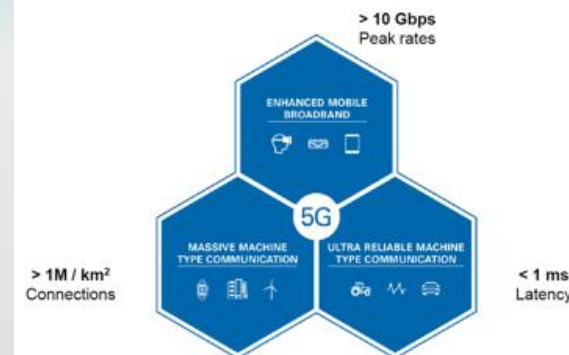




5G NR conformance and 3GPP status update

Hendry Yang



Two basic frequency ranges (FR1 and FR2) are used in 3GPP specifications, since cm-/mm-wave spectrum behaves differently in nature. FR1 (sub6) is tested conducted. FR2 (mmW) is tested over the air

Three pillars of 5G

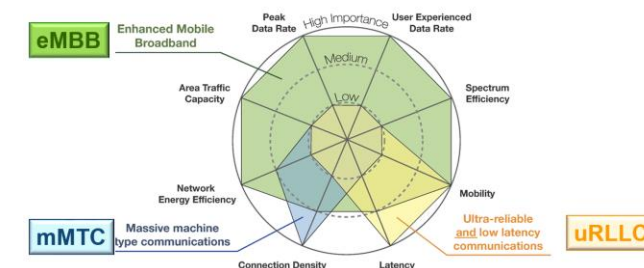
eMBB (R15: Now), URLLC (R16: 2020/21), mMTC (R17: 2021/22)

Two Network Architectures being followed

Option 3x – Non-Standalone (NSA) -> 2019-2022; Option 2 – Standalone (SA) -> 2H 2020+

LTE-A-Pro is a critical part of 5G (Release 12-15 Features)

7CC DL, 3CC UL, 1024QAM DL, 256QAM UL, 8x4 DL MIMO
eMTC & NB-IOT



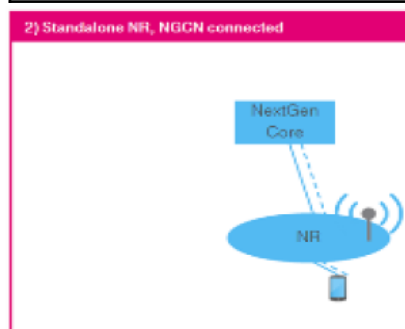
Frequency Range	Range Covered
FR1 (R15)	410MHz - 6GHz
FR1 (R16)	410MHz - 7.125GHz
FR2 (R15)	24GHz - 52.6GHz
FR2 (R17)	24GHz - 71GHz

Standalone or Non-standalone	Option	Core Network	RAN	Note
Standalone	1	EPC	eNB	Native LTE
	2	5GC	gNB	Pref. SA option
	5	5GC	NG-eNB	
Non-standalone	3	EPC	eNB, EN-gNB	eNB as anchor Pref. NSA option
	4	5GC	NG-eNB, gNB	gNB as anchor
	7	5GC	NG-eNB, gNB	Evolved eNB as anchor

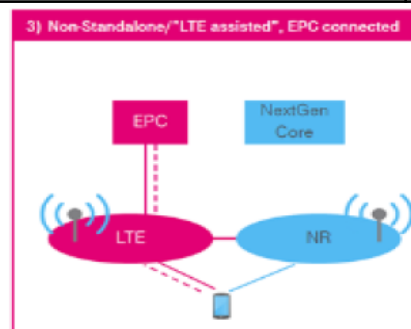
EN-DC

NGEN-DC

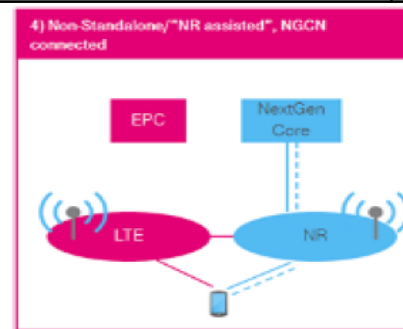
NE-DC



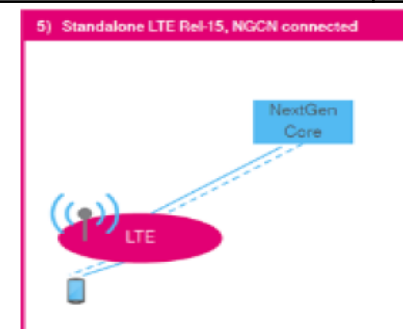
Option 2
Stand-alone NR



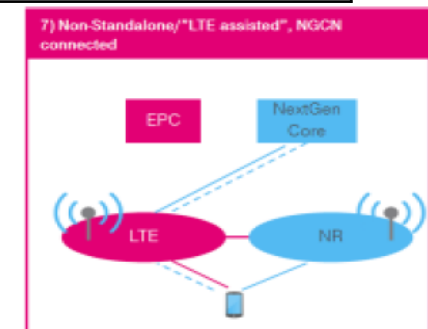
Option 3
LTE assisted, EPC



Option 4
NR-Assisted



Option 5
Stand-alone LTE



Option 7
LTE-Assisted

Frequency Range	Range Covered
FR1 (R15)	410MHz - 6GHz
FR1 (R16)	410MHz - 7.125GHz
FR2 (R15)	24GHz - 52.6GHz
FR2 (R17)	24GHz - 71GHz

EM Wave	
Frequency	Wave Length
1GHz	300mm
3GHz	100mm
6GHz	50mm
28GHz	10.7mm
39GHz	7.7mm



Acoustic	
Frequency	Wave Length
1kHz	340mm
4kHz	85mm
8kHz	42.5mm

Release 10 Introduced CA

- Aggregation of up to 5 DL CCs and 5 UL CCs
- Maximum bandwidth up to 100 MHz

Release 11 Enhanced CA

- Multiple Timing Advances (TAs) for uplink inter-band CA
- Support of different UL/DL Configurations on LTE TDD CA

Release 12 Extending CA across non-collocated cells

- LTE + LTE dual connectivity (DC)
- LTE anchor, WLAN booster
- Aggregation across non-collocated cells

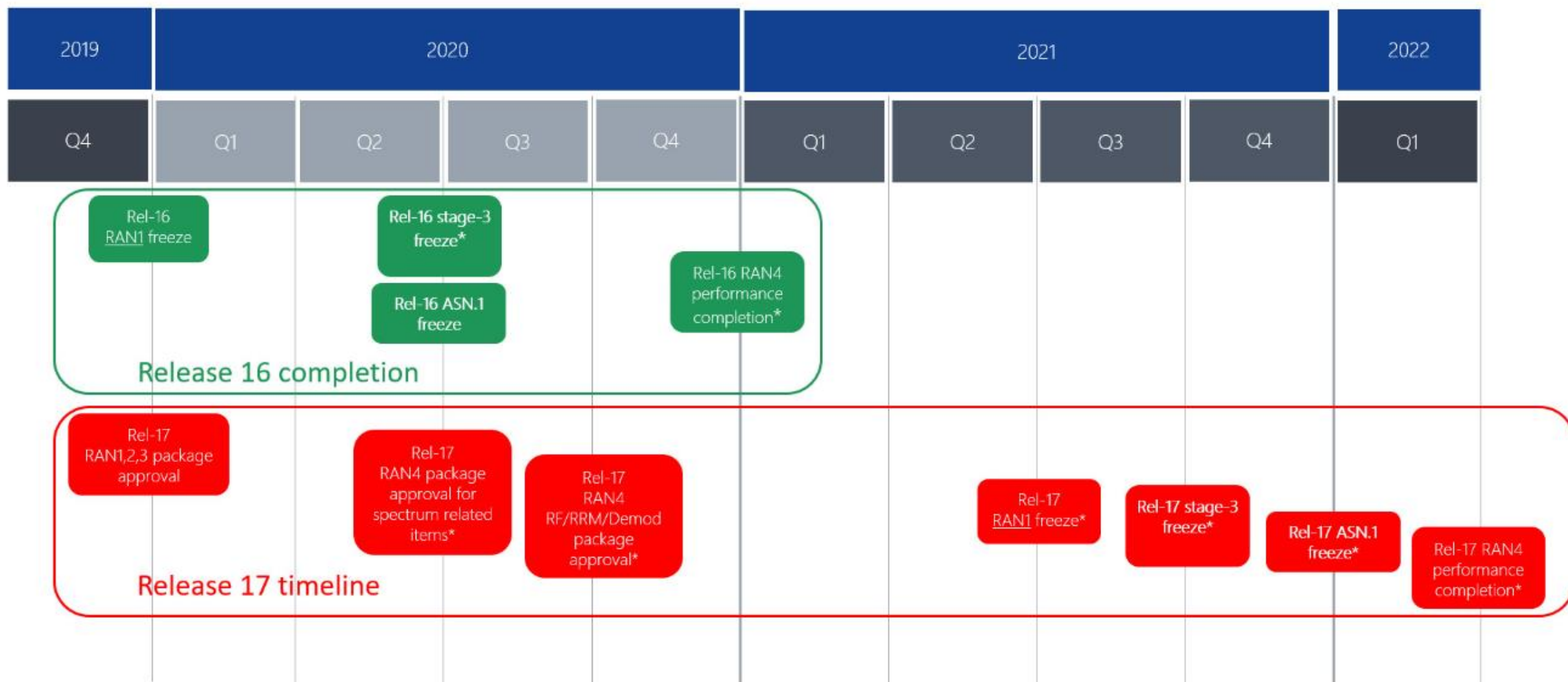
Release 13 Extending DC across RATs

- LTE + WLAN dual connectivity (LWA)
- LTE anchor, WLAN booster
- Inter RAT aggregation

Release 15 Extending DC Across Gs

- LTE + NR (EN-DC)
- LTE anchor, NR secondary cell
- Aggregation and fast switching for sub6 and mmW NR

	Carrier Aggregation	Dual Connectivity	CoMP
Benefit	Improve the throughput by utilizing more radio resource	Improve the throughput by utilizing more radio resource	Mainly use MIMO gain to improve the cell-edge throughput and increase system capacity
Frequency	Pcell and Scell operated in different frequencies	MeNB and SeNB operated in different frequencies and RATs	Operate in the same frequency
Backhaul	Ideal	Non-ideal	Ideal
Protocol Layer for traffic split	MAC	PDCCP	PHY
Multiple Bearers in a UE	Same	Different	Same



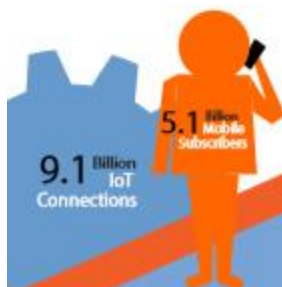
* These milestones show a 3-month shift compared to previously approved timelines

Release 15

- NR
- The 5G System – Phase 1
- Massive MTC and Internet of Things (IoT)
- Vehicle-to-Everything Communications (V2x) Phase 2
- Mission Critical (MC) interworking with legacy systems
- WLAN and unlicensed spectrum use
- Slicing – logical end-2-end networks
- API Exposure – 3rd party access to 5G services
- Service Based Architecture (SBA)
- Further LTE improvements
- Mobile Communication System for Railways (FRMCS)

Release 16

- The 5G System – Phase 2
- V2x Phase 3: Platooning, extended sensors, automated driving, remote driving
- Industrial IoT
- Ultra-Reliable and Low Latency Communication (URLLC) enhancements
- NR-based access to unlicensed spectrum
- 5G Efficiency: Interference Mitigation, SON, eMIMO, Location and positioning, Power Consumption, eDual Connectivity, Device capabilities exchange, Mobility enhancements
- Enhancements for Common API Framework for 3GPP Northbound APIs (eCAPIF)
- FRMCS Phase 2



Source: COMA

Release 17

- NR MIMO
- NR Sidelink enh.
- 52.6 - 71 GHz with existing waveform
- Dynamic Spectrum Sharing (DSS) enh.
- Industrial IoT / URLLC enh.
- **Study** - IoT over Non Terrestrial Networks (NTN)
- NR over Non Terrestrial Networks (NTN)
- NR Positioning enh.
- Low complexity NR devices
- Power saving
- NR Coverage enh.
- **Study** - NR eXtended Reality (XR)
- NB-IoT and LTE-MTC enh.
- 5G Multicast broadcast
- Multi-Radio DCCA enh.
- Multi SIM
- Integrated Access and Backhaul (IAB) enh.
- NR Sidelink relay
- RAN Slicing
- Enh. for small data
- SON / Minimization of drive tests (MDT) enh.
- NR Quality of Experience
- eNB architecture evolution, LTE C-plane / U-plane split
- Satellite components in the 5G architecture
- Non-Public Networks enh.
- Network Automation for 5G - phase 2
- Edge Computing in 5GC
- Proximity based Services in 5GS
- Network Slicing Phase 2
- Enh. V2x Services
- Advanced Interactive Services
- Access Traffic Steering, Switch and Splitting support in the 5G system architecture
- Unmanned Aerial Systems
- 5GC LoCation Services
- Multimedia Priority Service (MPS)
- 5G Wireless and Wireline Convergence
- 5G LAN-type services
- User Plane Function (UPF) enh. for control and 5G Service Based Architecture (SBA)

These are the Rel-17 headline features, prioritized during the December 2019 Plenaries (TSG#86)

Start of work: January 2020

In Rel-15 NR Specifications

- Two Frequency ranges
 - FR1: 450-6000MHz
 - FR2: 24.25-52.6GHz
- 37 NR bands
 - 3 new TDD bands FR1
 - 6 new SUL bands FR1
 - 4 new TDD bands FR2
 - 19 LTE re-farming
- 18 SUL(SA&NSA) combinations
- 71 LTE 1 band + NR 1 band EN-DC combinations, which is the basis for other EN-DC in Rel-15
 - LTE 2 Bands + NR 1 Band
 - LTE 3 Bands + NR 1 Band
 - LTE 4 Bands + NR 1 Band
 - LTE 5 Bands + NR 1 Band

Table 1: NR new bands

Band	Freq. Ranges (MHz)	Dlpx	FR
n1	1920-1980/2110-2170	FDD	FR1
n2	1850-1910/1930-1990	FDD	FR1
n3	1710-1785/1805-1880	FDD	FR1
n5	824-849/869-894	FDD	FR1
n7	2500-2570/2620-2690	FDD	FR1
n8	880-915/925-960	FDD	FR1
n12	699-716/729-746	FDD	FR1
n20	832-862/791-821	FDD	FR1
n25	1850-1915/1930-1995	FDD	FR1
n28	703-748/758-803	FDD	FR1
n34	2010-2025/2010-2025	TDD	FR1
n38	2570-2620/2570-2620	TDD	FR1
n39	1880-1920/1880-1920	TDD	FR1
n40	2300-2400/2300-2400	TDD	FR1
n41	2496-2690/2496-2690	TDD	FR1
n51	1427-1432/1427-1432	TDD	FR1
n66	1710-1780/2110-2200	FDD	FR1
n70	1695-1710/1995-2020	FDD	FR1
n71	663-698/617-652	FDD	FR1
n75	NA/1432-1517	SDL	FR1
n76	NA/1427-1432	SDL	FR1
n77	3300-4200/3300-4200	TDD	FR1
n78	3300-3800/3300-3800	TDD	FR1
n79	4400-5000/4400-5000	TDD	FR1
n80	1710-1785/NA	SUL	FR1
n81	880-915/NA	SUL	FR1
n82	832-862/NA	SUL	FR1
n83	703-748/NA	SUL	FR1
n84	1920-1980/NA	SUL	FR1
n86	1710-1780/NA	SUL	FR1
n257	26500-29500	TDD	FR2
n258	24250-27500	TDD	FR2
n260	37000-40000	TDD	FR2
N261	27500-28350	TDD	FR2

Table 2: Summary of NR new bands

Rel-15 NR bands			Frequency range	Duplex mode
sub-6GHz	LTE refarming bands	n5, n8, n12, n20, n28, n71	<1GHz	FDD
		n1, n2, n3, n7, n25, n51, n66, n70	1.4GHz~2.6GHz	FDD
		n34, n38, n39, n40, n41		TDD
	C-band	n77	3.3-4.2GHz	TDD
		n78	3.3-3.8GHz	TDD
		n79	4.4-5.0GHz	TDD
	SUL bands	n80	1710 MHz – 1785 MHz	SUL
		n81	880 MHz – 915 MHz	SUL
		n82	832 MHz – 862 MHz	SUL
		n83	703 MHz – 748 MHz	SUL
		n84	1920 MHz – 1980 MHz	SUL
		n86	1710 MHz – 1780MHz	SUL
mmWave	28GHz	n257	26.5-29.5GHz	TDD
	26GHz	n261	27.5-28.35GHz	TDD
	39GHz	n258	24.25-27.5GHz	TDD
		n260	37-40GHz	TDD

EN-DC band combinations (LTE 1 band + NR 1 band with C-band and mmWave)

LTE bands	NR bands
Band 1, 3, 8, 11, 18, 19, 20, 21, 26, 28, 40, 41, 42	3.3-4.2GHz
Band 1, 2, 3, 5, 7, 8, 11, 18, 19, 20, 21, 26, 28, 38, 39, 41, 42, 66	3.3-3.8GHz
Band 1, 3, 8, 11, 18, 19, 21, 26, 28, 39, 41, 42	4.4-5.0GHz
Band 1, 3, 5, 7, 8, 11, 18, 19, 21, 26, 28, 41, 42, 66	26.5-29.5GHz
Band 3, 7, 8, 20, 28, 39, 41	24.25-27.5G
Band 2, 5, 12, 30, 66	37-40GHz
Band 5, 66	27.5-28.35GHz

FR1 frequency bands (R15/16)

 TDD

 FDD

 Supplemental Uplink (SUL)

 Supplemental Downlink (SDL)

NR operating band	Uplink	Downlink	Duplex Mode
n1	1920 MHz – 1980 MHz	2110 MHz – 2170 MHz	FDD
n2	1850 MHz – 1910 MHz	1930 MHz – 1990 MHz	FDD
n3	1710 MHz – 1785 MHz	1805 MHz – 1880 MHz	FDD
n5	824 MHz – 849 MHz	869 MHz – 894 MHz	FDD
n7	2500 MHz – 2570 MHz	2620 MHz – 2690 MHz	FDD
n8	880 MHz – 915 MHz	925 MHz – 960 MHz	FDD
n12	699 MHz – 716 MHz	729 MHz – 746 MHz	FDD
n14	788 MHz – 798 MHz	758 MHz – 768 MHz	FDD
n18	815 MHz – 830 MHz	860 MHz – 875 MHz	FDD
n20	832 MHz – 862 MHz	791 MHz – 821 MHz	FDD
n25	1850 MHz – 1915 MHz	1930 MHz – 1995 MHz	FDD
n28	703 MHz – 748 MHz	758 MHz – 803 MHz	FDD
n29	N/A	717 MHz – 728 MHz	SDL
n30	2305 MHz – 2315 MHz	2350 MHz – 2360 MHz	FDD
n34	2010 MHz – 2025 MHz	2010 MHz – 2025 MHz	TDD
n38	2570 MHz – 2620 MHz	2570 MHz – 2620 MHz	TDD
n39	1880 MHz – 1920 MHz	1880 MHz – 1920 MHz	TDD
n40	2300 MHz – 2400 MHz	2300 MHz – 2400 MHz	TDD
n41	2496 MHz – 2690 MHz	2496 MHz – 2690 MHz	TDD
n48	3550 MHz – 3700 MHz	3550 MHz – 3700 MHz	TDD
n50	1432 MHz – 1517 MHz	1432 MHz – 1517 MHz	TDD ¹
n51	1427 MHz – 1432 MHz	1427 MHz – 1432 MHz	TDD

NR operating band	Uplink	Downlink	Duplex Mode
n65	1920 MHz – 2010 MHz	2110 MHz – 2200 MHz	FDD ⁴
n66	1710 MHz – 1780 MHz	2110 MHz – 2200 MHz	FDD
n70	1695 MHz – 1710 MHz	1995 MHz – 2020 MHz	FDD
n71	663 MHz – 698 MHz	617 MHz – 652 MHz	FDD
n74	1427 MHz – 1470 MHz	1475 MHz – 1518 MHz	FDD
n75	N/A	1432 MHz – 1517 MHz	SDL
n76	N/A	1427 MHz – 1432 MHz	SDL
n77	3300 MHz – 4200 MHz	3300 MHz – 4200 MHz	TDD
n78	3300 MHz – 3800 MHz	3300 MHz – 3800 MHz	TDD
n79	4400 MHz – 5000 MHz	4400 MHz – 5000 MHz	TDD
n80	1710 MHz – 1785 MHz	N/A	SUL
n81	880 MHz – 915 MHz	N/A	SUL
n82	832 MHz – 862 MHz	N/A	SUL
n83	703 MHz – 748 MHz	N/A	SUL
n84	1920 MHz – 1980 MHz	N/A	SUL
n86	1710 MHz – 1780 MHz	N/A	SUL
n89	824 MHz – 849 MHz	N/A	SUL
[n90]	2496 MHz – 2690 MHz	2496 MHz – 2690 MHz	TDD ⁵
n91	832 MHz – 862 MHz	1427 MHz – 1432 MHz	FDD
n92	832 MHz – 862 MHz	1432 MHz – 1517 MHz	FDD
n93	880 MHz – 915 MHz	1427 MHz – 1432 MHz	FDD
n94	880 MHz – 915 MHz	1432 MHz – 1517 MHz	FDD
n95	2010 MHz – 2025 MHz	N/A	SUL

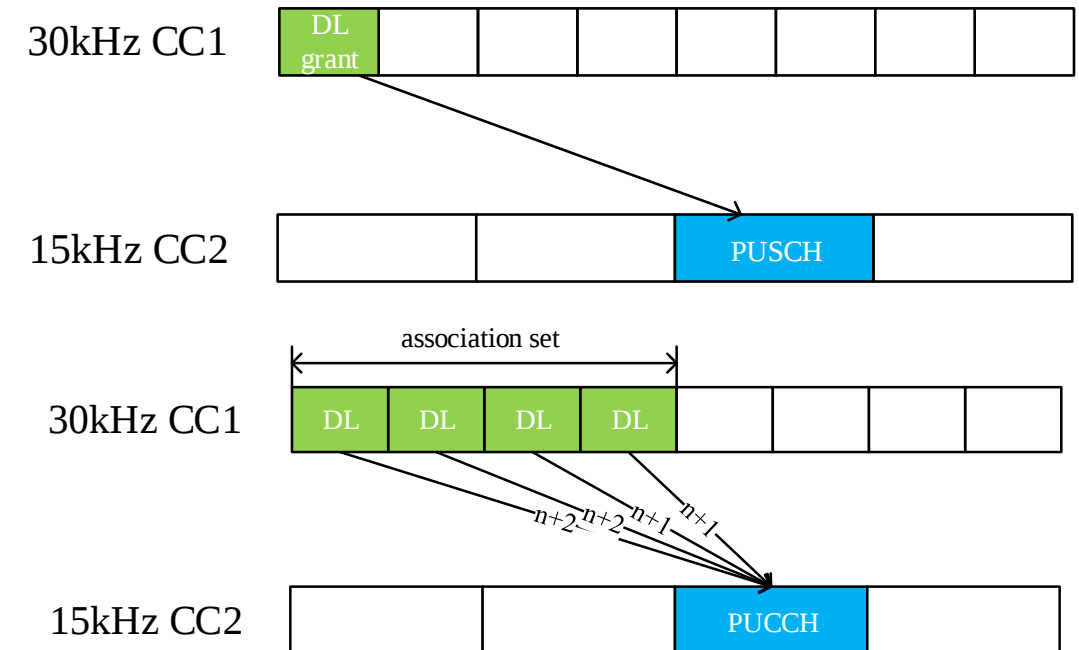
3GPP is currently discussing the introduction of two bands in this region for NR-U n96: 5925 -6425 MHz and n97: 5925 - 7125 MHz

Source: [3GPP TS 38.101-1](#)

	NR Operating Band	Uplink (UL) operating band BS receive UE transmit			Downlink (DL) operating band BS transmit UE receive			Duplex Mode	
		$F_{UL_low} - F_{UL_high}$			$F_{DL_low} - F_{DL_high}$				
	n257	26500 MHz	–	29500 MHz	26500 MHz	–	29500 MHz	TDD	
	n258	24250 MHz	–	27500 MHz	24250 MHz	–	27500 MHz	TDD	
	n260	37000 MHz	–	40000 MHz	37000 MHz	–	40000 MHz	TDD	
	n261	27500 MHz	-	28350 MHz	27500 MHz	-	28350 MHz	TDD	

47GHz band coming 37GHz & 39GHz bands
More relevant now

- Deployment scenarios for NR-NR CA
 - Same as LTE CA scenarios 1 to 4
 - Maximum 16 CCs for CA from RAN1 perspective
- Scheduling for NR-NR CA
 - Support both self-carrier and cross-carrier scheduling
 - Support CCs with the same and different numerology
- HARQ for NR-NR CA
 - One PUCCH in one PUCCH group
 - Joint UCI feedback for CCs with the same and different numerology
- NR-NR DC not supported by the June 2018 version



- **Regulatory (Mandatory)**

- CE, FCC, CTA, NCC, JPA, KCC, etc.
- Test Scope: Basic RF, EMC (EMI + EMS), Safety, SAR



- **Industrial Certification (Voluntary)**

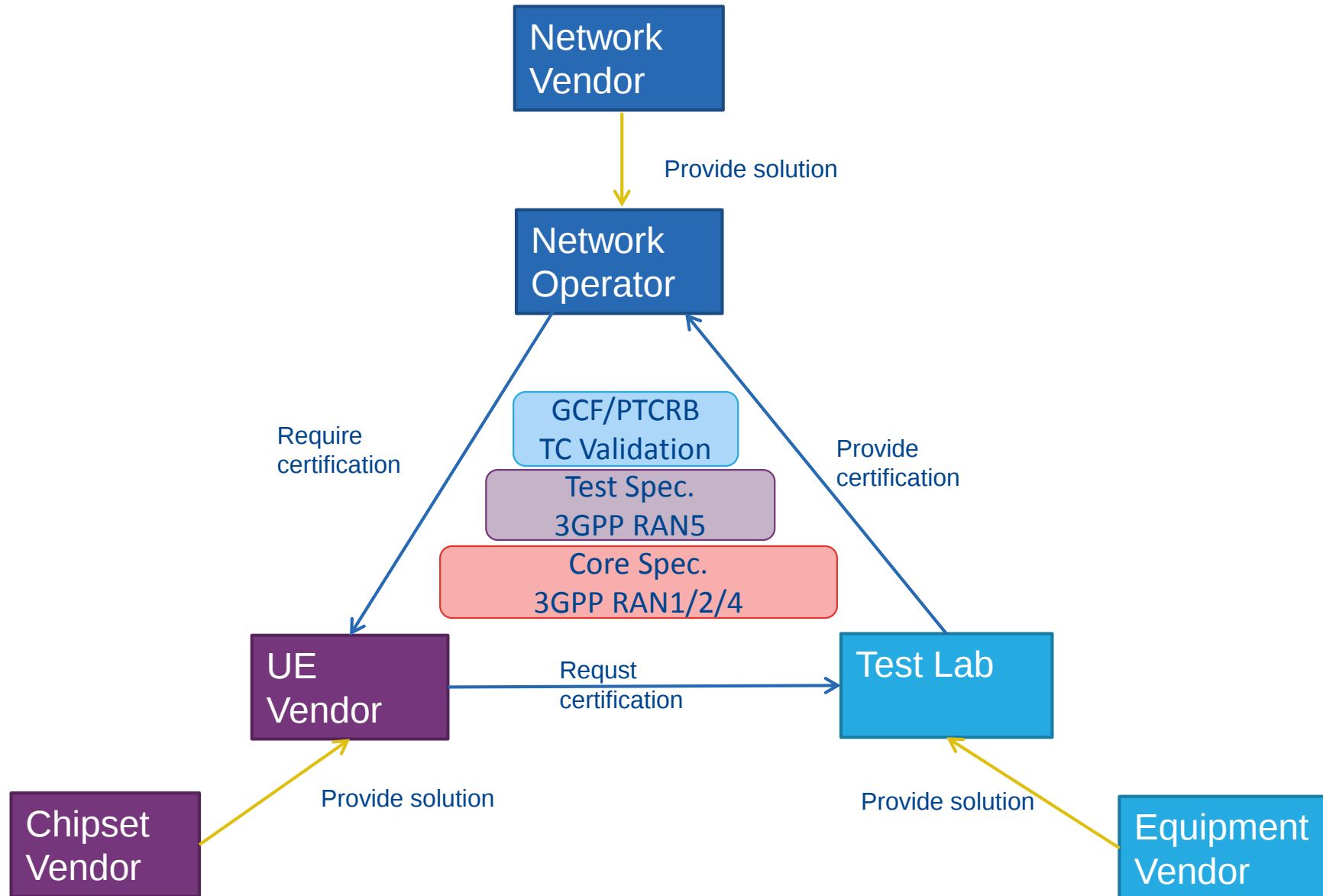
- GCF (3GPP), PTCRB (3GPP)
- Test Scope: Conformance, OTA, AE-IOP, Field Trial
- Conformance: TRx, Perf., RRM, Protocol, SIM, Acoustic, A-GPS, AE, etc.



- **Carrier Approval**

- AT&T, Verizon, T-Mobile, Sprint, Vodafone, Orange
- Test Scope: Lab test, IOT





No.	Umbrella WI	Sub-WI Name	No.	Umbrella WI	Sub-WI Name
1	WI-500 5G RF:	WI-500_NR-nx	4	WI-503: 5G AS Protocol Conformance	WI-503_NR-nx
		WI-500_EUTRA-5GC-x			WI-503_EUTRA-5GC-x
		WI-500_EN-DC_x_ny			WI-503_EN-DC_x_ny
		WI-500_NGEN-DC_x_ny			WI-503_NGEN-DC_x_ny
2	WI-501: 5G RRM	WI-501_NR-nx	5	WI-504: 5G NAS Protocol Conformance	WI-504_NR-nx
		WI-501_EUTRA-5GC-x			WI-504_EUTRA-5GC-x
		WI-501_EN-DC_x_ny			WI-504_EN-DC_x_ny
		WI-501_NGEN-DC_x_ny			WI-504_NGEN-DC_x_ny
3	WI-502: 5G De-Mod/CSI	WI-502_NR-nx	6	WI-505 IMS Protocol Conformance	
		WI-502_EUTRA-5GC-x	7	WI-506 5G Positioning Conformance	
		WI-502_EN-DC_x_ny			
		WI-502_NGEN-DC_x_ny			

NR: option 2
 EUTRA-5GC: option 5
 EN-DC: option 3
 NE-DC: option 4
 NGEN-DC: option 7

No.	Technology Area	RFT Title	RFT #
1	5G RF	5G RF NR	RFT 501-1
		5G RF EUTRA-5GC	RFT 501-2
		5G RF EN-DC	RFT 501-3
		5G RF NGEN-DC	RFT 501-4
2	5G RRM	5G RRM NR	RFT 502-1
		5G RRM EUTRA-5GC	RFT 502-2
		5G RRM EN-DC	RFT 502-3
		5G RRM NGEN-DC	RFT 502-4
3	5G De-Mod/CSI	5G De-Mod/CSI NR	RFT 503-1
		5G De-Mod/CSI EUTRA-5GC	RFT 503-2
		5G De-Mod/CSI EN-DC	RFT 503-3
		5G De-Mod/CSI NGEN-DC	RFT 503-4
4	5G RAN Protocol	5G RAN Protocol NR	RFT 504-1
		5G RAN Protocol EUTRA-5GC	RFT 504-2
		5G RAN Protocol EN-DC	RFT 504-3
		5G RAN Protocol NGEN-DC	RFT 504-4
5	5G NAS Protocol	5G NAS Protocol NR	RFT 505-1
		5G NAS Protocol EUTRA-5GC	RFT 505-2
		5G NAS Protocol EN-DC	RFT 505-3
		5G NAS Protocol NGEN-DC	RFT 505-4
6	5G IMS Protocol	5G IMS Protocol	RFT 506-1
7	5G Positioning	5G Positioning	RFT 507-1

- TS 36.508 – E-UTRA Common Test Environment
- TS 38.508-1 – 5GS Common Test Environment
- TS 38.508-2 – Common ICS proforma
- TS 38.509 – UE test functions
- TS 38.521-1 – Transmitter & Receiver test cases FR1
- TS 38.521-2 – Transmitter & Receiver test cases FR2
- TS 38.521-3 – Transmitter & Receiver test cases interworking LTE, FR1, FR2
- TS 38.521-4 – Radio transmission and reception; Performance
- TS 38.522 – Applicability RF/RRM test cases
- TS 38.523-1 – Protocol test cases
- TS 38.523-2 – Applicability protocol test cases
- TS 38.523-3 – 5GS ATS test suite / test model
- TS 38.533 – Radio Resource Management (RRM)
- TR 38.903 – Derivation of test tolerances and measurement uncertainty
- TR 38.905 – Derivation of test points for Rx and Tx test cases

Sub-6GHz SA	5G NR
Normal + Extreme	Normal + Extreme
Freq. Channel (L/M/H)	L/M/H Channel
Bandwidth	Lowest, Mid, Highest
SCS (H/L)	Lowest, Highest
Modulation	DFT-s-OFDM PI/2 BPSK, DFT-s-OFDM QPSK
RB Allocation	Multiple types

Sub-6GHz NSA	LTE (Anchor)	5G NR
Normal + Extreme	Normal + Extreme	Normal + Extreme
Freq. Channel (L/M/H)	Mid Channel	L/M/H Channel
Bandwidth	5MHz	Lowest, Mid, Highest
SCS (H/L)	N/A	Lowest, Highest
Modulation	QPSK	DFT-s-OFDM PI/2 BPSK, DFT-s-OFDM QPSK/16QAM/64QAM/ 256QAM, CP-OFDM
RB Allocation	Maximum	Multiple types

SA (Option 2)

n1
n3
n5
n7
n41
n77
n78

NE-DC (Option 4)

n41-FDD3
n41-TDD34
n41-TDD39
n41-TDD40
n41-TDD41
n79-FDD3
n79-TDD34
n79-TDD39
n79-TDD40

EN-DC (Option 3)

EN-DC_(n)41AA
EN-DC_1A_n77A
EN-DC_1A_n78A
EN-DC_1A_n79A
EN-DC_1A_n257A
EN-DC_2A_n5A
EN-DC_2A_n66A
EN-DC_2A_n260A
EN-DC_2A_n261A
EN-DC_3A_n28A
EN-DC_3A_n41A
EN-DC_3A_n77A
EN-DC_3A_n78A
EN-DC_3A_n79A
EN-DC_3A_n257A
EN-DC_4A_n260A
EN-DC_4A_n261A
EN-DC_5A_n2A
EN-DC_5A_n66A
EN-DC_5A_n78A
EN-DC_5A_n260A
EN-DC_5A_n261A
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EN-DC_8A_n78A
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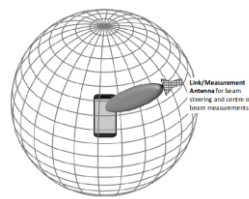
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EN-DC_18A_n79A
EN-DC_18A_n257A
EN-DC_19A_n77A
EN-DC_19A_n78A
EN-DC_19A_n79A
EN-DC_19A_n257A
EN-DC_20A_n78A
EN-DC_21A_n77A
EN-DC_21A_n78A
EN-DC_21A_n79A
EN-DC_21A_n257A
EN-DC_28A_n78A
EN-DC_39A_n41A
EN-DC_39A_n78A
EN-DC_39A_n79A
EN-DC_40A_n41A
EN-DC_41A_n41A
EN-DC_41A_n78A
EN-DC_41A_n79A
EN-DC_66A_n2A
EN-DC_66A_n5A
EN-DC_66A_n260A
EN-DC_66A_n261A

3GPP TRx Test Rule for SA/NSA and EN-DC combinations

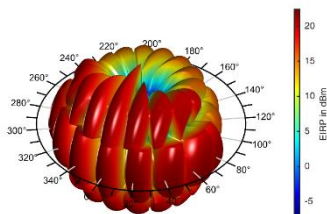
Spec.	Test Case	TC Description	Band	Spec.	Test Case	TC Description	Band
38.521-1	6.2.1	UE maximum output power	n41	38.521-3	6.2B.1.3	UE Maximum Output Power for Inter-Band EN-DC within FR1	3A_n41
38.521-1	6.2.2	UE maximum output power reduction	n41	38.521-3	6.2B.2.3	UE Maximum Output power reduction for inter-band EN-DC within FR1	3A_n41
38.521-1	6.2.3	UE additional maximum output power reduction	n41	38.521-3	6.2B.3.3	UE additional Maximum Output power reduction for inter-band EN-DC within FR1	3A_n41
38.521-1	6.2.4	Configured transmitted power	n41				
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38.521-1	6.3.3.4	PRACH time mask	n41	38.521-3	6.3B.4.3	PRACH Time Mask for inter-band EN-DC within FR1	3A_n41
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38.521-1	6.4.1	Frequency error	n41	38.521-3	6.4B.1.3	Frequency Error for inter-band EN-DC within FR1	3A_n41
38.521-1	6.4.2.1	Error Vector Magnitude	n41	38.521-3	6.4B.2.3.1	Error Vector Magnitude for inter-band EN-DC within FR1	3A_n41
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38.521-1	6.5.2.3	Additional spectrum emission mask	n41	38.521-3	6.5B.2.3.2	Additional Spectrum emissions mask for Inter-band EN-DC within FR1	3A_n41
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38.521-1	6.5.4	Transmit intermodulation	n41	38.521-3	6.5B.5.3	Transmit Intermodulation for Inter-band EN-DC within FR1	3A_n41

FR2 Core Requirements for RF (TS 38.101-2)

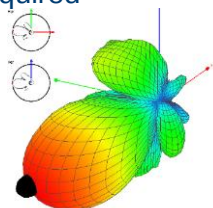
Test Case	Spatial requirement
Max Output Power	EIRP on beam peak direction
MPR and A-MPR	
Configured Tx Power	
Min Output Power	
ON/OFF time mask	
Power Control	Beam peak direction
Freq Error	
EVM	
Carrier leakage	
In-band emissions	
EVM equalizer spectrum flatness	
Occupied BW	



3D positioning is only required to accurately find the main beam



3D pattern (or scan) is required



Reference Sensitivity	EIS on beam peak direction
Max Input level	beam peak direction
Adjacent Channel Selectivity (ACS)	EIS + Blocker on beam peak direction
In-band blocking	beam peak direction

Test Case	Spatial requirement
Max Output Power	Spherical Coverage TRP (using Tx beam peak direction)
Tx OFF power	TRP (using Tx beam peak direction)
Spectrum Emission Mask	
ACLR	
Tx Spurious emissions	Spherical Coverage
Beam correspondence tolerance	

Reference Sensitivity	Spherical Coverage
Rx Spurious Emissions	TRP (using Rx beam peak direction)

TC	Test	Metric
xxx	Max Power	EIRP CDF
6.2.1	Max Tx Power	TRP/EIRP @BP
6.3.1	Min Tx Power	EIRP @BP
6.3.2	Off Power	TRP @BP
6.3.3	On/Off Time Mask	Beam Peak
6.4.1	Frequency Error	Beam Peak
6.4.2.1	Carrier Leakage	Beam Peak
6.4.2.2	EVM	Beam Peak
6.4.2.4	Spectral Flatness	Beam Peak
6.5.3.1	OBW	Beam Peak
6.5.2	SEM	TRP @BP
6.5.3.2.4	ACLR	TRP @BP
6.5.3.1	TX Spurious Emissions	TRP @BP
xx	RSRP Scan	EIS CDF
7.3	Ref. Sensitivity, EIS	Beam Peak
7.4	Max Input Level	Beam Peak
7.5	ACS	Beam Peak
7.6.1	In-Band Blocking	Beam Peak
7.9	Rx Spur. Emissions	TRP @BP



TIM Italy

- Option 3
- Sub 6
- n78
- Ericsson
- Rome

Deutsche Telekom

- Option 3
- Sub 6
- n78
- Ericsson & Huawei
- Bonn/Berlin & Darmstadt

Vodafone Italy

- Option 3
- Sub 6
- n78
- Nokia & Huawei
- Milano & Rome

Vodafone Spain

- Option 3
- Sub 6
- n78
- Ericsson & Huawei
- Coruña & Madrid

Sprint US

- Option 3
- Sub 6
- n41
- Nokia, Ericsson & Huawei
- Washington, DC, Kansas City, Chicago

Country	Operator	5G NR Band
Australia	Optus	n40, n78
	Telstra	n78, n258
New Zealand	Spark	n7
	Vodafone	n78

Country	Operator	5G NR Band
China	China Mobile	n41, n79
	China Telecom	n78
	China Unicom	n78
Hong Kong	3	n78
	China Mobile	n78, n79
	HKT	n78, n79
Japan	KDDI	n77, n78, n257
	NTT Docomo	n78, n79, n257
	Softbank	n77, n257
South Korea	LG U+	n78, n257
	KT	n78, n257
	SK Telecom	n78, n257

5G NR Network List- Europe

Country	Operator	5G NR Band
UK	3	n78
	EE	n78
	O2	n78
	Vodafone	n78
Ireland	Eir	n78
	Vodafone	n78
Denmark	TDC	n78
Norway	Telenor	n78, n258
	Telia	n28
Finland	DNA	n78
	Elisa	n78
	Telia	n78
Spain	Telefonica	n78
	Vodafone	n78

Pre-commercial

New

Country	Operator	5G NR Band
Austria	A1	n78
	Drei	n78
	Magenta Telekom	n78
Germany	Telekom	n1, n78
	Vodafone	n3, n28, n78
Netherland	T-Mobile	n28
	Vodafone	n3
Italy	Fastweb	n258
	TIM	n78, n258
	Vodafone	n78
Switzerland	Salt	n75, n78
	Sunrise	n28, n78, n80
	Swisscom	n1, n78

Country	Operator	5G NR Band
Canada	Rogers	n38
	Telus	n66
	Bell	n66
USA	AT&T	n5, n260
	Sprint	n41
	T-Mobile	n2, n66, n71, n260, n261
	U.S.Cellular	n71
	Verizon	n261*

**non-3GPP standard SA*

Operator Merge,

Pre-commercial



UXM System



**FR1 + FR2
(2 sets)**

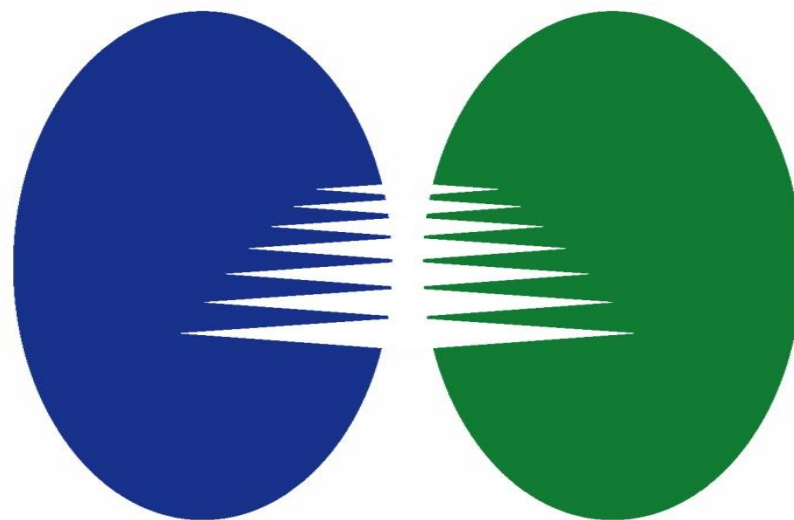


UXM E7515B



FR1 + FR2

誠摯感謝、敬請指導



SPORTON LAB.

