MIC MRA International Workshop 2019

5G Test Challenges

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- 5G Standardization and Test Challenges
- 5G RF Measurement
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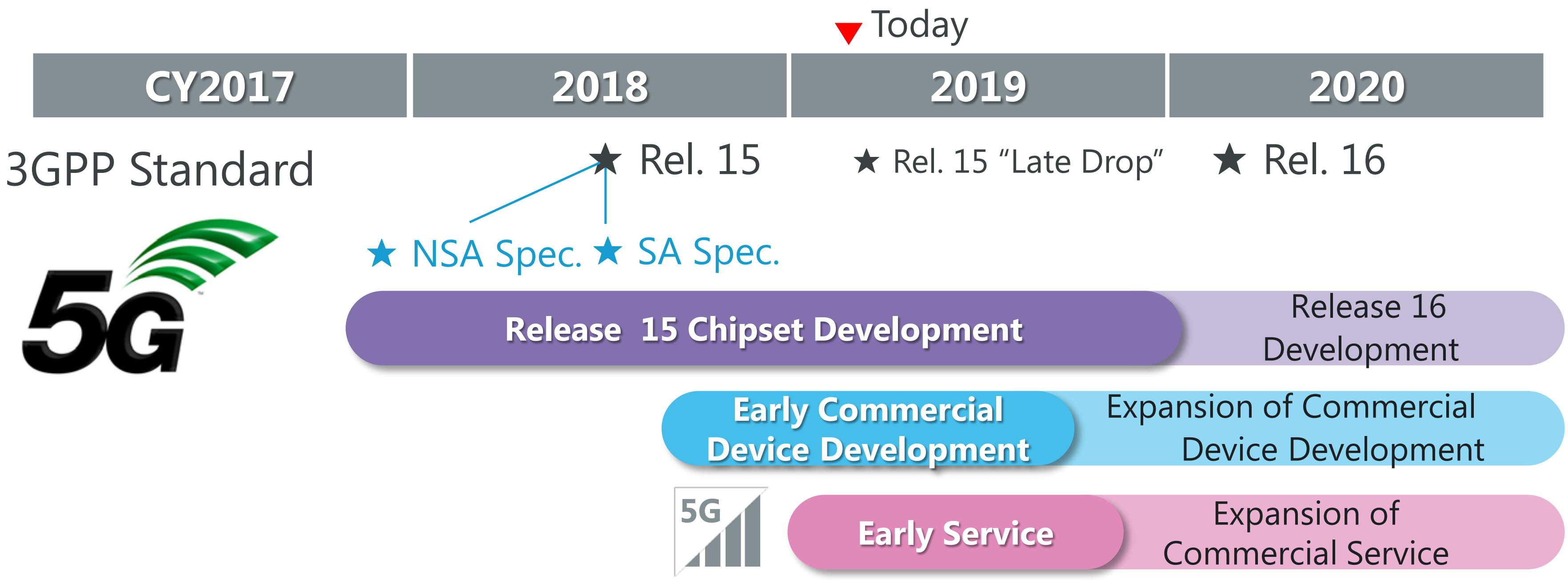
5G Standard and Commercialization Schedule



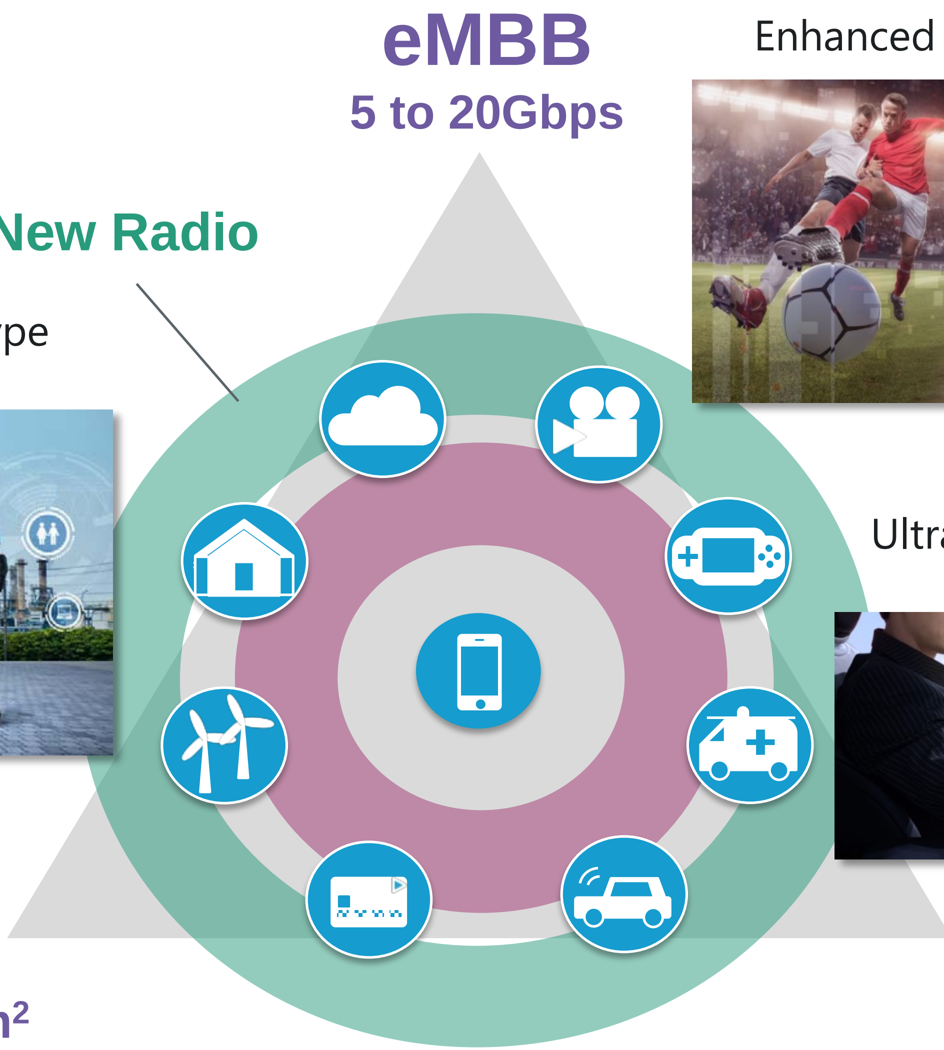
Release 15 NR

- New Radio (NR) Access Technology covering eMBB and URLLC use cases for NSA (Non-standalone) and SA (Standalone) connectivity
- EPC enhancements to support 5G NR via Dual connectivity for NSA concept where LTE serves as signaling anchor
- LTE Connectivity to 5G Core Network (5G-CN)

Release 16 NR Main Work Item

- NR eMIMO
- NR in unlicensed spectrum
- Dual Connectivity and Carrier Aggregation enhancements
- NR UE power consumption
- eURLLC (PHY centric),
- NR Industrial IOT – eURLLC but L2/L3 centric
- Integrated Access and Backhaul (IAB)
- NR V2X

5G: Network infrastructure for various use cases



Enhanced Mobile Broadband

Massive Machine Type Communication

Ultra-reliable and low-latency communications

eMBB: Enhanced Mobile Broadband **uRLLC**: Ultra-reliable and low-latency Communications
mMTC: Massive Machine Type Communications

Frequency Band Example in 3GPP

*FR: Frequency Range

FR1

Band Number	Uplnk	Downlink	Duplex	Region/Country
n41	2496 – 2690 MHz	2496 – 2690 MHz	TDD	US. China
n71	663 – 698 MHz	617 – 652 MHz	FDD	US
n77	3.3 – 4.2 GHz	3.3 – 4.2 GHz	TDD	China, Japan, South Korea, Europe
n78	3.3 – 3.8 GHz	3.3 – 3.8 GHz	TDD	
n79	4.4 – 5.0 GHz	4.4 – 5.0 GHz	TDD	Japan, China

FR2

Band Number	Uplink	Downlink	Duplex	Region/Country
n257	26.5 – 29.5 GHz	26.5 – 29.5 GHz	TDD	Japan, South Korea
n258	24.25 – 27.5 GHz	24.25 – 27.5 GHz	TDD	Europe, China
n260	37 – 40 GHz	37 – 40 GHz	TDD	US
n261	27.5 – 28.35 GHz	27.5 – 28.35 GHz	TDD	US

Requirement for 5G device and key test challenges

Leverage mmWave for Broadband Communication

- New measurement method for beamforming performance
- Establishment of OTA RF test environment and evaluation of measurement uncertainty

Flexible operation tailored for available frequency and network architecture

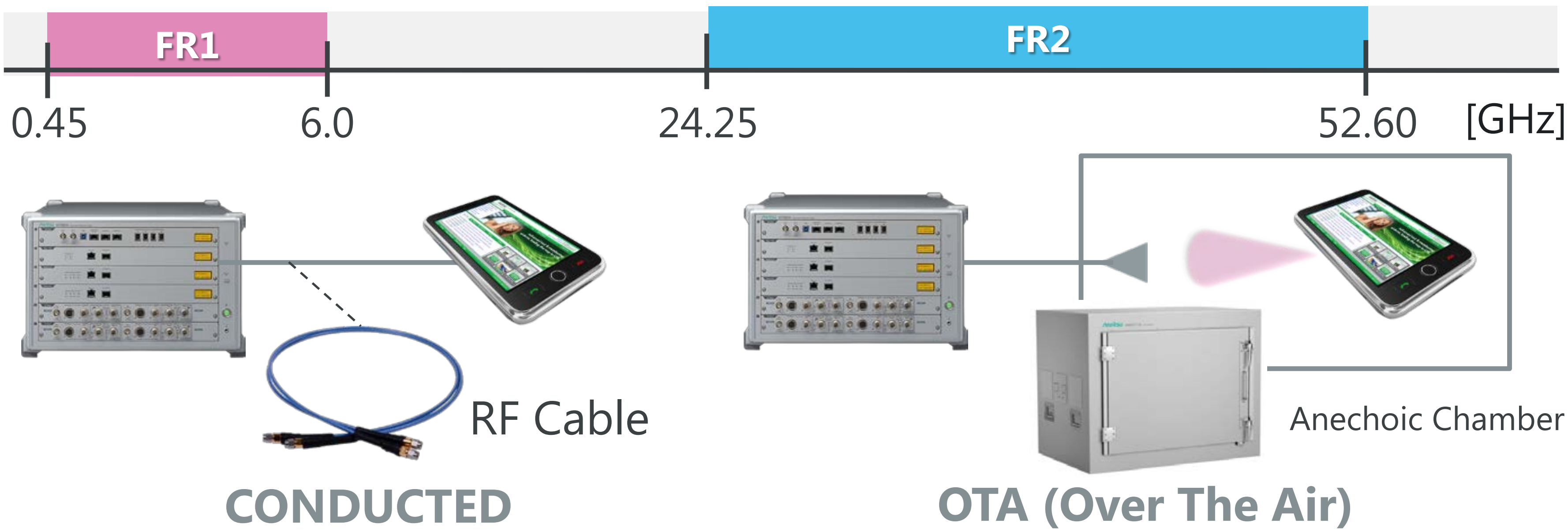
- Extended verification of Physical Layer for various combination of configuration conditions
- Verification of Non-standalone operation using LTE Anchor
- Verification of Beam Management functions to secure stable connectivity for mmWave

Enhanced User Experience for eMBB use cases

- Data throughput evaluation to achieve extremely broadband service
- Data transfer optimization for 5G and 4G split bearer
- Evaluation of power consumption and countermeasures for heat

5G RF Measurement

LTE, 5G NR Sub-6GHz & mmWave RF Measurement Comparison

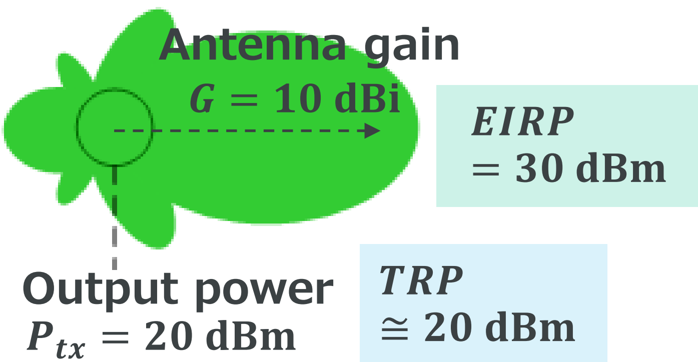


	Test Item	LTE (Conducted)	Sub-6GHz (Conducted)	mmWave (OTA)
TX	Tx Maximum Output Power	√	√	√ (EIRP & TRP)
	EIRP Spherical Coverage / 3D EIRP Scan			√ (EIRP-CDF)
	MPR/A-MPR / Configured transmitted Power	√	√	√ (EIRP)
	Minimum Output Power / OBW	√	√	√ (EIRP)
	ACLR / SEM / Off Power	√	√	√ (TRP)
	On/Off Time Mask / Power Control	√	√	√ (EIRP)
	EVM / Freq.Error / Carrier Leakage / In-band Emission	√	√	√ (Beam Peak)
RX	Reference Sensitivity	√	√	√ (EIS)
	Max Input Level	√	√	√ (EIS)
	EIS Spherical Coverage / 3D EIS Scan			√ (EIS-CDF)

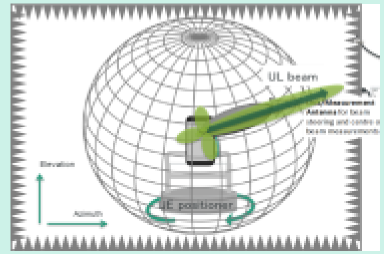
OTA (Over The Air) Measurement Method

3 methods are used to measure RF performance in OTA test environment.

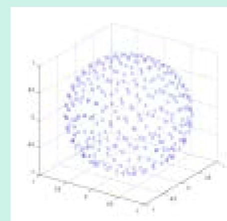
TRP / EIRP image

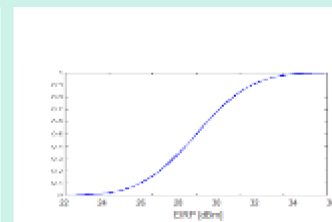


EIRP : Power at an any angle direction.
Evaluation target : Signal quality such as EVM.

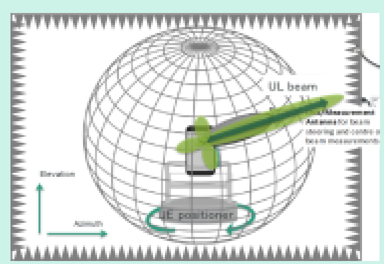


EIRP CDF : Power distribution at every angle.
Evaluation target : Spherical coverage.





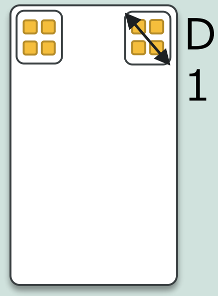
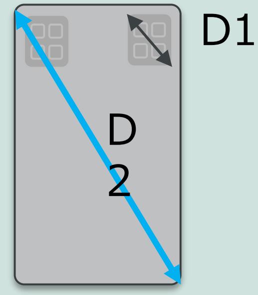
TRP : Total radiated power
Evaluation target : Emissions such as SEM.



Test Procedure

1. **Lock the beam of UE**
2. Change azimuth angle and elevation angle
3. Measure the power
4. Repeat Step 2 and Step 3
5. Integrate measurement result

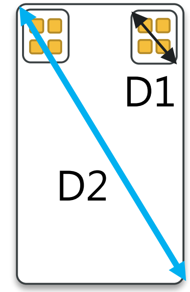
White Box, Gray Box, Black Box

	White Box	Gray Box	Black Box
Image			
Antenna size	Known (=D1) Actual antenna size	Known (=D1) Actual antenna size	Unknown (=D2) UE diagonal size
Antenna location	Known	Unknown	Unknown
Required QZ size	≥ D1 Actual antenna size	≥ D2 UE diagonal size	≥ D2 UE diagonal size
Far Field Condition	Calculated by using	Calculated by using	Calculated by using
Use case	R&D	R&D	R&D RF Conformance

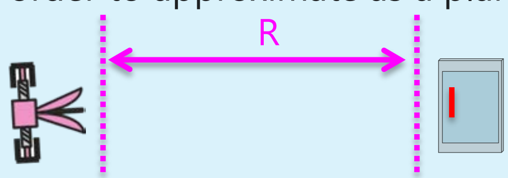
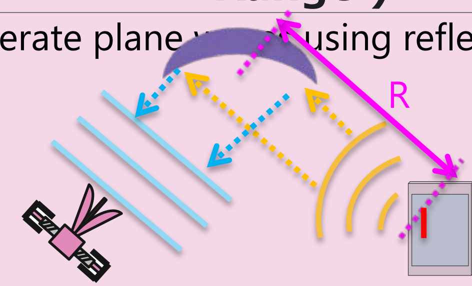
Requirement for QZ (Quiet Zone) and Far Field Condition differ depending on DUT size, presence or absence of determination of Antenna size and location.

DFF Method and IFF Method (CATR)

For FFM (Far Field Measurement), there are DFF (Direct Far Field) and IFF(Indirect Far Field). CATR is effective method to realize IFF measurement for Black Box approach.



D1 : Actual antenna size (white/gray box)
D2 : UE diagonal size (black box)

	DFF (Direct Far Field)	IFF CATR (Compact Antenna Test Range)
Overview	➢ Take a distance between UE and antenna in order to approximate as a plane wave.  $R > \frac{2D^2}{\lambda}$ λ : wavelength	➢ Generate plane wave using reflecting mirror.  $R \fallingdotseq 7D$
Merit	➢ OTA equipment configuration is simple. ➢ It is possible to simulate arrival of signals from some of directions by using multiple antenna.	➢ Plane wave can be created in shorter distance than DFF.
Demerit	➢ When the antenna size D is large, the distance between UE and antenna becomes larger.	➢ Because CATR needs refractor, OTA equipment configuration is complex and heavy. ➢ It is impossible to simulate arrival of signals from some of directions(For protocol testing.)
R length @28GHz	➢ 47cm (D1=5cm) ➢ 1,175cm (D2=25cm)	➢ 30cm (D1=5cm) ➢ 175cm (D2=25cm)
Suitable approach	➢ White box and Gray box	➢ Black box

Distance(cm)	47	175
Loss(dB)	54.8	66.3

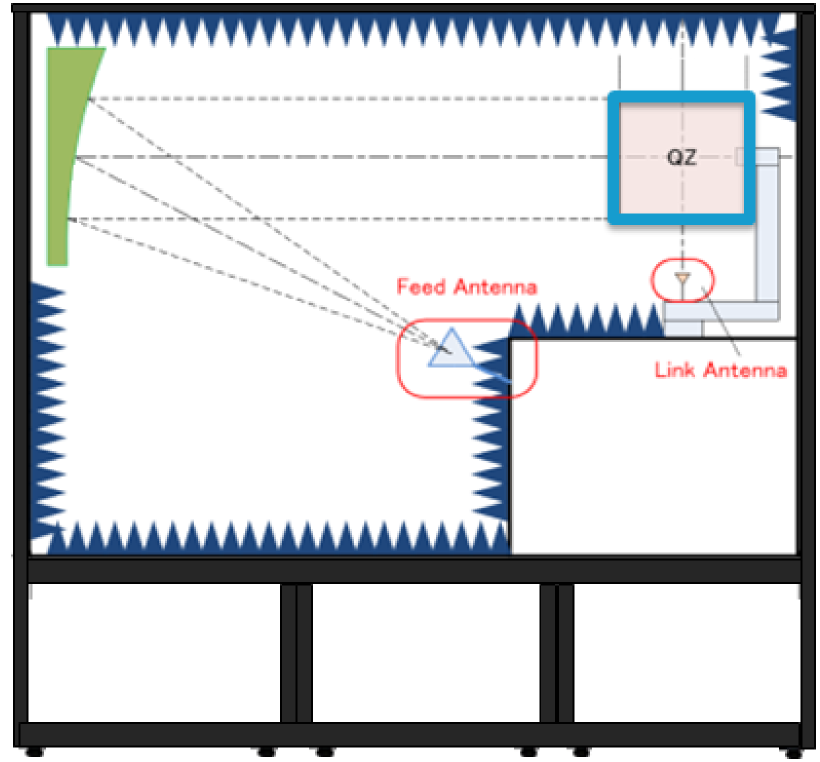
OTA RF Measurement Environment using CATR Chamber

Image of CATR Chamber

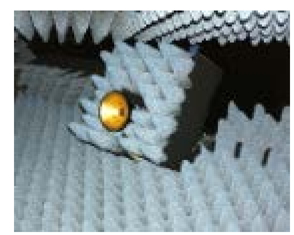
LTE Tester (LTE Anchor)

5G Tester

Positioner Controller



Reflector

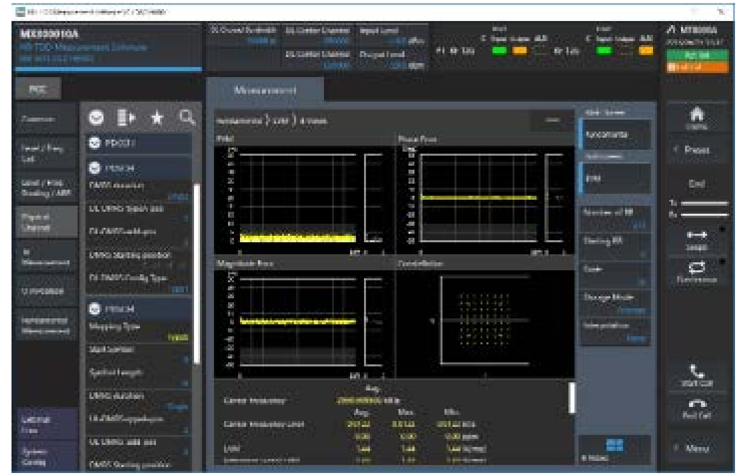


Test Antenna (Feed Antenna)

3D Positioner

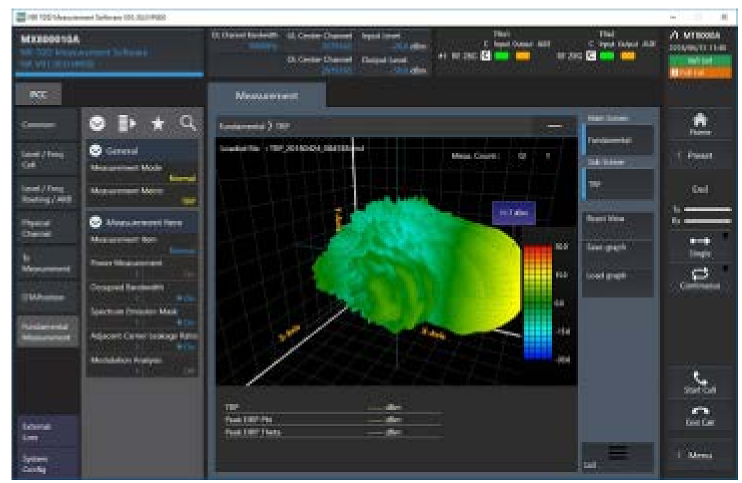
OTA RF Measurement Result Example

TX Power, OBW, SEM, ACLR, Frequency Error



EVM, Phase Error, Magnitude Error, Constellation

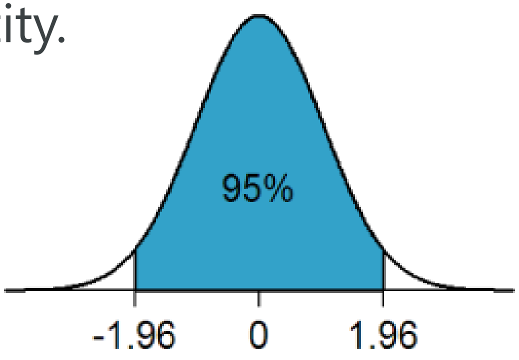
Various PHY parameters configuration
Reference sensitivity, max input level



Automated OTA measurement for 3D graph,
TRP, Peak EIRP (Phi, Theta)

MU and TT

MU (Measurement Uncertainty)： MU is expression of the statistical dispersion of the values attributed to a measured quantity.



- Collect uncertain factors that affect measurement result
- Calculate each factor by statistical method
- Get standard deviation of each factor
- Get RSS (Root Sum Squares)
- Use expanded measurement uncertainty with 95% probability

TT (Test Tolerance)：Value for test requirement tolerance

- Determined by uncertainty of test system, regulatory requirement and importance
- Test requirement is determined by adding TT to minimum requirement

3GPP Test	Minimum Requirement in TS 36.101	Test Tolerance (TT)	Test Requirement in TS 36.521-1
6.2.2 UE Maximum Output Power	f ≤ 3.0GHz Power class 3: 23dBm ±2 dB	0.7 dB	Formula: Upper limit + TT, Lower limit – TT ±2.7 dB

MU Factors in OTA RF Measurement

- **Cable to OTA (Over The Air)**

  ⇒ Decrease of SNR due to Free space path loss

$$\mathrm{FSPL} = \left(\frac{4\pi R}{\lambda}\right)^2$$

  ⇒ Addition of new MU factor

  Quality of Quiet Zone, Influence of XPD, Absolute gain of calibration antenna, etc.

- **Frequency requirement changes form <6GHz to mmWave**

  ⇒ Impedance miss match, increase of measurement error

- **Increase of Maximum Test System Uncertainty in FR2 (mmWave)**

  (Test Cases related to TRx Power)

  LTE (<6 GHz) : around 1dB ⇒ 5G FR2 : around 5dB

MU has big performance impact to 5G service

We need continuous effort to recue MU by testing theory and collecting data through experiment.

5G Protocol and Performance Test

Physical Layer of 5G NR

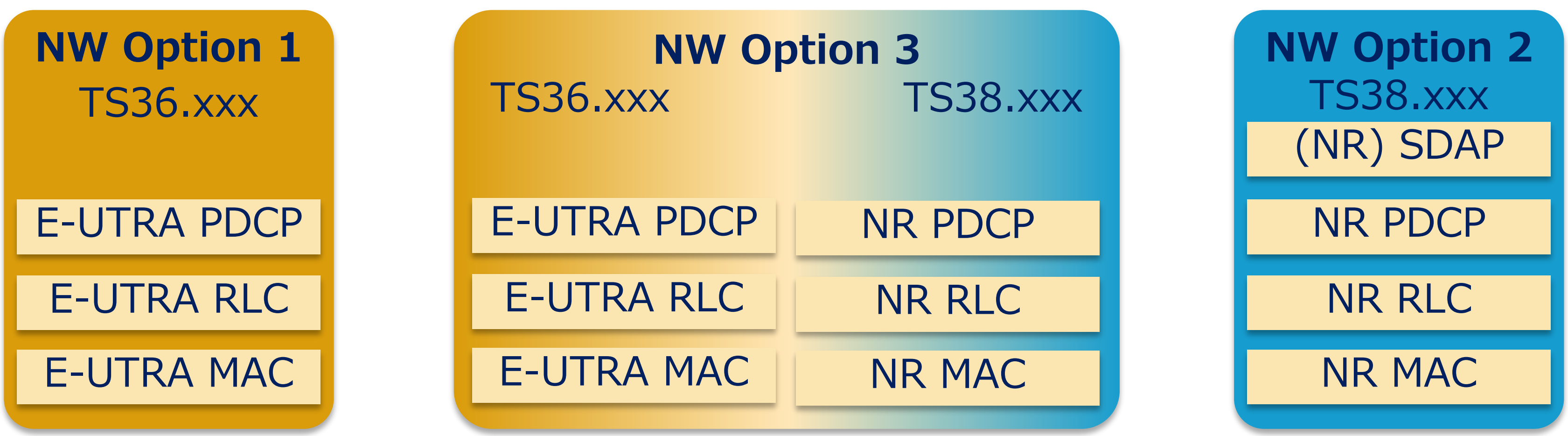
5GNR provides flexibility to support various condition of sub-carrier spacing, signal bandwidth, waveform, MIMO and carrier aggregation to in order to best utilize available frequency resources. This flexibility make the verification challenging due to the various combination of configuration.

	Frequency Range	帯域 (MHz)	SCS (kHz)	Waveform	MIMO	CA
LTE	Sub6	1.4, 3, 5, 10, 15, 20,	15	DL: CP-OFDM UL: SC-FDMA	DL: 4x4MIMO UL: 2x2MIMO	8CC
NR	FR1 (Sub6)	5, 10, 15, 20,25, 30, 40, 50, 60, 80, 90, 100	15, 30, 60	DL: CP-OFDM UL: CP-OFDM DFT-S-OFDM	DL: 4x4MIMO UL: 2x2MIMO	Intra-band 4CC Inter-band 2CC
	FR2 (mmW)	50, 100, 200, 400	60, 120	DL: CP-OFDM UL: CP-OFDM DFT-S-OFDM	DL: 2x2MIMO UL: 2x2MIMO	8 CC

NSA/SA Network Option

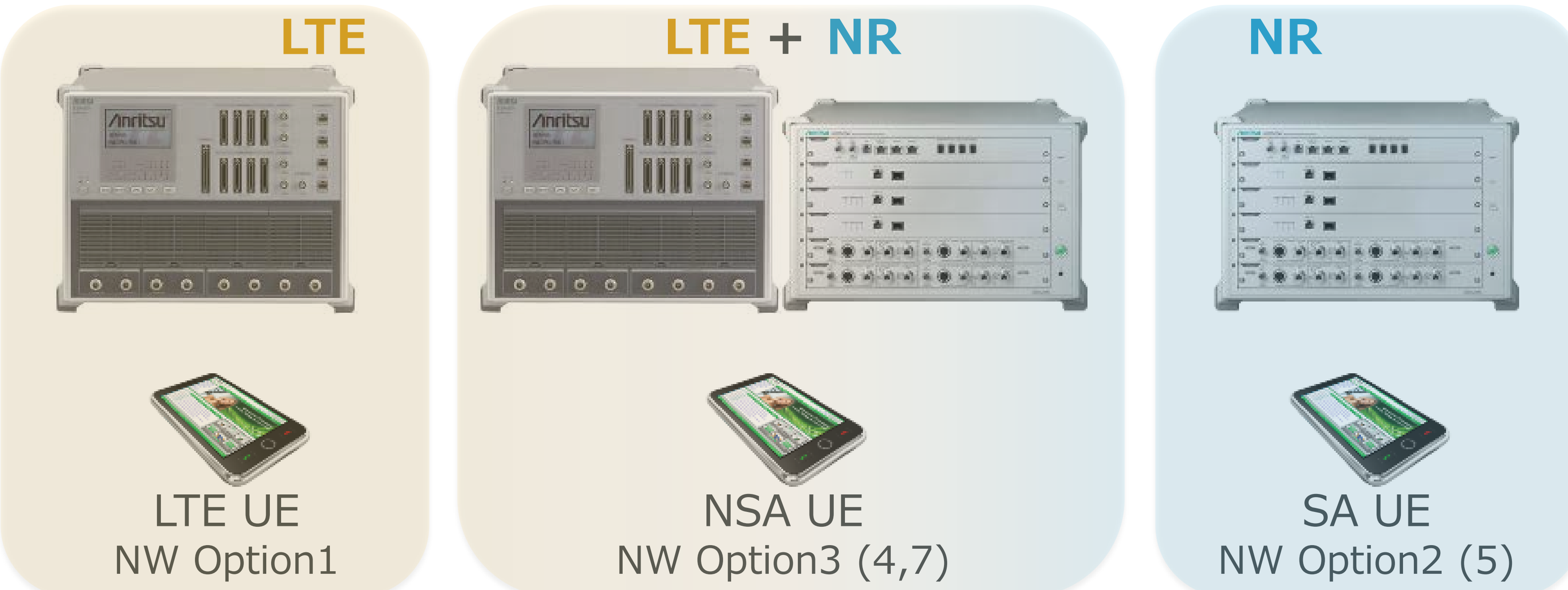
- Following are the network architecture options defined by 3GPP for

NW Option		Core NW	Signaling	User data	3GPP(ASN.1)
1	LTE(E-SA?)	EPC	LTE	LTE	
2	NR-SA	NGC	NR	NR	2018/06(18/09)
3	EN-DC	EPC	LTE	LTE + NR (NSA)	2017/12(18/03)
4	NE-DC	NGC	NR	LTE + NR (NSA)	2019/03(19/06)
5	NGE-SA	NGC	LTE	LTE	
7	NGEN-DC	NGC	LTE	LTE + NR (NSA)	

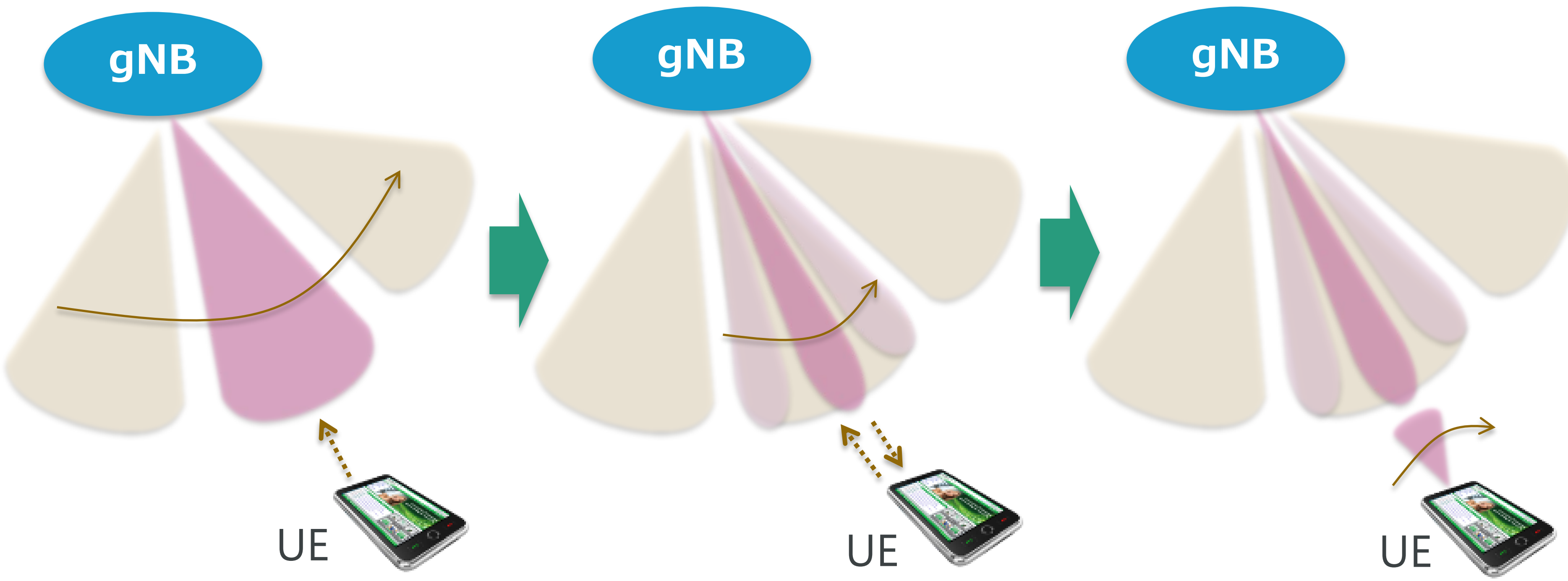


Example of NSA/SA Operation Test Setup

- Efficient and unified test environment is required for test creation, execution and analysis to test devices supporting various network options.
  - ➢ Consistent operation for LTE and NT
  - ➢ Re-use of test case across network options
  - ➢ Common test environment across network options



Basic Process of Beam Management



1. gNB beam acquisition
UE select beam with best condition and start access process.

2. gNB beam adjustment
UE report detailed information of beams and gNB assign best beam for the UE.

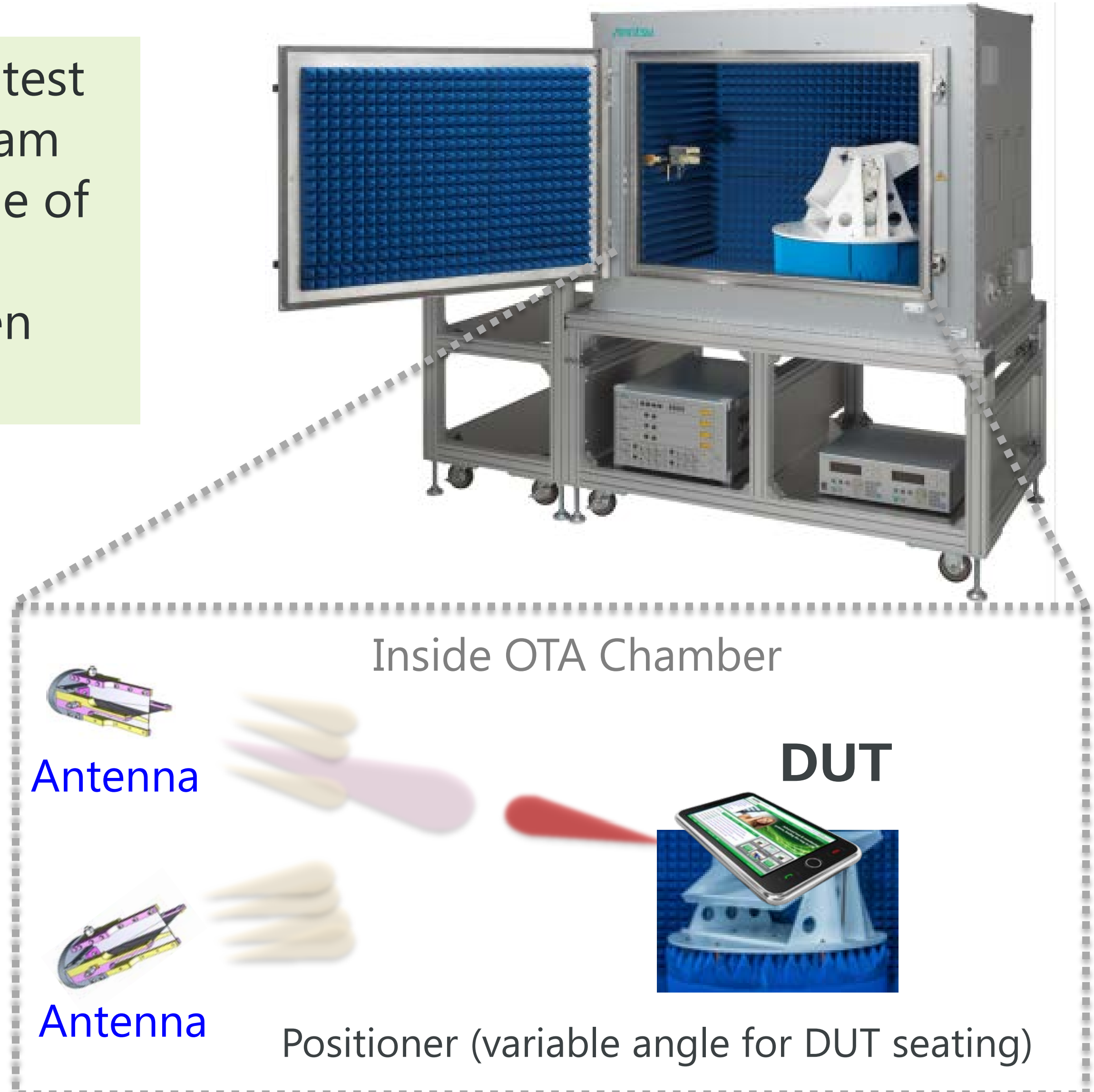
3. UE bam adjustment
UE adjusts direction of uplink signal transmission and downlink beam reception.

Beam tracking and beam switching are the other important functions for stable mobility operation.

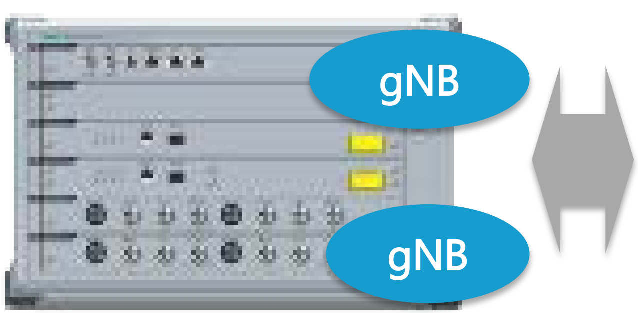
Beam Management Test Environment Example

This example shows OTA test environment simulate beam power from multiple angle of arrivals to support beam management test between gNB and UE.

DFF OTA Chamber



5G gNB Simulator



Data Speed Example in 5G NR eMBB Use Case

eMBB (Enhanced Mobile Broadband): Realize high-speed data by utilizing broadband signal.

	Item	LTE (4G)	5G	
			Sub6	mmW
3GPP Requirement	Bandwidth (1CC)	Max 20MHz	Max 100MHz	Max 400MHz
	Sub-Carrier Spacing	15kHz	15/30/60kHz	60/120/240kHz
	Data Peak Rate	1Gbps	20Gbps	20Gbps
PHY condition and data speed example	Bandwidth (1CC)	20MHz	100MHz	100MHz
	Sub-Carrier Spacing	15kHz	30kHz	120kHz
	Carrier Aggregation	5CA	1CA	8CA
	MIMO	2x2MIMO	4x4MIMO	2x2MIMO
	Modulation	256QAM	256QAM	64QAM
	DL/UL比	FDD	DL : UL = 4 : 1	DL : UL = 4 : 1
	Throughput	**1Gbps**	**1.7Gbps**	**5Gbps**

Test environment to replicate high-load condition is required for power consumption evaluation and measure for heat dissipation.

5G Conformance Test Status (for reference)

5G NR RF Conformance Test Item (NSA FR1)

TS	Clause	Title	Regulatory
38.521-3	6.2B.1.3	UE Maximum Output Power for Inter-Band EN-DC within FR1	x
38.521-3	6.2B.2.3	UE Maximum Output power reduction for inter-band EN-DC within FR1	
38.521-3	6.2B.3.3	UE additional Maximum Output power reduction for inter-band EN-DC within FR1	
38.521-3	6.2B.4.1.3	Configured Output power level for inter-band EN-DC within FR1	
38.521-3	6.3B.1.3	Minimum output power for inter-band EN-DC within FR1	
38.521-3	6.3B.2.3	Transmit OFF Power for inter-band EN-DC within FR1	x
38.521-3	6.3B.3.3	Tx ON/OFF time mask for inter-band EN-DC within FR1	
38.521-3	TBD	PRACH time mask	
38.521-3	TBD	PUCCH time mask	
38.521-3	TBD	SRS time mask	
38.521-3	TBD	PUSCH-PUCCH and PUCCH-SRS time mask	
38.521-3	TBD	absolute Power tolerance	
38.521-3	TBD	relative Power tolerance	
38.521-3	TBD	aggregate Power tolerance	
38.521-3	6.4B.1.3	Frequency Error for inter-band EN-DC within FR1	x
38.521-3	6.4B.2.3.1	Error Vector Magnitude for inter-band EN-DC within FR1	
38.521-3	6.4B.2.3.2	Carrier Leakage for inter-band EN-DC within FR1	
38.521-3	6.4B.2.3.3	In-band Emissions for inter-band EN-DC within FR1	
38.521-3	6.4B.2.3.4	EVM Equalizer Flatness for inter-band EN-DC within FR1	

TS	Clause	Title	Regulatory
38.521-3	6.5B.1.3	Occupied bandwidth for inter-band EN-DC within FR1	x
38.521-3	6.5B.2.3.1	Spectrum emissions mask for Inter-band EN-DC within FR1	x
38.521-3	6.5B.2.3.2	Additional Spectrum emissions mask for Inter-band EN-DC within FR1	
38.521-3	6.5B.2.3.3	Adjacent channel leakage ratio for inter-band EN-DC within FR1	x
38.521-3	6.5B.3.3.1	General Spurious Emissions for Inter-band EN-DC within FR1	x
38.521-3	6.5B.3.3.2	Spurious Emission band UE co-existence for Inter-band EN-DC within FR1	x
38.521-3	6.5B.4.3	Additional Spurious Emissions for Inter-band EN-DC within FR1	
38.521-3	6.5B.4.3	Intermodulation Distortion for inter-band EN-DC within FR1	x
38.521-3	7.3B.2.3	Reference sensitivity for Inter-band EN-DC within FR1	
38.521-3	7.4B.3	Maximum Input Level for inter-band EN-DC within FR1	
38.521-3	7.5B.3	Adjacent Channel Selectivity for inter-band EN-DC within FR1	
38.521-3	7.6B.2.3	Inband blocking for inter-band EN-DC within FR1	
38.521-3	7.6B.3.3	Out-of-band blocking for inter-band EN-DC within FR1	
38.521-3	7.6B.4.3	Narrow band blocking for inter-band EN-DC within FR1	
38.521-3	7.7B.3	Spurious Response for inter-band EN-DC within FR1	
38.521-3	7.8B.2.3	Wideband Intermodulation for inter-band EN-DC within FR1	
38.521-3	7.9B.3	Spurious Emissions for inter-band EN-DC within FR1	x

5G NR RF Conformance Test Item (NSA FR2)

TS	Clause	Title	Regulatory
38.521-3	6.2B.1.4	UE Maximum output power for Inter-Band EN-DC including FR2	x
38.521-3	6.2B.2.4	UE Maximum output power reduction for Inter-Band EN-DC including FR2	
38.521-3	6.2B.3.4	UE Additional Maximum output power reduction for Inter-Band EN-DC including FR2	
38.521-3	6.3B.1.4	Minimum output power for inter-band EN-DC including FR2	
38.521-3	6.3B.2.4	Transmit OFF Power for inter-band EN-DC including FR2	x
38.521-3	6.3B.3.4	Tx ON/OFF time mask for inter-band EN-DC including FR2	
38.521-3	TBD	PRACH time mask	
38.521-3	TBD	PUCCH time mask	
38.521-3	TBD	SRS time mask	
38.521-3	TBD	PUSCH-PUCCH and PUCCH-SRS time mask	
38.521-3	TBD	absolute Power tolerance	
38.521-3	TBD	relative Power tolerance	
38.521-3	TBD	aggregate Power tolerance	
38.521-3	6.4B.1.4	Frequency Error for inter-band EN-DC including FR2	x
38.521-3	6.4B.2.4.1	Error Vector Magnitude for inter-band EN-DC including FR2	
38.521-3	6.4B.2.4.2	Carrier Leakage for inter-band EN-DC including FR2	
38.521-3	6.4B.2.4.3	In-band Emissions for inter-band EN-DC including FR2	
38.521-3	6.4B.2.4.4	EVM Equalizer Flatness for inter-band EN-DC including FR2	

TS	Clause	Title	Regulatory
38.521-3	6.5B.1.4	Occupied bandwidth for Inter-Band EN-DC including FR2	x
38.521-3	6.5B.2.4.1	Spectrum emissions mask for Inter-band EN-DC including FR2	x
38.521-3	6.5B.2.4.2	Additional Spectrum emissions mask for Inter-band EN-DC including FR2	
38.521-3	6.5B.2.4.3	Adjacent channel leakage ratio for inter-band EN-DC including FR2	x
38.521-3	6.5B.3.4.1	General Spurious Emissions for Inter-band including FR2	x
38.521-3	6.5B.3.4.2	Spurious emission band UE co-existence for Inter-band including FR2	x
38.521-3	TBD	Additional spurious emissions	
38.521-3	7.3B.2.4	Reference sensitivity for Inter-band EN-DC including FR2	
38.521-3	7.5B.4	Adjacent Channel Selectivity for inter-band EN-DC including FR2	
38.521-3	7.6B.2.4	Inband blocking for inter-band EN-DC including FR2	
38.521-3	7.9B.4	Spurious Emissions for inter-band EN-DC including FR2	x

5G NR Protocol Conformance Test (NSA FR1/2)

- TS38.523 – MAC, RLC, PDCP

Test case	Testcase Name	Group
7.1.1.2.1	Correct Handling of DL MAC PDU / Assignment / HARQ process	MAC
7.1.1.3.1	Correct Handling of UL MAC PDU / Assignment / HARQ process	MAC
7.1.1.3.2	Logical channel prioritization handling	MAC
7.1.1.3.4	Correct handling of MAC control information / Buffer status / UL data arrive in the UE Tx buffer / Regular BSR	MAC
7.1.1.3.5	Correct handling of MAC control information / Buffer Status / UL resources are allocated / Padding BSR	MAC
7.1.1.3.6	Correct handling of MAC control information / Buffer status / Periodic BSR timer expires	MAC
7.1.2.2.1	UM RLC / Segmentation and reassembly / 6-bit SN / Segmentation Info (SI) field	RLC
7.1.2.2.2	UM RLC / Segmentation and reassembly /12-bit SN / Segmentation Info (SI) field	RLC
7.1.2.2.3	UM RLC / 6-bit SN / Correct use of sequence numbering	RLC
7.1.2.3.1	AM RLC / 12-bit SN/Segmentation and reassembly / Segmentation Info (SI) field	RLC
7.1.2.3.2	AM RLC / 18-bit SN/Segmentation and reassembly / Segmentation Info (SI) field	RLC
7.1.2.3.3	AM RLC / 12-bit SN / Correct use of sequence numbering	RLC
7.1.2.3.4	AM RLC / 18-bit SN / Correct use of sequence numbering	RLC
7.1.2.3.5	AM RLC / Control of transmit window/Control of receive window	RLC
7.1.2.3.6	AM RLC / Polling for status	RLC
7.1.2.3.7	AM RLC / Receiver status triggers	RLC
7.1.2.3.11	AM RLC / RLC re-establishment procedure	RLC
7.1.3.1.1	Maintenance of PDCP sequence numbers / User plane / 12 bit SN	PDCP
7.1.3.1.2	Maintenance of PDCP sequence numbers / User plane / 18 bit SN	PDCP
7.1.3.2.1	Integrity protection / Correct functionality of encryption algorithm SNOW3G/SRB/DRB	PDCP
7.1.3.2.2	Integrity protection / Correct functionality of encryption algorithm AES/SRB/DRB	PDCP
7.1.3.2.3	Integrity protection / Correct functionality of encryption algorithm ZUC/SRB/DRB	PDCP
7.1.3.3.1	Ciphering and deciphering / Correct functionality of encryption algorithm SNOW3G/SRB/DRB	PDCP
7.1.3.3.2	Ciphering and deciphering / Correct functionality of encryption algorithm AES/SRB/DRB	PDCP
7.1.3.3.3	Ciphering and deciphering / Correct functionality of encryption algorithm ZUC/SRB/DRB	PDCP
7.1.3.4.2	PDCP handover / Non Lossless handover / PDCP sequence number maintenance	PDCP
7.1.3.5.1	PDCP Discard	PDCP
7.1.3.5.2	PDCP Uplink Routing / Split DRB	PDCP
7.1.3.5.3	PDCP Data Recovery / Reconfiguration of DRB	PDCP

5G NR Protocol Conformance Test (NSA FR1/2)

- TS38.523 – RRC, EPC

Test case	Testcase Name	Group
8.2.2.4.1	PSCell addition, modification and release / SCG DRB / EN-DC	RRC
8.2.2.5.1	PSCell addition, modification and release / Split DRB / EN-DC	RRC
8.2.2.6.1	Bearer Modification / MCG DRB / SRB / PDCP version change / EN-DC	RRC
8.2.2.7.1	Bearer Modification / Handling for bearer type change without security key change / EN-DC	RRC
8.2.2.8.1	Bearer Modification / Handling for bearer type change with security key change / EN-DC	RRC
8.2.3.1.1	Measurement configuration control and reporting / Inter-RAT measurements / Event B1 / Measurement of NR cells / EN-DC	RRC
8.2.3.4.1	Measurement configuration control and reporting / Event A1 / Measurement of NR PSCell / EN-DC	RRC
8.2.3.13.1	PCell Handover with SCG change / Reconfiguration with sync / SCG DRB / EN-DC	RRC
8.2.5.1.1	Radio link failure / PSCell addition failure / EN-DC	RRC
8.2.5.2.1	Radio link failure / PSCell out of sync indication / Radio link failure / EN-DC	RRC
8.2.5.3.1	Radio link failure / RLC-MaxNumRetx failure / EN-DC	RRC
8.2.5.4.1	Reconfiguration failure / SCG change failure / EN-DC	RRC
10.2.1.1	Default EPS bearer context activation	EPC
10.2.1.2	Dedicated EPS bearer context activation	EPC
10.2.2.1	EPS bearer resource allocation / modification	EPC

Conformance Test Specification Progress (1/2)

WI overall completeness vs NSA/SA options

SA					NSA								
Option 2			Option 5		Option 3					Option 4		Option 7	
18%					53%								
1	2	3	1	2	1	1.5	2	3	4	1	2	1	2
RAN5#81 (Nov-18)	RAN5#82 (Feb-19)	RAN5#83 (May-19)	RAN5#83 (May-19)	FFS	RAN5#79 (May-18)	RAN5#80 (Aug-18)	RAN5#81 (Nov-18)	RAN5#82 (Feb-19)	RAN5#83 (May-19)	RAN5#83 (May-19)	FFS	RAN5#83 (May-19)	FFS
100% (+84%)	21% (+21%)	0% (0%)	9% (+5%)		100% (+/-0%)	100% (+74%)	100% (+52%)	34% (+33%)	33% (+32%)	26% (+12%)		27% (+9%)	

Overview of completed test cases by RAN5#81

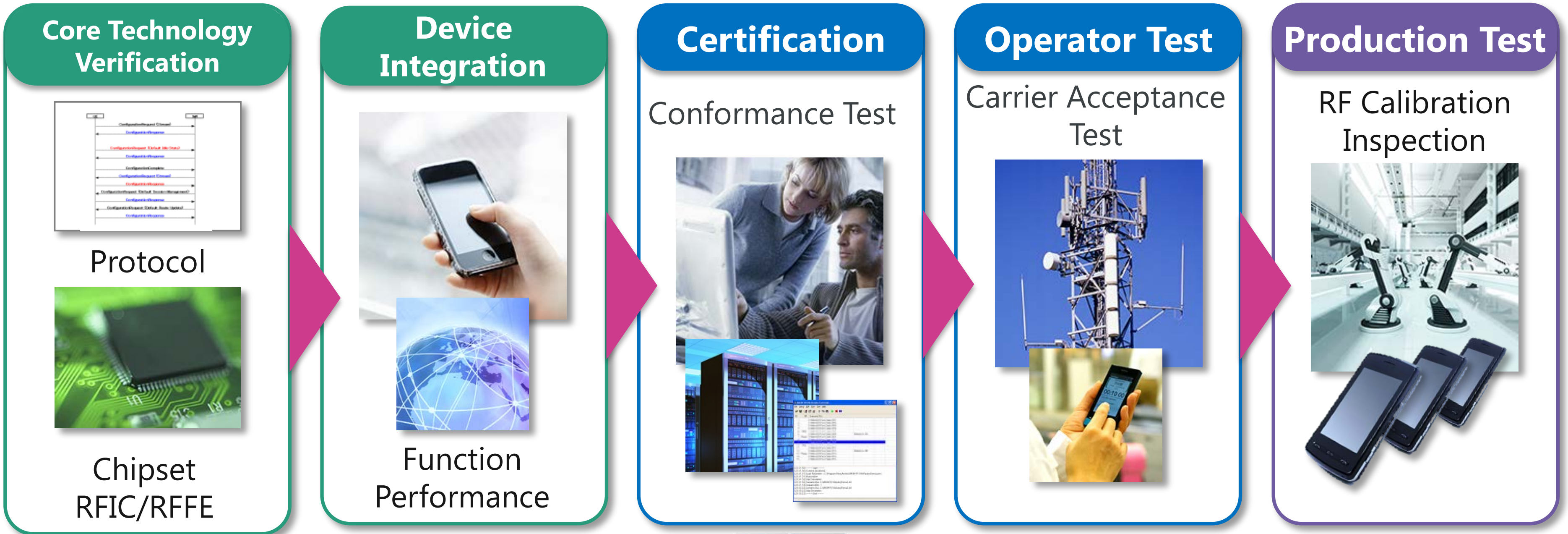
		Number of completed test cases				
	Area	SA Option 2	SA Option 5	NSA Option 3	NSA Option 4	NSA Option 7
	Positioning	0		10		
RF	RF Rx Tx FR1	13		25		
RF	RF Rx Tx FR2	0		0		
RF	RF Rx Tx FR1+FR2	0		0		
Protocol	Protocol Idle Mode	2				
Protocol	Protocol Layer 2	70		64		
Protocol	Protocol RRC	2		15		
Protocol	Protocol EPC Option 3			3		
Protocol	Protocol 5GC	3				
	Overall number of test cases	90		117		

Conformance Test Specification Progress (1/2)

WI completeness vs WP sub-areas

		SA					NSA								
	Option:	Option 2			Option 5		Option 3					Option 4		Option 7	
	Phase:	1	2	3	1	2	1	1.5	2	3	4	1	2	1	2
Area	**TS/TR** Target date:	RAN5#81 (Nov-18)	RAN5#82 (Feb-19)	RAN5#83 (May-19)	RAN5#83 (May-19)	FFS	RAN5#79 (May-18)	RAN5#80 (Aug-18)	RAN5#81 (Nov-18)	RAN5#82 (Feb-19)	RAN5#83 (May-19)	RAN5#83 (May-19)	FFS	RAN5#83 (May-19)	FFS
Completion of sub-areas		100%	21%	19%	8%		100%	100%	100%	34%	33%	23%		24%	
Contribution from WP		5%	5%	5%	2%		5%	5%	5%	5%	5%	2%		2%	
Contribution RF testing		5%	5%	5%				5%	5%	5%	5%				
Contribution Protocol		2%	2%	2%			2%	2%	2%	2%	2%	2%		2%	
Overall		**100%**	**21%**	0%	**9%**		**100%**	**100%**	**100%**	**34%**	**33%**	**26%**		**27%**	
WP sub-areas	**TS/TR**														
UE test functions	38.509	100%	0%		2%		100%		100%	0%		31%		31%	
Common ICS	38.508-2	100%			57%		100%					57%		57%	
Common test environment	38.508-1	100%	0%	34%	24%		100%	100%	100%	34%	0%	54%		56%	
RF Tx Rx FR1	38.521-1	100%	23%	0%											
RF Tx Rx FR2	38.521-2		28%	0%											
RF Tx Rx Interworking FR1, FR2 and other radio	38.521-3 38.522			10%				100.0%	100%	31%	17%	42%		42%	
RF performance	38.521-4		6%							6%		6%		6%	
RRM	38.533		11%	30%						9%	28%				
MU/TT	TR 38.903		14%	0%											
Test points analysis	TR 38.905	100%	80%					100%	100%	80%		96%		96%	
Protocol Layer 2	38.523-1	100%	5%				100%		100%	2%		26%		34%	
Protocol Idle Mode	38.523-1	100%	0%												
Protocol RRC	38.523-1	100%	3%				100%		100%	90%		0%		0%	
Protocol EPC Option 3	38.523-1,						100%								
Protocol 5GC	38.523-1	100%	3%		0%							0%		0%	
Positioning	37.571-x			0%					100%		0%				
Protocol IMS	34.229-x		0%		0%					0%		0%		0%	
Protocol Test Models	38.523-3	100%	0%		16%		100%		100%	0%		17%		18%	

Summary



- Extensive and complicated verification is required in order to establish 5G technology to support various use cases.
- We need OTA-based new measurement methods and test approaches to utilize mmWave.
- Test solutions are being introduced to support R&D, Certification and Production toward commercialization of 5G services.

Anritsu

envision : ensure