)	6LoWPAN	ZigBee 3.0 — ‡ † ZigBee PRO	6LoWPAN		2015 . ZigBee EnOcean 2,4 .	2016 . Bluetooth 4 100 % †			

1. • 2. • • 3. ‡ • SIGFOX LoRAWAN

SystemVue W1906EP, : 5G | ADS Advanced Design | 89600 VSA | X | MXG/EXG | Signal Studio | PNA ENA | •N6705B | CX3300A | E7515A UXM • | N9038A | MXE | M9420A • VXT• • | PXIe | X | E6640A EXM • | NFC T3111A | RCT RRM T4000S | FieldFox | i3070

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