



Test specification and certification requirement for 5G user equipment

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Course Objectives:

- UE Conformance test aspects - 5G system with NR and LTE
- Global Certification requirements
- Research progress of 5G chipset and UE
- Conformance Test solutions



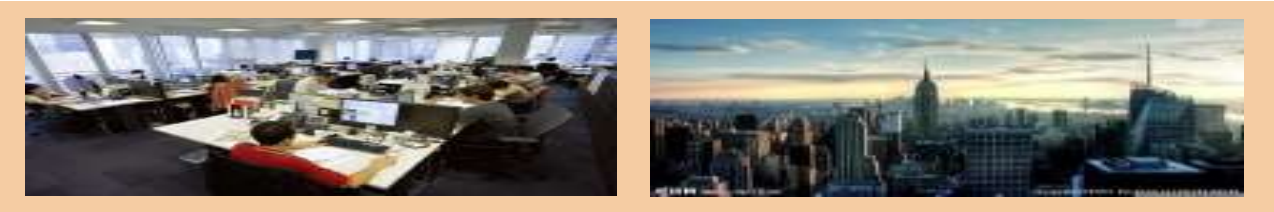
Agenda

- **UE Conformance test aspects - 5G system with NR and LTE**
 - *5G typical scenarios*
 - *5G RAN architecture*
 - *5G NR Roadmap*
 - *Technical specification*
 - *UE conformance specification*
 - *5G NR testing challenges*
- Global Certification requirements
- Research progress of 5G chipset and UE
- Conformance Test solutions

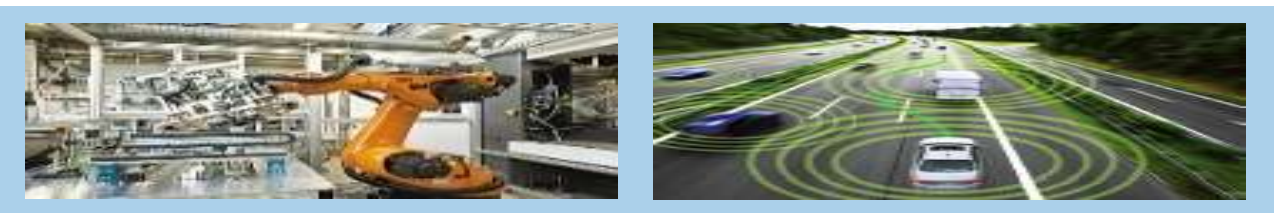


5G typical scenarios

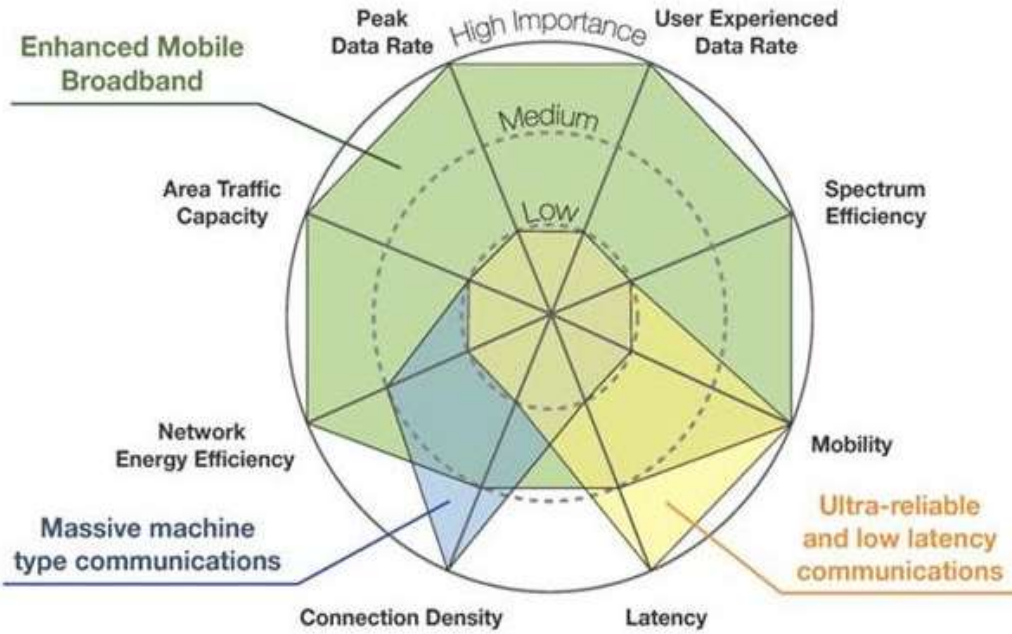
eMBB (Enhanced Mobile Broadband)



URLLC (Ultra-reliable and Low Latency Communications)



mMTC (Massive Machine Type Communications)



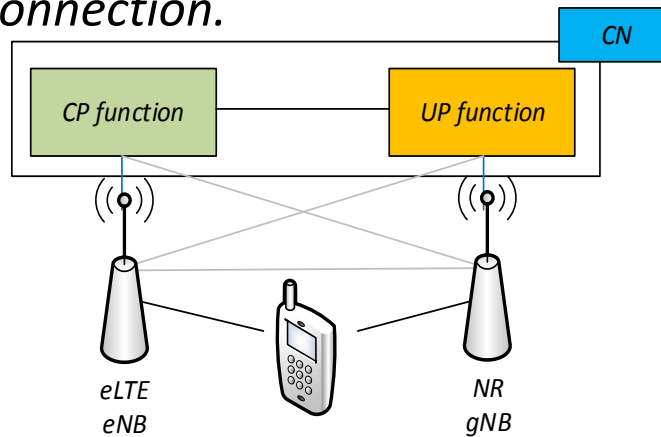
Performance requirements



5G RAN architecture

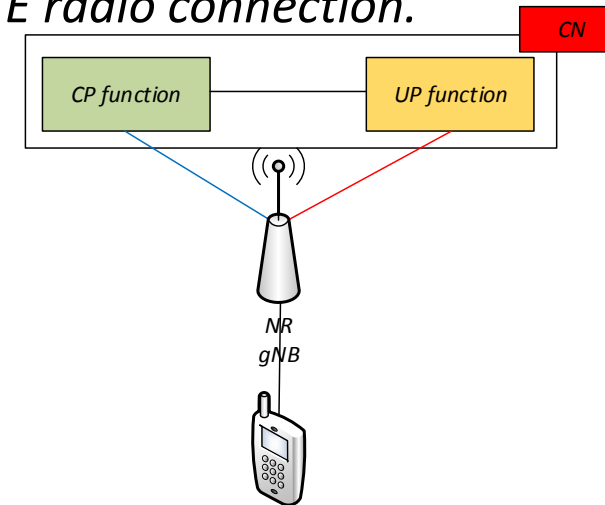
NSA

- 5G UE requires an anchor LTE radio connection with an eNB.
- UE adds a secondary 5G NR connection.



SA

- 5G UE operates connected with an anchor gNB without a need for an LTE radio connection.



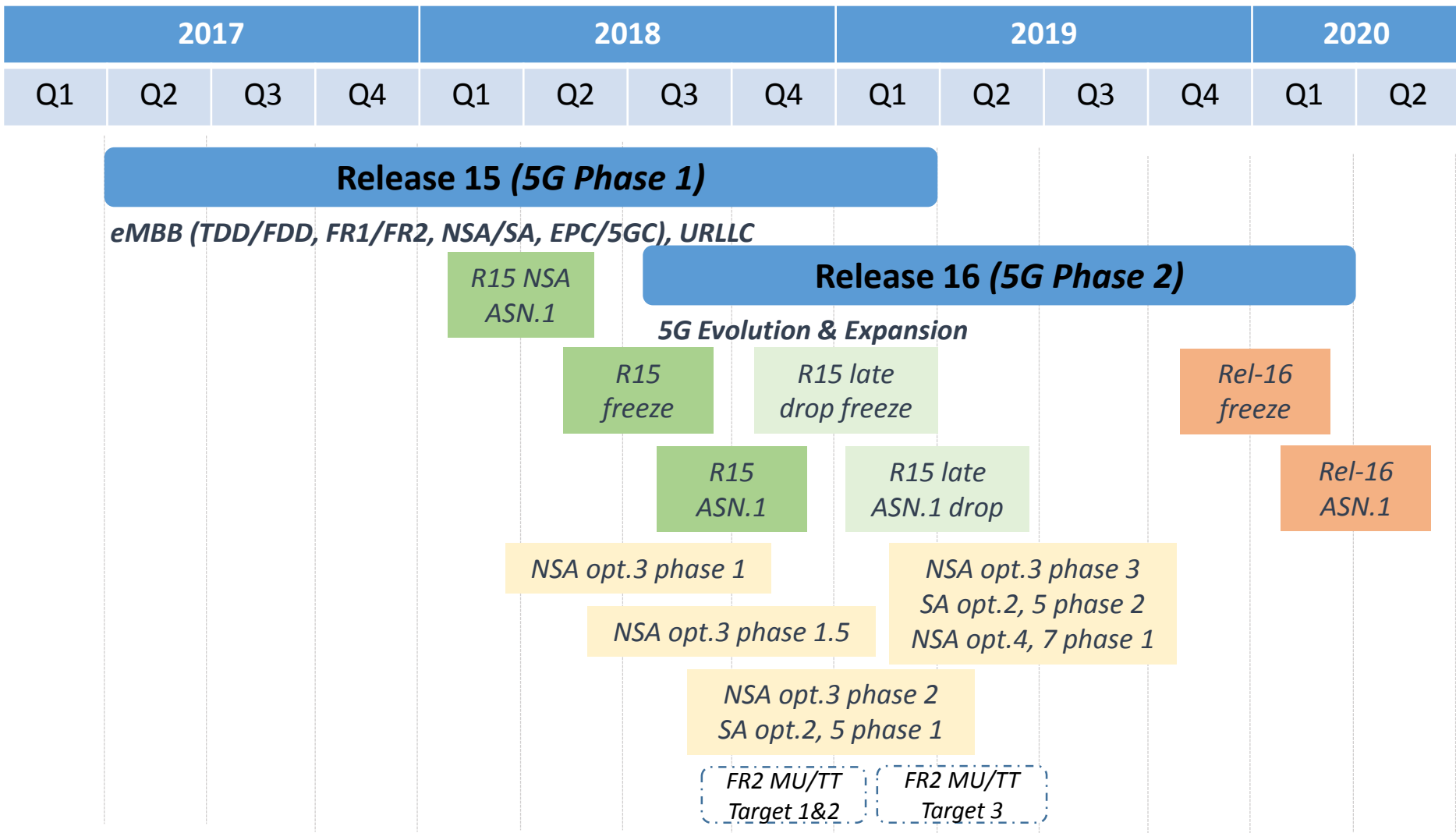
Option	SA/NSA	Structures (= CP+UP, -UP)
Option 2	SA	5G-CN = NR
Option 3/3a/3x	NSA	EPC = LTE - NR
Option 4/4a	NSA	5G-CN = NR - LTE
Option 5	SA	5G-CN = LTE
Option 7/7a/7x	NSA	5G-CN = LTE - NR

Vocabulary:

- **CP:** Control-Plane
- **UP:** User-Plane
- **CN:** Core Network
 - **NGC:** 5G Core
 - **EPC:** LTE Core
- **BS:** Base Station
 - **eNB:** LTE BS
 - **gNB:** 5G BS



5G NR roadmap

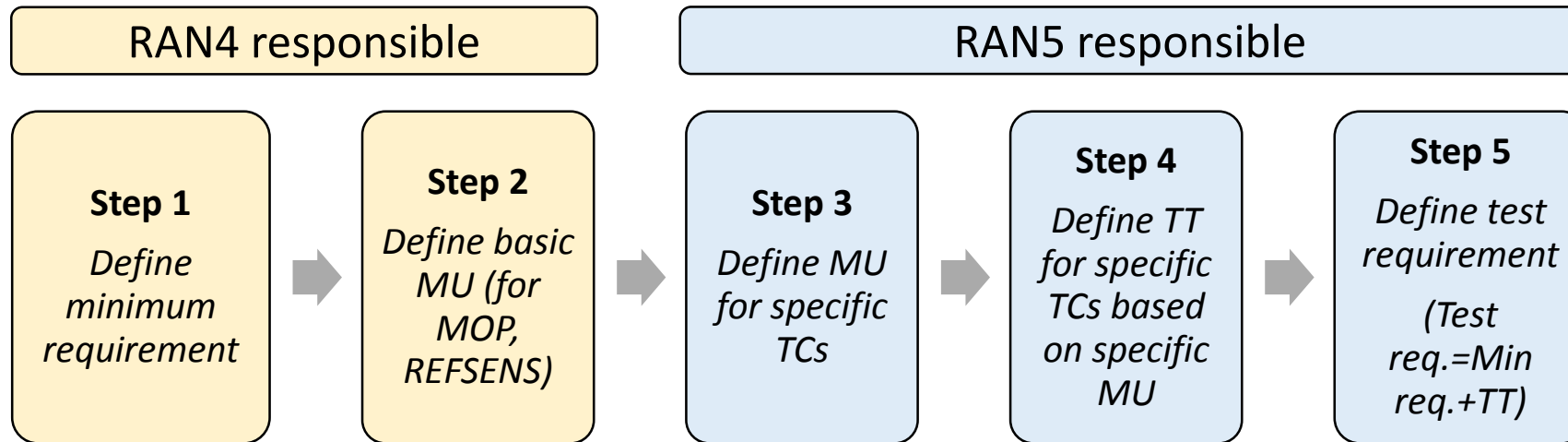


RAN

RAN5



5G NR roadmap - MU and TT for RF tests



Priority	Test case
1st Priority	Maximum output power
	REFSENS
2nd Priority	Transmit OFF power
	Frequency Error
	Occupied bandwidth
	Spectrum emission mask
	Adjacent Channel Leakage Ratio
	General spurious emissions
	Spurious emissions for UE co-existence
3rd Priority	Receiver Spurious emissions
	Other TCs



5G NR roadmap - NSA option 3 delivery phases and targets

NSA option 3 phase 1 content

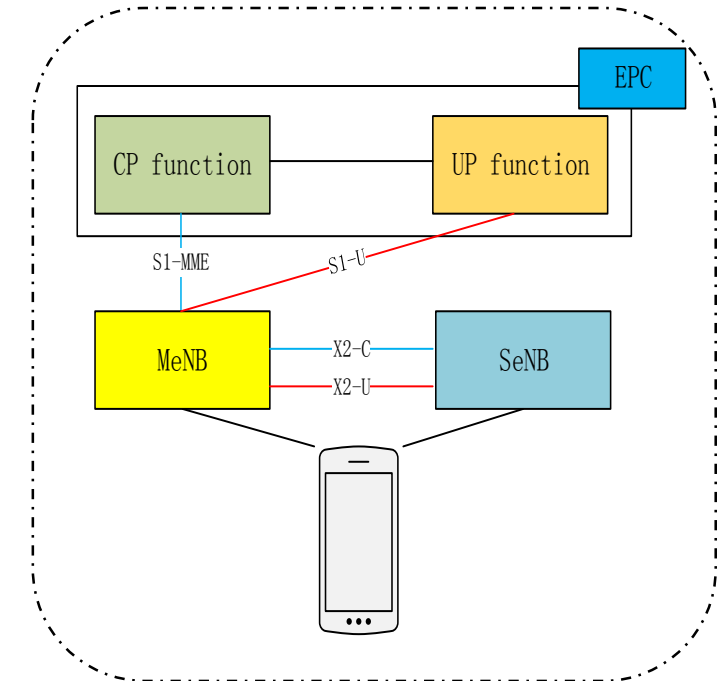
- Protocol
 - TS 38.523-x
 - 54 NR Layer 2 test cases: 23 MAC, 17 RLC and 14 PDCP
 - 12 RRC test cases for single NR cell scenarios
 - 3 NAS EPC test cases

➔ **TARGET MAY-18 (Completed!)**
EN-DC golden test cases shall be selected among these test case

NSA option 3 phase 1.5 content

- RF
 - TS 38.521-3, TS 38.522, TS 38.521-1, TR 38.903, TR 38.905
 - Test definition, MU for all LTE+NR FR1 Rx and Tx test cases
 - Progress on Test definition for all LTE+NR FR2 Rx and Tx test cases

➔ **TARGET AUG-18**



Option 3: E-UTRA-NR DC via EPC where the E-UTRA is the master

Frequency range designation	Corresponding frequency range	
FR1	450 MHz – 6000 MHz	Sub-6GHZ
FR2	24250 MHz – 52600 MHz	mmWave



5G NR roadmap - NSA option 3 delivery phases and targets

NSA option 3 phase 2 content

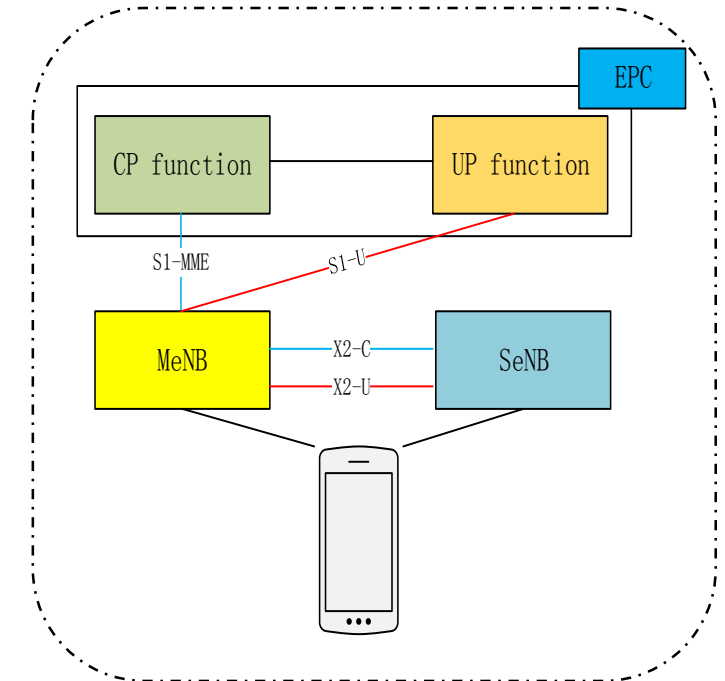
TARGET NOV-18

- RF-TS 38.521-3, TS 38.522, TS 38.521-1, TS 38.521-2, TR 38.903, TR 38.905
 - *FR1: Rx and Tx test cases not completed in NSA Opt.3 Phase 1, FR2 RF MU/TT Target 1 and Target 2 test cases*
- Protocol-TS 38.523-x, TS 37.571-x
 - *Enhanced test coverage for Layer 2, RRC test coverage, L1 configurations, etc (32 test case: 4MAC, 28RRC)*

NSA option 3 phase 3 content

TARGET MAY-19

- RF&RRM- TS 38.521-3, TS 38.522, TS 38.521-1, TS 38.521-2 TS 38.521-4, TS 38.533, TR 38.903, TR 38.905
 - *TT part for RF MU/TT Target 3 test cases , Demod/CSI reporting , RRM*
- Protocol- TS 38.523-x, TS 34.229-x, TS 37.571-x:
 - *Remaining test cases not completed in NSA Opt.3 Phase 2*



Option 3: E-UTRA-NR DC via EPC where the E-UTRA is the master



5G NR roadmap - SA option 5 delivery phases and targets

SA option 5 Phase 1 content

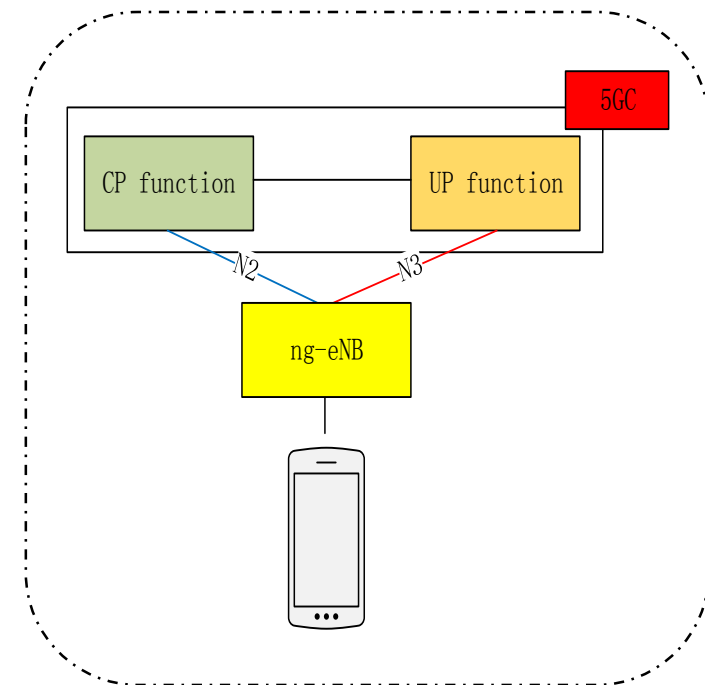
→ TARGET NOV-18

- Protocol
 - TS 38.523-x
 - Adoption legacy E-UTRA test cases for 5GC
 - New AS test cases for RRC connected to 5GC
 - Basic NAS 5GC test cases

SA option 5 Phase 2 content

→ TARGET MAY-19

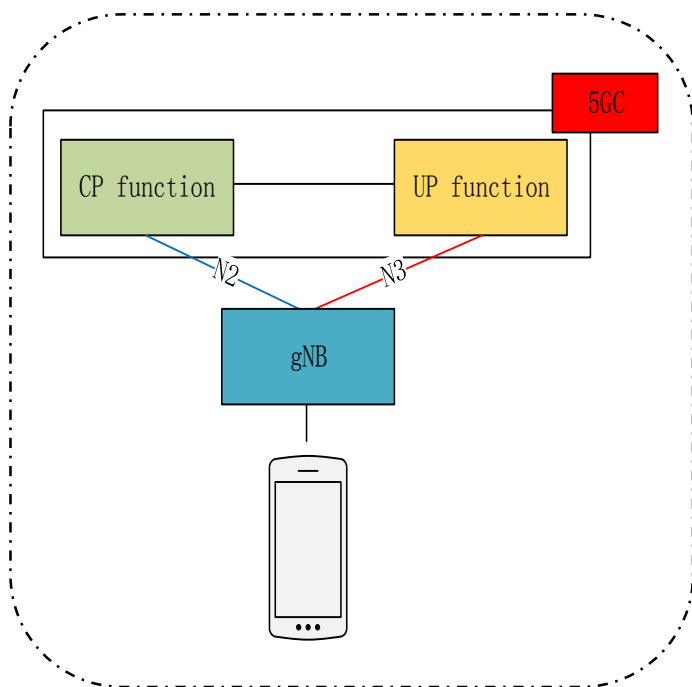
- Protocol
 - TS 38.523-x, TS 34.229-x, TS 37.571-x
 - Enhanced test coverage for SA Opt.5



Option 5: Standalone LTE, 5GC connected



5G NR roadmap - SA option 2 delivery phases and targets



Option 2: Standalone NR, 5GC connected

SA option 2 phase 1 content



TARGET NOV-18

- RF - TS 38.521-1, TS 38.521-2, TR 38.903, TR 38.905
 - *all FR1 test cases, FR2 RF MU/TT Target 1 and Target 2 test cases*
- Protocol- TS 38.523-x
 - *Basic NR SA Layer 2, basic NAS 5GC test cases*

SA option 2 phase 2 content



TARGET MAY-19

- RF&RRM - TS 38.521-1, TS 38.521-2, TS 38.521-3, TS 38.521-4, TS 38.533, TR 38.903, TR 38.905
 - *FR2 Rx and Tx RF MU/TT target 3 test cases, Demod/CSI reporting, RRM*
- Protocol - TS 38.523-x, TS 34.229-x, TS 37.571-x
 - *Enhanced test coverage for NR SA Layer 2, SA NR positioning test cases, IMS*



Technical specification - 5G NR RAN4 to RAN5

RF/RRM specs mapping

RAN4 Specs	Comments	RAN5 Specs	Comments
38.101-1	<i>Establish the minimum RF characteristics and minimum performance requirements for NR User Equipment (UE) operating on frequency Range 1.</i>	38.521-1	<i>Radio transmission and reception; Part 1: Range 1 Standalone</i>
38.101-2	<i>Establish the minimum RF characteristics and minimum performance requirements for NR User Equipment (UE) operating on frequency Range 2.</i>	38.521-2	<i>Radio transmission and reception; Part 2: Range 2 Standalone</i>
38.101-3	<i>Establish the minimum RF characteristics and minimum performance requirements for NR User Equipment (UE) Interworking operation with other radios. (Full NR f1 +NR f2 and NR+LTE RF spec)</i>	38.521-3	<i>Radio transmission and reception; Part 3: Range 1 and Range 2 Interworking operation with other radios</i>
38.101-4	<i>TS for NR UE performance requirements. Different chapters for: NR range 1, NR range 2, NR interworking</i>	38.521-4	<i>Radio transmission and reception; Part 4: Performance</i>
38.133	<i>Specify requirements for support of Radio Resource Management for the FDD and TDD modes of New Radio(NR)</i>	38.533	<i>Radio resource management (RRM)</i>



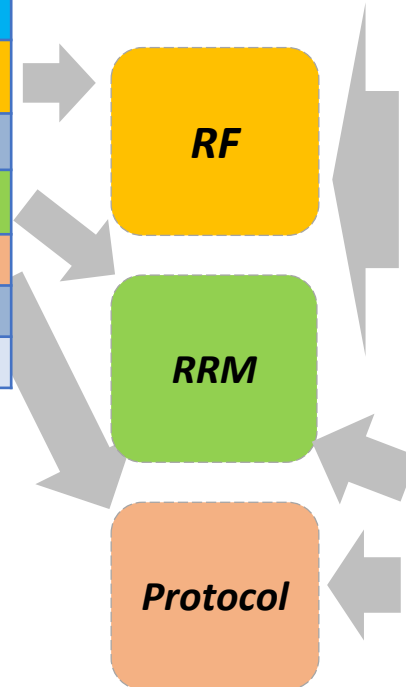
Technical specification - 5G NR RAN2 to RAN5 protocol specs mapping

RAN2 Specs	Comments	RAN5 Specs	Comments
38.304	<i>User equipment procedures in idle mode and in RRC inactive state</i>	38.523-1	<i>Specify the protocol conformance testing for the 3GPP UE connecting to the 5G System (5GS) via its radio interface(s).</i>
38.321	<i>Medium Access Control (MAC)</i>		
38.322	<i>Radio Link Control (RLC)</i>		
38.323	<i>Packet Data Convergence Protocol (PDCP)</i>		
38.331	<i>Radio Resource Control (RRC)</i>		
37.324	<i>Service Data Adaptation Protocol (SDAP)</i>		



Technical specification - LTE vs. 5G NR

Spec no.	Title
36.508	<i>Common test environment</i>
36.509	<i>Special conformance testing functions</i>
36.521-1	<i>Radio transmission and reception</i>
36.521-2	<i>ICS</i>
36.521-3	<i>Radio resource management</i>
36.523-1	<i>Protocol</i>
36.523-2	<i>ICS</i>
36.523-3	<i>Test Suites</i>



Spec no.	Title
38.508-1	<i>Common test environment</i>
38.508-2	<i>Common Implementation Conformance Statement (ICS) proforma</i>
38.509	<i>Special conformance testing functions</i>
38.521-1	<i>Radio transmission and reception; Part 1: Range 1 Standalone</i>
38.521-2	<i>Radio transmission and reception; Part 2: Range 2 Standalone</i>
38.521-3	<i>Radio transmission and reception; Part 3: Range 1 and Range 2 Interworking operation with other radios</i>
38.521-4	<i>Radio transmission and reception; Part 4: Performance</i>
38.522	<i>Applicability of radio transmission, radio reception and radio resource management test cases</i>
38.533	<i>Radio resource management</i>
38.523-1	<i>Part 1: Protocol</i>
38.523-2	<i>Part 2: Applicability of protocol test cases</i>
38.523-3	<i>Part 3: Protocol Test Suites</i>



Technical specification - Technical status

- The estimated overall completion of WI: **15%**
- The estimated completion per RAN-CN interface options and delivery phase:

SA				NSA							
Option 2		Option 5		Option 3				Option 4		Option 7	
1	2	1	2	1	1.5	2	3	1	2	1	2
RAN5#81 (Nov-18)	RAN5#83 (May-19)	RAN5#81 (Nov-18)	RAN5#83 (May-19)	RAN5#79 (May-18)	RAN5#80 (Aug-18)	RAN5#81 (Nov-18)	RAN5#83 (May-19)	RAN5#83 (May-19)	-	RAN5#83 (May-19)	-
16% (+2%)	0% (+0%)	4% (-1%)	0% (+/-0%)	100% (+58%)	26% (+26%)	48% (+40%)	1% (+1%)	13% (+2%)		18% (+6%)	

* Refer to R5-182333



Technical specification - Technical status

- The estimated completion per work plan sub-areas and RAN-CN interface options :

* Refer to R5-182333

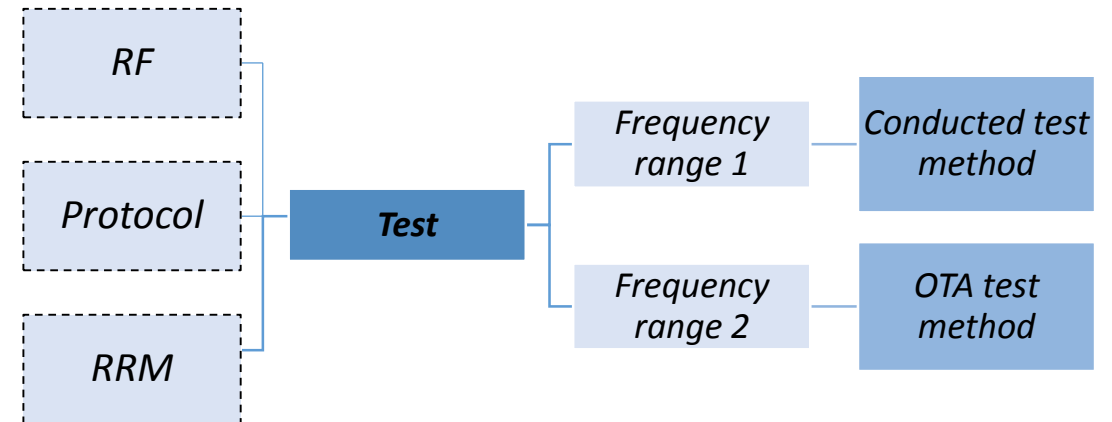
Area	Option: Phase: Target date:	SA				NSA							
		Option 2		Option 5		Option 3			Option 4		Option 7		
		1	2	1	2	1	1.5	2	3	1	2	1	2
TS/TR	TS/TR	RANS#61 (Nov-18)	RANS#63 (May-19)	RANS#61 (Nov-18)	RANS#63 (May-19)	RANS#79 (May-18)	RANS#80 (Aug-18)	RANS#61 (Nov-18)	RANS#63 (May-19)	RANS#63 (May-19)	-	RANS#63 (May-19)	-
WP sub-areas	TS/TR												
UE test functions	38.509	13%		23%		100%		35%		13%		23%	
Common ICS	38.508-2	57%		57%		100%				57%		57%	
Common test environment	38.508-1	35%	0%	9%		100%	39%	19%	0%	28%		32%	
RF Tx Rx FR1	38.521-1 38.522	16%	0%										
RF Tx Rx FR2	38.521-2 38.522	10%	0%										
RF Tx Rx Interworking FR1, F	38.521-3 38.522	0%					17.8%	0%		0%		14.6%	
RF performance	38.521-4 38.522		0%		0%				0%	0%		0%	
RRM	38.533 38.522		0%		0%				0%	0%		0%	
MU/TT	TR 38.903	3%	0%					3%		1%		1%	
Test points analysis	TR 38.905	92%					92%			92%		92%	
Protocol Layer 2	38.523-1 38.523-2	34%				100%		0%	0%	35%		47%	
Protocol Idle Mode	38.523-1 38.523-2	0%								0%			
Protocol RRC	38.523-1 38.523-2	0%				100%		74%	6%	0%			
Protocol EPC Option 3	38.523-1, 36.508					100%							
Protocol 5GC	38.523-1 38.523-2	0%		0%						0%		0%	
Positioning	37.571-w	0%		0%						0%		0%	
Protocol IMS	34.229-w		0%	0%					0%	0%		0%	
Protocol Test Models	38.523-3 36.523-3 34.229-3 37.571-4	20%		18%		100%		11%		19%		20%	



UE conformance specification

- All test equipment used to perform conformance testing for frequency range 1 on a UE shall provide the following minimum functionality:
 - *Conducted test method*
- All test equipment used to perform conformance testing for frequency range 2 on a UE shall provide the following minimum functionality:
 - *OTA test method*

Clause suffix	Variant
None	Single Carrier
A	Carrier Aggregation (CA)
B	Dual-Connectivity (DC)
C	Supplement Uplink (SUL)
D	UL MIMO

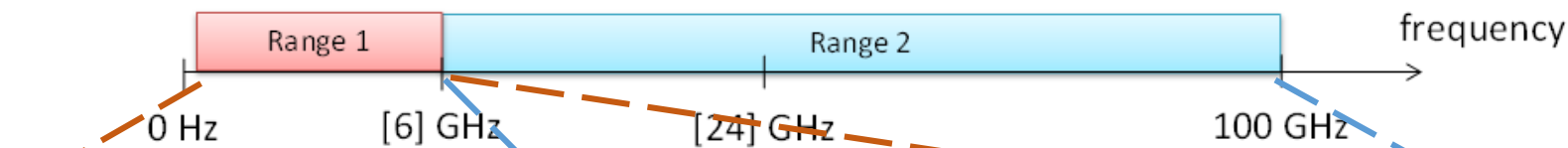




Frequency ranges

Range 1: Conducted (OTA is not precluded)

Range 2: Only OTA



• **Note:** threshold frequency of conducted and OTA tests (i.e. [6] GHz) can be further discussed.

NR operating band	UL	DL	Duplex mode
n41	2496MHZ-2690MHZ	2496MHZ-2690MHZ	TDD
n71	663MHZ-698MHZ	617-652MHZ	FDD
n77	3.3-4.2GHZ	3.3-4.2GHZ	TDD
n79	4.4-5.0GHZ	4.4-5.0GHZ	TDD

NR operating band	UL	DL	Duplex mode
n257	26.5-29.5GHZ	26.5-29.5GHZ	TDD
n258	24.25-27.5GHZ	24.25-27.5GHZ	TDD
n259	40.5-43.5GHZ	40.5-43.5GHZ	TDD
n260	37-40GHZ	37-40GHZ	TDD



UE conformance specification - Conducted vs. OTA test

- OTA based test is required for mmWave in 5G NR
 - **Reasons:**
 - *Large pass loss by coaxial cable*
 - *It is difficult to equip connector on AiP (Antenna in Package) /AoC (Antenna in Chip) front end*
 - *Cabling cannot test beamforming*
 - *Beamforming both BS and UE (only BS has beamforming in LTE)*

	Conducted	OTA
Measurement uncertainty	<i>< 1 dB</i>	<i>2 dB to 6 dB</i>
Test time	<i>Fast</i>	<i>Slow due to 3D aspects</i>
Connectivity cost	<i>Low (cables)</i>	<i>High (shielded chambers)</i>
Predictor of end-user performance	<i>Increasingly unrealistic</i>	<i>Realistic</i>



UE conformance specification - Test method for NR-UE RF testing methodology

Direct far field (DFF)

- Manufacturer declaration
 - *Manufacturer declares antenna array size*
- EIRP, TRP, **EIS, EVM**, spurious emissions and blocking metrics can be tested.

Indirect far field (IFF)

- Definition
 - *The IFF method creates the far field environment using a parabolic reflector. This is also known as the compact antenna test range (CATR).*
- Manufacturer declaration :
 - **No manufacturer declaration is needed**
- EIRP, TRP, **EIS, EVM**, spurious emissions and blocking metrics can be tested.

Near field to far field transform (NFTF)

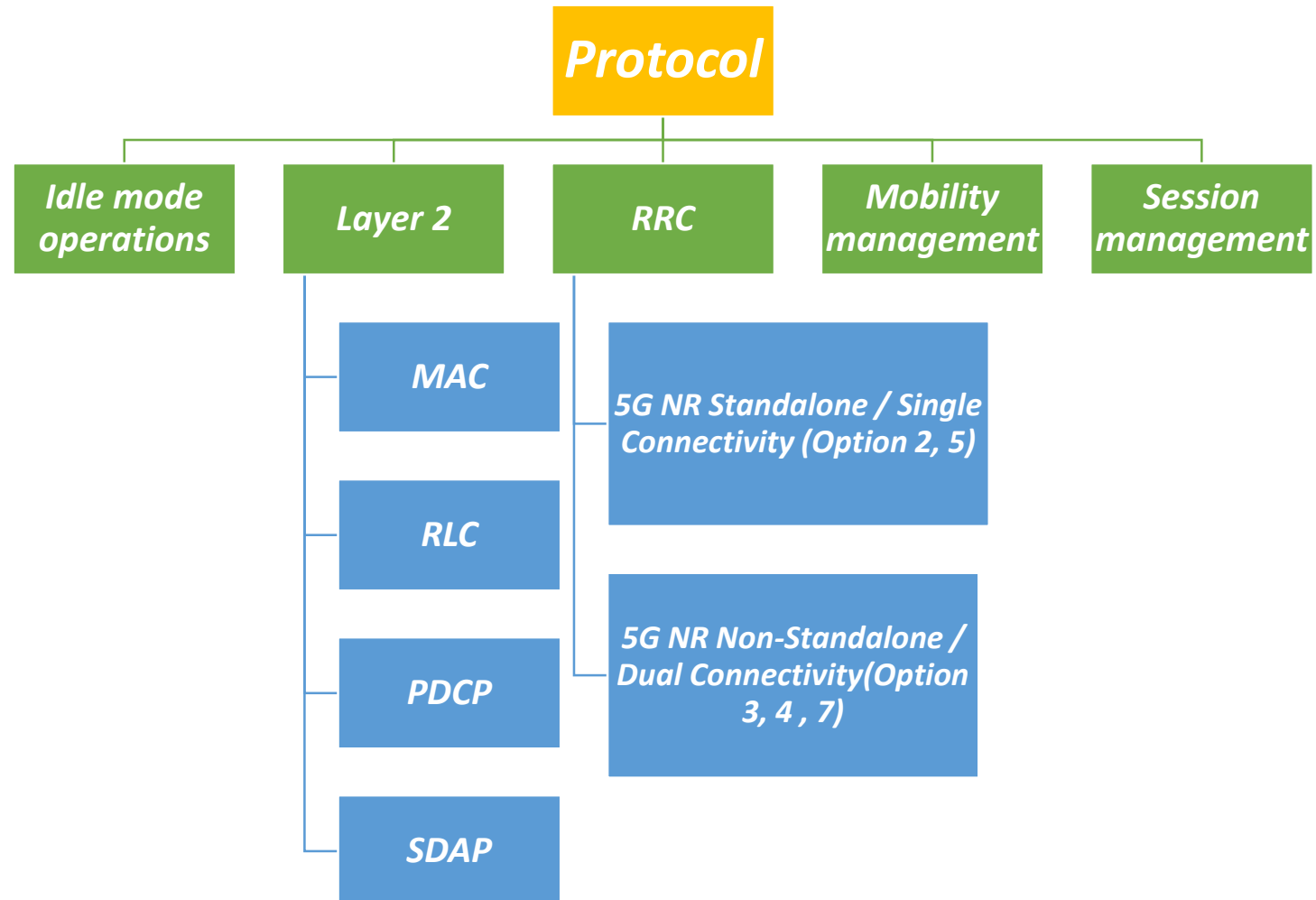
- Definition
 - *The NFTF method computes the metrics defined in Far Field by using the Near Field to Far Field transformation.*
- Manufacturer declaration :
 - *Manufacturer declares antenna array size*
- EIRP, TRP, and spurious emissions metrics can be tested.

* Refer to TR 38.810

➤ *Conformance testing for frequency range 2 in extreme conditions needs further discussion*



UE conformance specification - Protocol



Technical specification:

- ※ 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



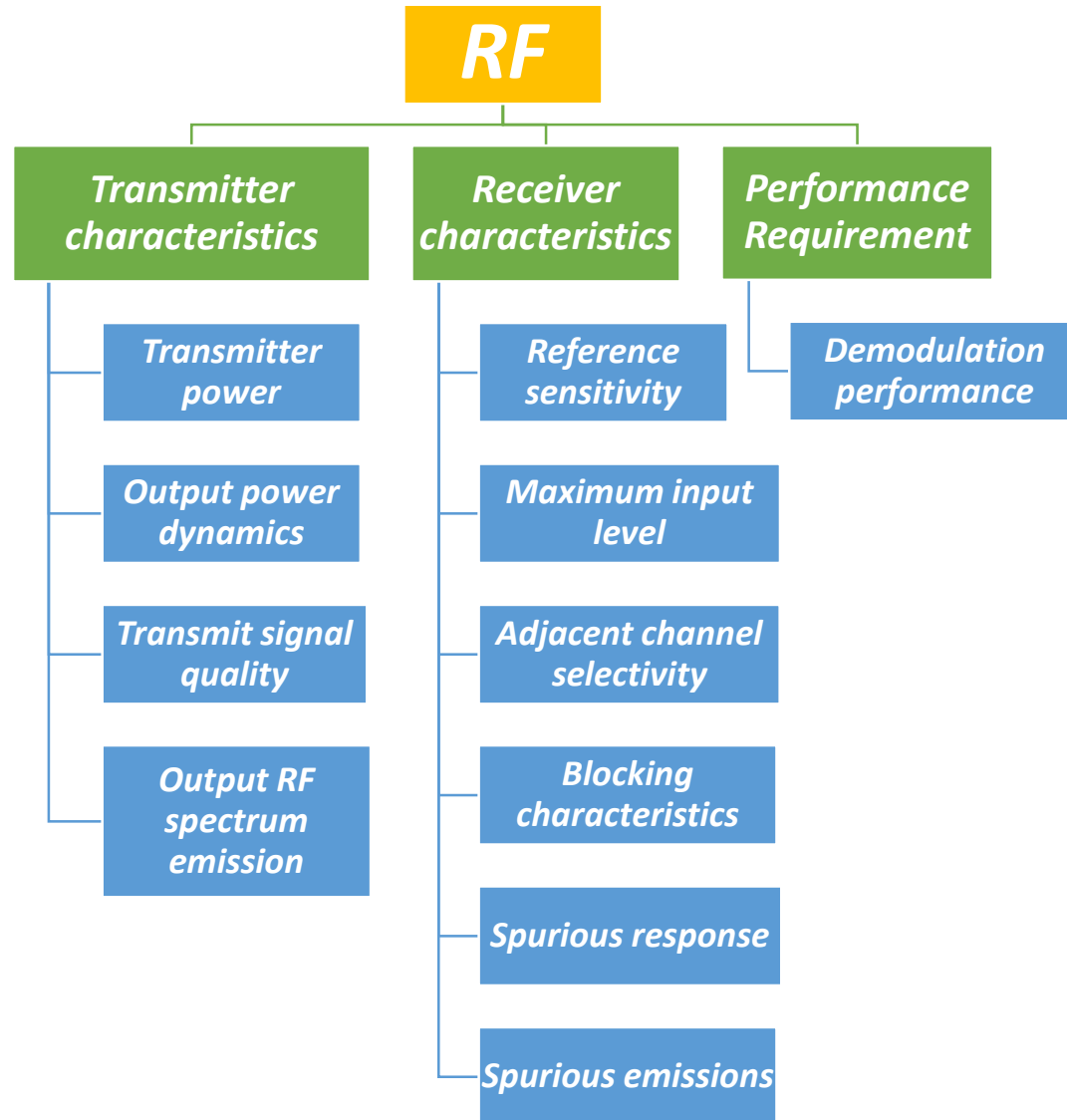
UE conformance specification - Protocol

5G NR RAN5 – Protocol test case number estimations

5GS Rel-15	TCs # estimates	Comments
NSA option 3 (EN-DC)	Phase 1:69 Phase 2:32 Phase 3:TBC Total: 101	TC breakdown – MAC: 27, RLC:17, PDCP:14, RRC:40, EPC:3 Note: Phase 3 may contain TCs for NR L1/L2 flexibility testing
SA option 2,5	~250	Including all layers of option 3 + Idle mode, NR SDAP/RRC, 5GC, inter-RAT with 4G
NSA option 4,7	~75	Option 4: extension of option 2, test scope limited to DC Option 7: extension of option 5, test scope limited to DC
IMS	~75	Voice, video, SMS, emergency, codecs,...
Positioning	~40	
TOTAL	~541	



UE conformance specification - RF



Technical specification:

- ※ 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 – Performance requirements



UE conformance specification – FR1 RF test cases (candidate)

	FR1 (Transmitter)
Transmitter power	<i>UE maximum output power</i>
	<i>Maximum Power Reduction (MPR)</i>
	<i>UE additional maximum output power reduction</i>
	<i>Configured transmitted power</i>
Output power dynamic	<i>Minimum output power</i>
	<i>Transmit OFF power</i>
	<i>Transmit ON/OFF time mask</i>
	<i>Power Control</i>
Transmitter signal quality	<i>Frequency error</i>
	<i>Transmit modulation quality</i>
Output RF spectrum emissions	<i>Occupied bandwidth</i>
	<i>Out of band emission</i>
	<i>Spurious emissions</i>
	<i>Transmit intermodulation</i>

FR1 (Receiver)
<i>Reference sensitivity power level</i>
<i>Maximum input level</i>
<i>Adjacent channel selectivity</i>
<i>In-band Blocking</i>
<i>Out-of-band blocking</i>
<i>Narrow band blocking</i>
<i>Spurious response</i>
<i>Receiver intermodulation</i>
<i>Receiver Spurious emissions</i>

Blocking characteristics

✘ Test configurations (environmental conditions, test frequencies, test channel bandwidths, sub-carrier spacing based on NR operating bands, etc.) become more complex.



UE conformance specification – FR2 RF test cases (candidate):

	FR2 (Transmitter)
Transmitter power	<i>UE maximum output power</i>
	<i>UE maximum output power for modulation / channel bandwidth</i>
	<i>UE maximum output power with additional requirements</i>
Output power dynamic	<i>Configured transmitted power</i>
	<i>Minimum output power</i>
	<i>Transmit OFF power</i>
Transmitter signal quality	<i>Transmit ON/OFF time mask</i>
	<i>Frequency error</i>
Output RF spectrum emissions	<i>Transmit modulation quality</i>
	<i>Occupied bandwidth</i>
	<i>Out of band emission</i>
	<i>Spurious emissions</i>

FR2 (Receiver)
<i>Reference sensitivity power level</i>
<i>Maximum input level</i>
<i>Adjacent channel selectivity</i>
<i>In-band Blocking</i>
<i>Out-of-band blocking</i>
<i>Spurious response</i>
<i>Receiver Spurious emissions</i>

Blocking characteristics

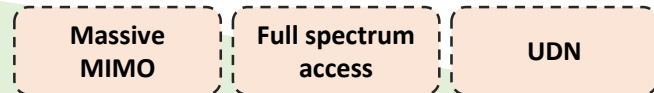
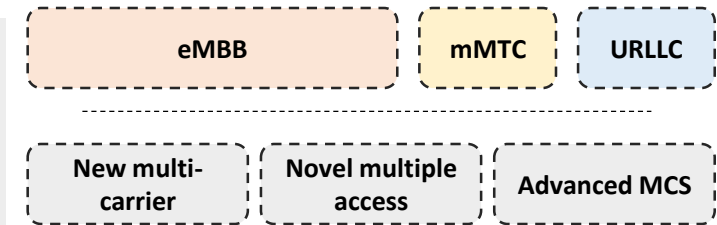
✘ FR2 test methodology (OTA) might require longer test time.



5G NR UE test challenges

General scenario

- In order to generate high frequency and wide band signal, the hardware of test instrument requires phase-amplitude synchrony and accuracy of the signal.



eMBB (Enhanced Mobile Broadband)

- Increase requirement of channel measurement and change test methods
- Require modeling of high frequency channels and the corresponding high frequency channel emulation
- Channel emulation in high-speed scenarios is still in the research stage and the complexity of protocol, RRM testing brought by seamless connectivity is improved

mMTC (Massive Machine Type Communications)

- Diversity of test scenarios and terminal
- Security test of IoT devices
- Increase test difficulty due to massive connections
- How to test battery life of chipset

URLLC (Ultra-reliable and Low Latency Communications)

- Test instrument: performance (latency, reliability), protocol, channel simulator



CTTL-Terminal 3GPP 5G NR contributions



3GPP RAN4

- *Focus on TS 38.101, TR 38.810*
- *Responsible for TR 38.810*
 - *Define OTA testing methodology for UE RF, UE RRM, and UE demodulation requirements for New Radio, the associated measurement uncertainty budget(s), and the related test tolerances.*
- *Lead the research of Test Methods for NR MIMO*
- *3GPP MIMO OTA reference lab*

3GPP RAN5

- *Focus on TS 38.521, TS 38.523*
- *Rapporteur of TS 38.521*
 - *Cover NR transmitter and receiver test cases for SA Range 1, Range 2*
- *Compile test case of TS 38.521, TS 38.523*



Agenda

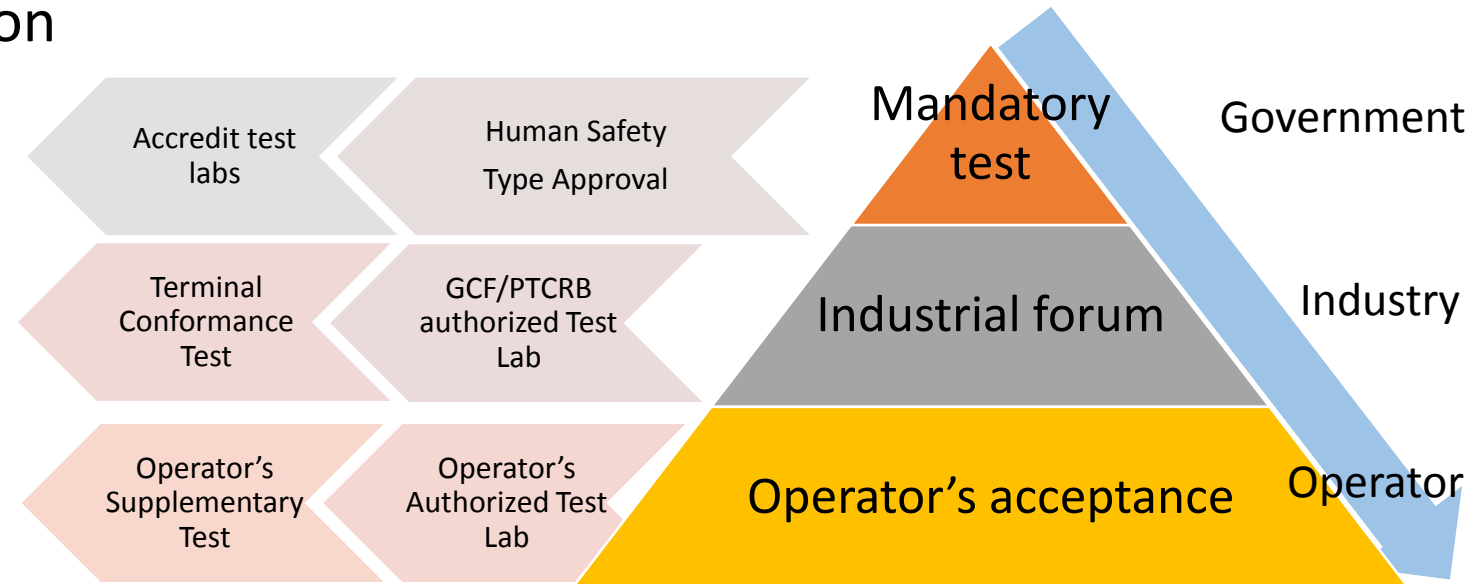
- UE Conformance test aspects - 5G system with NR and LTE
- **Global Certification requirements**
 - *Three Levels of testing certification*
 - *Standards requirement of GCF, PTCRB*
- Research progress of 5G chipset and UE
- Conformance Test solutions



Global Certification requirements

Three levels of testing certification

- Mandatory test:
 - *CE, FCC, CCC, CTA, etc.*
- Industrial forum
 - *GCF, PTCRB*
- Operator's acceptance
 - *T-Mobile US, AT&T, etc.*

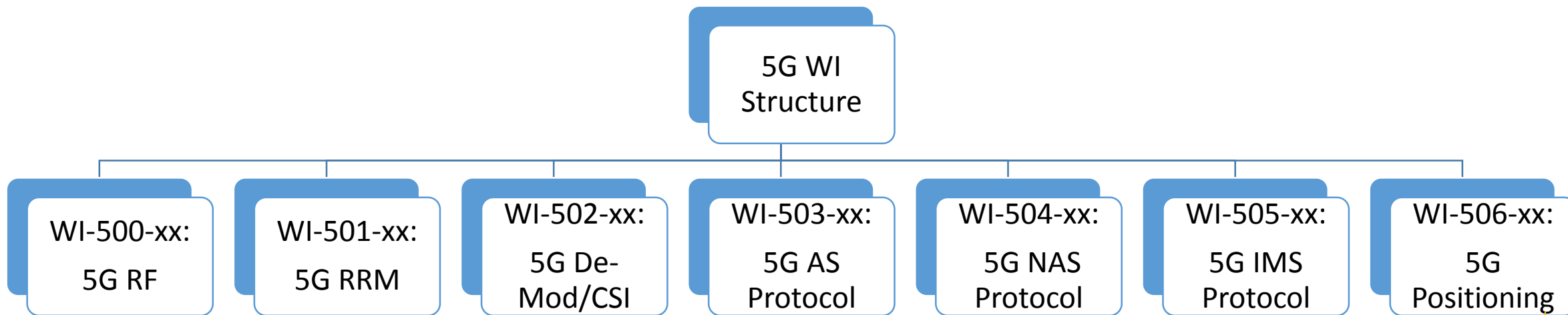




Global Certification requirements

5G WI Structure of GCF (1 of 2)

- There are seven umbrella work items for 5G, including RF, RRM, De-mod/CSI, AS PCT, NAS PCT, IMS and positioning.



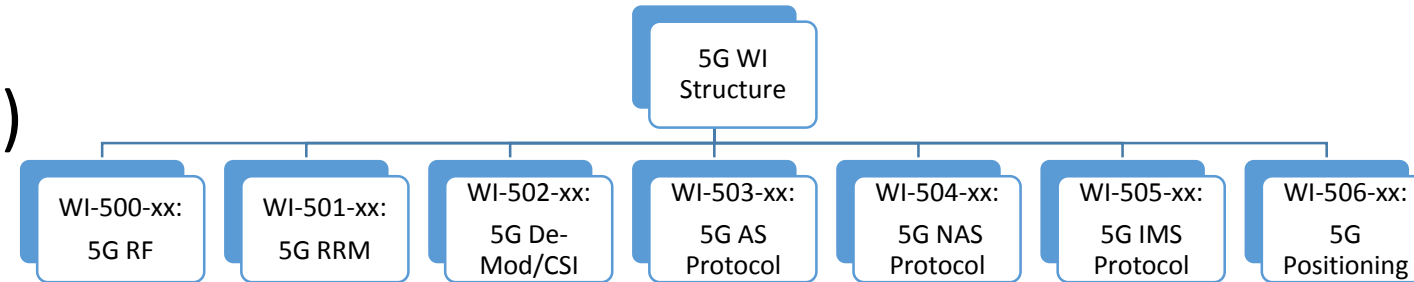


Global Certification requirements

5G WI Structure of GCF (2 of 2)

- Deployment option

- NR: SA NR connected to 5GC, Option 2
- EN-DC: NSA E-UTRA and NR Dual Connectivity with E-UTRA as master connected to EPC, Option 3
- EUTRA-5GC: E-UTRA connected to 5GC, Option 5
- NGEN-DC: NSA NR and EUTRA Dual Connectivity with EUTRA as master connected to 5GC), Option 7



Umbrella WI

WI-500-xx:
5G RF

Sub-WI

WI-500_NR-nx

WI-500_EUTRA-5GC-x

WI-500_EN-DC_x_ny

WI-500_NGEN-DC_x_ny

Label	Deliverables	Comments	RAN5 Target Completion Date	RAN Plenary Target Completion Date
NSA1	NSA Phase 1	Option 3 Phase 1	RAN5#79 (May-18)	RAN#80 (June-18)
NSA2	NSA Phase 2	Option 3 Phase 2, Option 7	RAN5#81 (Nov-18)	RAN#82 (Dec-18)
NSA3	NSA Phase 3	Option 4	FFS	FFS
SA1	SA Phase 1	Option 2, Option 5 Phase 1	RAN5#81 (Nov-18)	RAN#82 (Dec-18)
SA2	SA Phase 2	Option 2, Option 5 Phase 2	FFS	FFS

Global Certification requirements



PTCRB

- PTCRB PVG #80
 - *Protocol validation may be expected end of 2018 or early 2019, depending on completion of specification, delivery of Test Case TTCN and UE availability*



Agenda

- UE Conformance test aspects - 5G system with NR and LTE
- Global Certification requirements
- **Research progress of 5G chipset and UE**
 - *HUAWEI, QUALCOMM, INTEL, etc*
- Conformance Test solutions



Research progress of 5G chipset and UE

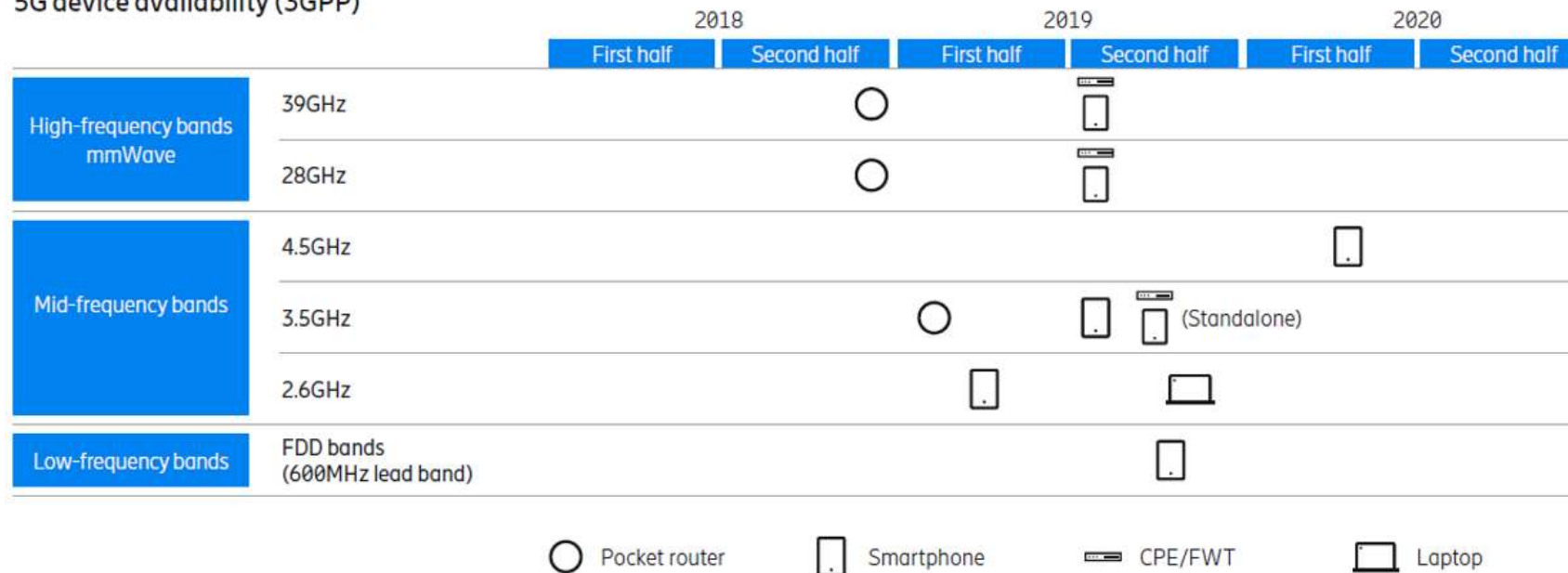
	Products	Company	Description
1	Snapdragon X50 Modem	QUALCOMM	<ul style="list-style-type: none"> ➤ Support operation in the 28 GHz millimeter wave band ➤ Provide multi-mode 4G/5G capability via dual connectivity ➤ Supporting up to 5 gigabits per second download speeds
2	XMM8060	INTEL	<ul style="list-style-type: none"> ➤ Multi-mode support for 5G NR (NSA&SA) and various 2G, 3G, and 4G legacy modes ➤ Support both sub-6GHZ bands & mmWave spectrum ➤ Commercial customer devices shipping in the middle of 2019
3	Balong 5G01	HUAWEI	<ul style="list-style-type: none"> ➤ Peak rate 2.3Gbps ➤ Sub-6GHZ & mmWave multi-frequency ➤ NSA/SA networking
4	Exynos Modem 5100	SAMSUNG	<ul style="list-style-type: none"> ➤ Support both sub-6GHZ & mmWave spectrum for 5G system as well as legacy networks from 2G to 4G ➤ Maximum downlink speed of up to 2Gbps in 5G's sub-6GHZ settings, and 6Gbps in mmWave settings





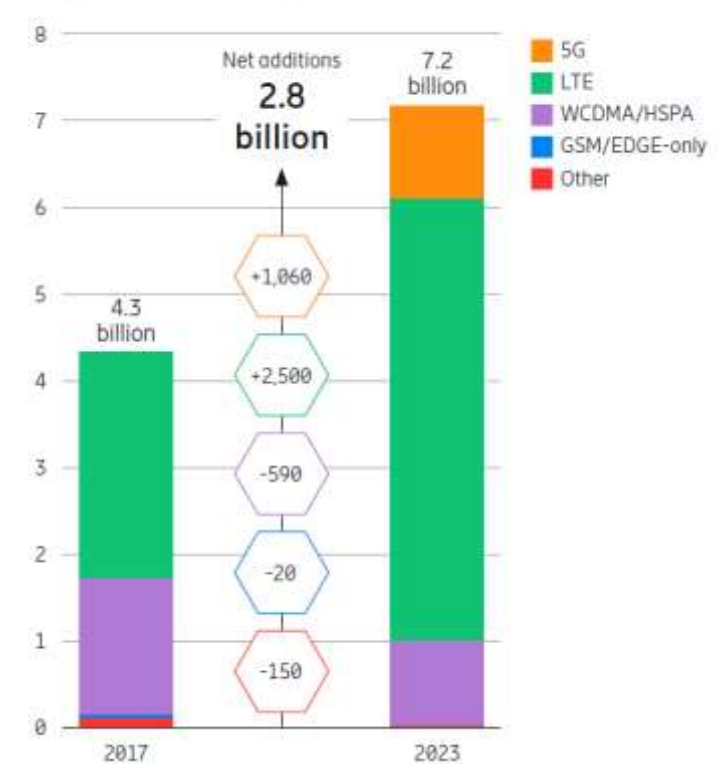
Research progress of 5G chipset and UE

5G device availability (3GPP)



The first 3GPP smartphones supporting 5G are expected in early 2019.

Smartphone subscriptions by technology



* Refer to Ericsson Mobility Report



Agenda

- UE Conformance test aspects - 5G system with NR and LTE
- Global Certification requirements
- Research progress of 5G chipset and UE
- **Conformance Test solutions**
 - *Test solutions*
 - *Certification solution roadmap*

Test solutions



Products		Description
1	<i>Vector signal generator</i>	<i>➤ Generating complex, digitally modulated signals of high quality</i>
2	<i>Signal and spectrum analyzer</i>	<i>➤ High end spectrum/ signal analyzer for R&D and production ➤ Wide analysis: up to 1GHZ BW analysis bandwidth ➤ Excellent flatness</i>
3	<i>5G wireless test platform</i>	<i>➤ Supports 5G signaling & RF testing ➤ Supports both Sub-6GHZ and mmWave ➤ High performance<ul style="list-style-type: none">– Provide optimum OTA test environment for mmWave/beamforming➤ Utilize existing LTE asset for NSA operation<ul style="list-style-type: none">– Provide LTE-5G NR interworking test environment by utilizing existing LTE test platforms as LTE anchor for 5G NSA-NR</i>





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