Based on the discussions and the inputs received from the stakeholders, the 5G/5Gi trials test schedule and test procedure has been framed. Before finalisation of the said document, comments/inputs may be **provided by 4th November 2021.**
This is the final opportunity being given to the stakeholders before finalisation of the document. If no comments are received, the document will be finalised as it is.

1 Scope

The scope of the document is to develop a test schedule and test procedure for uniform assessment of various use cases in 5G/ 5Gi, which are being trialled by telecom service providers (TSPs), through the measurement of parameters related to performance and interoperability.

In the following sections 2 and 3, the information pertaining to the system overview, set up and configuration which are to be recorded are given. This is followed by the parameters to be measured in section 4. The corresponding test procedure is mentioned in the Annexure.

<For section 2 onwards, the data for each scenario should be recorded separately as per format below and similarly the parameters measured should be recorded, measured as per the procedure in the Annexure-I.>

2 System Overview

Note: Include aerial or images of the sites and the environment

The following table may be filled by the TSP to give a snapshot of the use cases being shown under each scenario and test environment. The use-cases may be indicated against whichever trial location-scenario- test environment combination they are shown, otherwise not applicable (NA) may be indicated. This table is in the consolidated format, and more rows may be added as needed by the TSPs.

Trial Location[+]	**Scenario**	**Test environment**	**Use Case / Application**[*] **and Max. No. of users connected**
	eMBB	Indoor hotspot	i) ….. ii)….
		Dense urban	
		a) Rural-eMBB	
		b) Rural-eMBB LMLC	
	URLLC	Urban macro	
	mMTC	Urban macro	

[+] separate rows may be added for multiple trial locations.

[*] Application could be YouTube, video call and some specific application with their names as available on the Play/AppStore.

3 Network Architecture

1. Provide network connectivity diagram showing the eNB, 5G gNB/5Gi Base Station, core network and test server and other relevant nodes, test and measurement equipment with its connectivity
2. Core network technology details, including Release:
3. Backhaul technology:
4. Radio Parameters/Configurations: As per Table below.

S.No.	**Parameter**	**700 MHz**	**3.5 GHz**	**26/28 GHz**

1.	Technology (Indicate the technology being shown- 3GPP 5G/ 5Gi) *<In case both are offered, separate tables may be filled>*			
2.	Which mode- NSA or SA please indicate			
3.	- Indicate total number of gNBs/Small Cells/5Gi Base Station shown - One control plane eNB supports how many User Plane gNB/5Gi Base Station (small cells) (For NSA Mode) - Indicate configuration like 3.x etc. (For NSA Mode)			
4.	Anchor carrier (if applicable) (For NSA Mode)			
5.	Duplex Mode (FDD or TDD)			
6.	DL/UL Split Ratio (please indicate if TDD)			
7.	Channel Bandwidth (DL)			
8.	Channel Bandwidth (UL)			
9.	CA support- bandwidth details			
10.	Subcarrier Spacing (SCS)			
11.	BS Max. DL Modulation Order			
12.	BS Max. UL Modulation Order			
13.	MIMO Layers			
14.	MIMO Order			
15.	Antenna Elements (Massive MIMO) and configuration			
16.	Support of Analog or Digital Beamforming			
17.	Dual connectivity (For NSA Mode)			
18.	AAS Support			
19.	AAS TRP Level			
20.	UE Min & Max DL Modulation Order			
21.	UE Min & Max UL Modulation Order			
22.	UE MIMO Layers			

23.	UE MIMO Order			
24.	UE Antenna Elements			
25.	Peak BTS Tx Power			
26.	Peak UE Tx Power			
27.	BS Antenna Gain			
28.	UE Antenna Gain			
29.	BS EIRP			
30.	As per WRC-19 RES 750, TRP level (for BS) [Calculation sheet to be submitted]	N/A	N/A	
31.	EMF exposure assessment (Broadband measurement method)			

The following table needs to be filled for each location, individually:

S.No.	Parameter	700 MHz	3.5 GHz	26/28 GHz
1.	Antenna Height			
2.	Mechanical Down Tilt			

Signed by <*TSP*- > **Signed by <*LSA*- >**

4 Tests to be carried out

A. Functional tests

The purpose is to demonstrate the readiness and maturity of 5G/5Gi technology in the Indian context.

The following are the tests:

S.No.	Tests*	Yes/No	Remarks
a.	Initial Acquisition of the 5G SA/NSA mode cell/5Gi by UE and decoding of MIB and SIB1 messages		
b.	Validation of Contention Based RACH Procedure for initial access and UL synchronization		
c.	RRC Establishment Procedure		
d.	Registration Procedure with the Core		
e.	Authentication Procedure for SIM card authentication with the HSS		
f.	Access Stratum Security Mode Procedure		
g.	Non-Access Stratum (NAS) Security Mode Procedure		
h.	UE Capability Exchange Procedure		
i.	PDU Session Establishment for the eMBB Data Services		
j.	PDU Session Establishment for the IMS Services and IMS Registration of the Device		
*** [Note: Test procedure is as per Annexure-I]**			

Signed by <Authorised representative of *TSP*- > **Verified by <*LSA*- >**

B. Application Tests

S. No.	Location, Scenario	Test environment*	Applications	Yes/No	Measurement		Remarks
1.	<*Location*>, eMBB		i) Entertainment/ Streaming Applications eg. real time streaming apps, non-real time streaming apps including 4K (UHD) video		Download / Upload speeds, type of content	=	
			ii) Communication Applications eg. Video call app, group meeting app		Download / Upload speeds, type of content	=	
			iii) Other Data Services eg. File Download, social media etc.		Download / Upload speeds, type of content	=	
2.	<*Location*>, URLLC		*<to be filled as in S.No.1 of this table>*				
3.	<*Location*>, mMTC		*<to be filled as in S.No.1 of this table >*				

* Mention whichever test environment is applicable: i) eMBB - Indoor hotspot, Dense urban, Rural-eMBB, Rural eMBB LMLC, ii) URLLC – Urban Macro, iii) mMTC – Urban Macro

Signed by < Authorised representative of *TSP*- > **Signed by <*LSA*- >**

C. Mobility Tests

S.No.	Tests*	Measured parameters		Remarks
a.	Mobility in 5G b. 5G NSA mobility from MeNB to SgNB– sec cell addition.	*i)* NSA Mobility success rate= SgNB__NSA_Admission_Success /SgNB_NSA_Admission_Request *100.	=	
		ii)E-UTRAN Total SgNB Addition Success Ratio	=	
	c. LTE R15 to 5G SA	i) Inter-RAT SA NR handover completion success rate	=	
		ii)	=	
	d. 5G NSA to 5G SA	i) 5G Radio admission success rate in handover for SA users	=	
	a. Mobility within 5G SA	i) Intra-gNB NR cell handover	=	
		ii) Inter-gNB NR cell handover	=	
	- If any other mobility scenario, is applicable, relevant KPI to be indicated and measured.			
b.	Mobility in 5Gi^ *(^ if 5Gi technology is demonstrated/deployed)* a. 5Gi NSA mobility from MeNB to SgNB– sec cell addition.	i) 5Gi NSA Mobility success rate= SgNB__NSA_Admission_Success /SgNB_NSA_Admission_Request *100.	=	
		ii) E-UTRAN Total 5Gi SgNB Addition Success Ratio	=	
	b. LTE R15 to 5Gi SA	i) Inter-RAT 5Gi SA NR handover completion success rate	=	
		ii) 5Gi SA RRC connection establishment success ratio	=	
	c. 5Gi NSA to 5Gi SA	i) 5Gi Radio admission success rate in handover for SA users	=	
	d.Mobility within 5Gi SA	i) Intra-gNB NR cell handover	=	
		ii) Inter-gNB NR cell handover	=	
	To test backward compatibility to 4G network e. From LTE Rel 14 (existing) to 5Gi NSA (LTE Rel 15) HO^{++}, $^{++}$If LTE Release 14 or lower Release is	i) LTE-5Gi Inter frequency or Intra frequency Handover success rate	=	

	part of trial network.			
c.	Mobility 5G (NSA/SA) to 5Gi^	5G-5Gi Inter frequency or Intra frequency Handover success rate	=	

*** [<u>Note:</u> Test procedure is as per Annexure-I]**

Also, if in the use case, the user device is not able to support additional apps that can measure speed, latency etc. then the parameters to be measured in the user side may be measured through an additional mobile handset/Drive Test handset etc. with the requisite apps. This is for Sections D also.

Signed by < Authorised representative of *TSP*- **>** **Signed by <*LSA*-** **>**

D. Performance

Location:				
Scenario:				
Test environment:				
Use case/application:				
S.No.	**Tests***	**Measured parameters**		**Remarks**
a.	Latency (Control Plane and User Plane)	Control plane latency for RRC Establishment	=	
		User Plane latency (Round Trip Ping Latency)	=	
b.	Peak User Throughput and Spectral efficiency	Peak UL User Throughput	=	
		Peak DL User Throughput	=	
		Uplink Spectral Efficiency	=	
		Downlink Spectral Efficiency	=	
c.	Coverage i. Outdoor Single-cell Coverage	RSRP, SINR, Throughput vs Distance, Radial distance between UE and Base station for bottom 5% samples for UL and DL.	= Table to be attached separately, as per format in corresponding procedure in Annexure I- Clause 1.6.	
	ii. Outdoor to Indoor Coverage	Average Indoor Penetration Loss Standard Deviation of RSRP in Outdoor Standard Deviation of RSRP in Indoor	= = =	
d.	Energy Efficiency	Energy Efficiency Gain of NR over LTE	=	
e.	UL Data Split in NSA 3.x (if NSA mode is deployed)	Yes/No	=	

*** [<u>Note:</u> Test procedure is as per Annexure-I]**

Signed by <Authorised representative of *TSP*- >

Signed by <*LSA*- >

5 Security

Lawful Interception capabilities in Core (SA or NS

A mode to be indicated)

i. Control plane
ii. User plane

Test Outcome

The lawful interception can be shown to the LEAs as per the existing methods used in LSA.

* The list of parameters to be noted for 5G trials has been shared separately to the LSAs.

Annexure I

Test Procedures for given parameters

1. Functional tests
2. Application Tests
3. Mobility between different network technology – 4G , 5G and 5Gi
4. Latency (Control Plane and User Plane)
5. User Throughput (Peak and Average) and Spectral efficiency
6. Coverage
7. UL data split in NSA 3.x, (*If shown in the trial*)

1.1 Functional Tests

Test Title	Basic 5G/5Gi network demonstration through Functional tests
Test Objective	To Connect 5G/5Gi device for Network access
Pre-Condition	1. LTE eNB (if NSA mode), 5G/5Gi base station on air 2. 5G/5Gi UE 3. EPC/5GC 4. SIM
Test Execution Step	1. Connect the Phone to a Drive Test Tool or a Diagnostic Manager like QXDM tool or enable logging of Layer 3 messages from appropriate network nodes. 2. Turn on the UE and let it connect to the 5G/5Gi network. 3. Submit the RRC and NAS Layer Messaging logs from the network as the UE tries to Register to the 5G/5Gi Core network and establish PDU Session for the functional tests (from Section 4.A: *a-j*).
Test outcome	The phone connects successfully to the 5G/5Gi network.

1.2 Application Tests

Test Title	Basic 5G/5Gi network demonstration by showing the various applications
Test Objective	To check that various applications work in the 5G/5Gi network
Pre-Condition	1. LTE eNB (if NSA mode), 5G/5Gi base station on air 2. 5G/5Gi UE 3. EPC/5GC 4. SIM
Test Execution Step	1. Register / Attach the UE to the network and ensure that the PDU Session is established and IP Address is acquired by the phone. 2. Open the Android / iOS App for a specific test or a Web Browser on the phone 3. Access the application and wherever possible measure the download / upload speeds / times and also note down the type of content UHD/HD/SD etc.

	4. Check that there are no video stalls / degradation of video resolution when testing video streaming applications.
Test outcome	1. All applications listed in the test cases are accessible with 100% success 2. There is no video stalling even for 4K – UHD video 3. Live Streaming content does not suffer from any stalls or lags. 4. HD Video Streaming can be streamed in uplink without any glitches or downgrade of resolution. 5. Video meeting experience is seamless with good video quality and real time meeting collaboration experience.

1.3 Mobility

1.3.1 Mobility in 5G

Test Title	Mobility in 5G
Test Objective	To check that the service is continuous across LTE R15 MeNB, 5G SgNB, 5G gNB
Pre-Condition	1. LTE eNB, 5G gNB on air 2. 5G UE 3. Interface tracing tools (Wireshark) 4. UE logging tools (e.g. QXDM) or Layer 3 RRC messages from the network side.
Test Execution Step	1. 5G gNB and UE are up and running 2. UE is connected to the Cell A (serving cell, LTE). 3. Connect the Phone to a Drive Test Tool or a Diagnostic Manager like QXDM tool or enable logging of Layer 3 messages from appropriate network nodes. 4. Drive through coverage overlap region between Cell A (4G) and Cell B (5G). Here, Cell A (4G) is Master node (MeNB) (Release 15) with Cell B (5G) as Secondary node (SgNB). *For the case of SA, both Cell A and Cell B will be 5G gNB.* 5. From the RRC messages from the base station, it can be checked if Idle mode mobility/Connected mode mobility occurs. 6. The RRC and NAS Layer Messaging from the network as the UE tries to register to the cell B due to mobility event are logged. 7. In case of idle mode mobility, the apps/calls are successfully initiated at cell A and again at cell B. In case of connected mode mobility, the call/app sustains through the handover from cell A to cell B.
Test outcome	The mobility event occurs successfully and the KPIs mentioned in the Section B- Measured parameters are noted.

1.3.2 Mobility in 5Gi

Test Title	Mobility in 5Gi
Test Objective	To check that the service is continuous across LTE R15 eNB, 5Gi base station
Pre-Condition	1. LTE eNB, 5Gi Base Station on air 2. UE 3. Interface tracing tools (Wireshark) 4. UE logging tools (e.g. QXDM) or Layer 3 RRC messages from the network side.
Test Execution Step	1. 5Gi base station and5Gi UE are up and running 5Gi UE is connected to the Cell A (serving cell, LTE). 2. Connect the Phone to a Drive Test Tool or a Diagnostic Manager like QXDM tool or enable logging of Layer 3 messages from appropriate network nodes. 8. Drive through coverage overlap region between Cell A (4G) and Cell B (5Gi Cell). Here, Cell A (4G) is Master node (MeNB) (Release 15) with Cell B (5Gi) as Secondary node. 3. From the RRC messages from the base station, it can be checked if Idle mode mobility/Connected mode mobility occurs. 4. The RRC and NAS Layer Messaging from the network as the UE tries to register to the cell B due to mobility event are logged. 5. In case of idle mode mobility, the call/app are successfully initiated at cell A and again at cell B. In case of connected mode mobility, the call/app sustains through the handover from cell A to cell B.
Test outcome	The mobility event occurs successfully and the KPIs mentioned in the Section B- Measured parameters are noted.

1.3.3 Mobility 5G to 5Gi

Test Title	Mobility between 5G and 5Gi
Test Objective	To check that the service is continuous across 5G, 5Gi
Pre-Condition	1. LTE eNB, 5G gNB, 5Gi Base Station on air 2. UE 3. Interface tracing tools (Wireshark) 4. UE logging tools (e.g. QXDM) or Layer 3 RRC messages from the network side.
Test Execution Step	1. 5GNB/5Gi base station and UE are up and running 2. UE is connected to the Cell A (serving cell, 5G gNB) 3. Connect the Phone to Diagnostic Manager like QXDM tool or use a Drive Test Tool or enable logging of Layer 3 messages from appropriate network nodes. 4. Drive through coverage overlap region between Cell A (5G gNB) and Cell B (5Gi Base station). 5. From the RRC messages from the base station, it can be checked if Idle mode

	mobility/Connected mode mobility occurs. 6. Note down the RRC and NAS Layer Messaging from the network as the UE tries to register to the cell B due to mobility event. 7. In case of idle mode mobility, the apps/calls are successfully initiated at cell A and again at cell B. In case of connected mode mobility, the call/app sustains through the handover from cell A to cell B.
Test outcome	The mobility event occurs successfully and the KPIs mentioned in the Section B- Measured parameters are noted.

1.4 Latency

1.4.1 Control plane latency for the UEs in 5G /5Gi

Test Title	Service access time from idle to connected mode*
Test Objective	Measure the time from the 4G preamble is sent until the 5G/5Gi RACH procedure is successful and RRC Connection is established
Test Environment	LTE eNB (NSA if used), 5G gNB/5Gi Base Station and active on air
Test parameter and Tools	1. LTE eNB, 5G NB/5Gi Base Station on AIR 2. UE 3. 5G/5Gi interface tracing tools (Wireshark) 4. UE logging tools (e.g. QXDM) or Layer 3 RRC messages from the network side
Pre-Condition	LTE eNB, 5G NB cell/5Gi Base Station on air
Test Execution Steps	1. Initiate data session from the 5G/5Gi UE 2. From UE logs capture the timestamp when the preamble is sent or timestamp from RRC setup request message log is noted. 3. UE has successfully received the information required to trigger the 5G random access procedure via RRC message. 4. UE triggers the random-access procedure over NR air interface 5. 5G/5Gi RACH procedure is successful 6. From UE logs capture the timestamp when the 5G/5Gi RACH is successfully completed and RRC Setup is competed or timestamp from RRC message log is noted. 7. The time difference between RRC Setup Complete received by the UE and first preamble sent by UE can be measured as Control Plane latency.
Test Outcome	The control plane latency is noted.

1.4.2 User plane latency for the UEs in 5G /5Gi

Test Title	Latency when the device is in RRC active mode
Test Objective	Measure the time from the data packet is sent to when the response comes back
Test Environment	LTE eNB (NSA if used), 5G gNB/5Gi Base Station and active on air
Test parameter and Tools	1. LTE eNB, 5G NB/5Gi base station on AIR 2. UE 3. 5G/5Gi interface tracing tools (Wireshark) 4. UE logging tools (e.g. QXDM) or app on UE that measures latency
Pre-Condition	LTE eNB, 5G/ 5Gi base station on air
Test Execution Steps	1. Initiate data session from the UE 2. Send user data in RRC connected mode use app on phone to ping test server and measure average round drip user plane latency over 1000 ping packets
Test Outcome	The user plane latency is noted.

1.5 Downlink and uplink throughput for 5G/5Gi UE and Spectral Efficiency

1.5.1 Peak Downlink throughput Peak and Spectral Efficiency

Test Title	5G NR Downlink throughput
Test Objective	The test measures the peak downlink throughput
Test Environment	5gNB/5Gi Base Station, LTE eNB (if NSA), EPC/5GC, UE
Test equipment and Tools	1. LTE eNB, 5G NB/5Gi Base Station on AIR 2. UE 3. Traffic generator (e.g. Iperf or FTP server) 4. UE logging tools (e.g. QXDM) or logs from the network 5. Throughput measurement applications (e.g. Ookla speed test, NetPerSec)
Pre-Condition	1. LTE eNB is up and running 2. 5G gNB/5Gi Base Station is up running, cell is one-air 3. EPC/5GC is up and running 4. X2 link is setup between LTE eNB and 5G gNB/5Gi base station
Test Execution Steps	Peak Downlink throughput 1. 5G gNB/5Gi base station and UE are up and running 2. Maximum achievable DL/UL data rate measured in the field environment, with only one UE in the cell under test, positioned in the ideal radio conditions and no other UEs placed in the surrounding cells. Peak rate test should be executed in stationary scenario. The UE under test is attached to the cell 3. TSP can choose location as per most suitable for maximum throughput 4. Identify a location(s) where highest data rate in the DL can be attained with stability. 5. Start DL data transfer and measure it using app/ from network KPI. 6. The UE receives data with DL throughput. Also record the corresponding resources (bandwidth) assigned to the user from the network logs. 7. Instantaneous peak throughput during the course of the data session will be termed as" Peak Throughput" 8. If massive MIMO is deployed, relevant number of UEs to maximise the cell throughput to be deployed at different locations and the UE_DL_Throughput_1+ UE_DL_Throughput_2……..+ UE_DL_Throughput_x. Spectral Efficiency Divide the peak user throughput (from point 7 or 8) by Bandwidth assigned to user to get Peak spectral efficiency for DL.
Test Outcome	i) Peak Downlink throughput and peak spectral efficiency is noted. ii) If massive MIMO is deployed, the UE_DL_Throughput_1+ UE_DL_Throughput_2……..+ UE_DL_Throughput_x is noted. This is used to calculate the peak spectral efficiency for DL and is noted.

1.5.2 Peak Uplink throughput and Spectral Efficiency

Test Title	5G NR Uplink throughput
Test Objective	The test measures the peak uplink throughput
Test Environment	5gNB/5Gi Base Station, LTE eNB, EPC/5GC, UE
Test equipment and Tools	1. LTE eNB, 5G NB/5Gi Base Station on AIR 2. 5G/5Gi UE 3. Traffic generator (e.g. Iperf or FTP server) 4. UE logging tools (e.g. QXDM) or logs from the network 5. Throughput measurement applications (e.g. Ookla speed test, NetPerSec)
Pre-Condition	1. LTE eNB is up and running 2. 5G gNB/5Gi Base Station is up running, cell is one-air 3. EPC/5GC is up and running 4. X2 link is setup between LTE eNB and 5G gNB/5Gi base station
Test Execution Steps	Peak Uplink throughput 1. 5G gNB/5Gi base station and UE are up and running 2. Maximum achievable UL data rate measured in the field environment, with only one UE in the cell under test, positioned in the ideal radio conditions and no other UEs placed in the surrounding cells. Peak rate test should be executed in stationary scenario. The UE under test is attached to the cell 3. TSP can choose location that is most suitable for maximum throughput 4. Identify a location(s) where highest data rate in the UL can be attained with stability. 5. Start UL data transfer and measure it using app/from network KPI. 6. 5G gNB/5Gi base station receives data with an UL throughput. Also record the corresponding resources (bandwidth) assigned to the user from the network logs. 7. Instantaneous peak throughput during the course of the data session will be termed as“ Peak Throughput’ . 8. If massive MIMO is deployed, relevant number of UEs to maximise the cell throughput to be deployed at different locations and the UE_UL_Throughput_1+ UE_UL_Throughput_2……..+ UE_UL_Throughput_x. Peak spectral efficiency Divide the peak user throughput (from point 7 or 8) by Bandwidth assigned to user to get Peak spectral efficiency for UL.
Test Outcome	i) Peak Uplink throughput is noted and peak spectral efficiency. ii) If massive MIMO is deployed, the UE_UL_Throughput_1+ UE_UL_Throughput_2……..+ UE_UL_Throughput_x is noted. This is used to calculate the peak spectral efficiency for UL and is noted.

1.6 Coverage

1.6.1 Outdoor Single-cell Coverage

<table>
<tr><td>Test Title</td><td>Outdoor Single-cell Coverage</td></tr>
<tr><td>Test Objective</td><td>The coverage performance will be tested in DL, in control and data channels, in terms of both the maximum distances in LOS and NLOS conditions, and the corresponding data rates.</td></tr>
<tr><td>Test Environment</td><td>5G gNB/5Gi Base Station, LTE eNB, EPC/5GC, UE</td></tr>
<tr><td>Test equipment and Tools</td><td>1. LTE eNB, 5G NB/5Gi Base Station on AIR
2. 5G/5Gi UE
3. Traffic generator (e.g. Iperf or FTP server)
4. UE logging tools (e.g. QXDM) or logs from the network
5. Throughput measurement applications (e.g. Ookla speed test, NetPerSec)</td></tr>
<tr><td>Pre-Condition</td><td>1. LTE eNB is up and running
2. 5G gNB/5Gi Base Station is up running, cell is on-air
3. EPC/5GC is up and running
4. X2 link is setup between LTE eNB and 5G gNB (NSA mode)
5. 5G/5Gi cell is on.
6. Only Single Cell under test is radiating and all other cells are RF Locked so that no handovers happen and farthest coverage point can be determined.</td></tr>
<tr><td>Test Execution Steps</td><td>1. 5G gNB/ 5Gi Base Station
2. Four UEs to be used for testing – Two for DL and Two for UL
3. All Four UEs under test are attached to the cell in Good RF (Near Cell)
4. DL Data Throughput is started on two UEs designated for DL
5. UL Data Throughput is started on two UEs designated for UL
6. Drive using all four UEs from Cell Centre to Cell Edge till the point where Radio Link Failure is observed and UE disconnects from the Cell. At 5 points in between, measure the RSRP, SINR and throughput versus distance from base station for the downlink.
7. Note down the parameters as per table for 5% Edge and 50% Median Samples
8. For RSRP corresponding to 5% Edge samples, determine radial distance between gNB Tower and farthest 5% RSRP sample for DL and UL differently.
DL UEs:
<table>
<tr><td></td><td>UE1</td><td>UE2</td><td>Aggregate/Average</td><td>UE1</td><td>UE2</td><td>Aggregate/Average</td></tr>
<tr><td></td><td colspan="3">Bottom 5% Samples (Cell Edge)</td><td colspan="3">50% Median Samples</td></tr>
<tr><td>RSRP</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>SINR</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>CQI</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
</table>
</td></tr>
</table>

Rank						
MCS						
DL PRB						
DL Throughput						
Radial distance between UE and BS						

UL UEs:

	UE1	UE2	Aggregate/Average	UE1	UE2	Aggregate/Average
	Bottom 5% Samples (Cell Edge)			50% Median Samples		
RSRP						
Tx Power (MTPL)						
MCS						
UL PRB						
UL Throughput						
Radial distance between UE and BS						

Coverage at high frequency bands (above 6GHz to mmWave):

If deployed, same table to be filled as above.

Test outcome	The data in above tables to be reported.

1.6.2. Outdoor to Indoor Coverage

Test Title	Outdoor to Indoor Coverage
Test	To measure the One-wall Penetration Loss of 5G NR signal in 3.5 GHz band and thereby check Indoor Coverage in terms of RSRP, SINR and Throughputs.

<table>
<tr><td>Objective</td><td></td></tr>
<tr><td>Test Environment</td><td>5G gNB/5Gi Base Station, LTE eNB, EPC/5GC, UE</td></tr>
<tr><td>Test equipment and Tools</td><td>1. LTE eNB, 5G NB/5Gi Base Station on AIR
2. 5G/5Gi UE
3. Traffic generator (e.g. Iperf or FTP server)
4. UE logging tools (e.g. QXDM) or logs from the network
5. Throughput measurement applications (e.g. Ookla speed test, NetPerSec)

Note: The site for this testing should be selected in such a way that there should be one or more buildings in the close vicinity of the 5G site. This is important to carry out indoor penetration loss measurement effectively.</td></tr>
<tr><td>Pre-Condition</td><td>1. LTE eNB is up and running
2. 5G gNB/5Gi Base Station is up running, cell is on-air
3. EPC/5GC is up and running
4. X2 link is setup between LTE eNB and 5G gNB (for NSA mode)
5. 5G/5Gi cell is on.
6. Only Single Cell under test is radiating and all other cells are RF Locked so that no handovers happen and farthest coverage point can be determined.</td></tr>
<tr><td>Test Execution Steps</td><td>1. Single UE to be used for testing.

2. At least 5 points to be identified prior to conducting the test where both Outdoor Signal and Indoor Signal behind one wall can be measured. This is important to measure penetration loss more accurately.

3. These 5 points should have average outdoor RSRP in the range of -70 to -85 dBm.

4. At each of the 5 points following tests shall be conducted in sequence while collecting the UE logs
a. DL Throughput Test – 5 minutes
b. UL Throughput Tests – 5 minutes
c. Ping – 100 pings
5. At each point, test will be conducted at both Outdoor and One-wall Indoor Location
6. Following tables will be filled up from the UE Logs

<table>
<tr><td></td><td colspan="2">Point 1</td><td>……..</td><td colspan="2">Point 5</td></tr>
<tr><td></td><td>Outdoor</td><td>Indoor</td><td></td><td>Outdoor</td><td>Indoor</td></tr>
<tr><td>RSRP</td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>SINR</td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>DL Throughput</td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>UL Throughput</td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Ping Latency</td><td></td><td></td><td></td><td></td><td></td></tr>
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<table>
<tr><td></td><td>
7. In addition to comparison of Average Values, a more granular analysis of RSRP should also be tabulated for similar duration of test. Following table can be used for each point.
<table>
<tr><td></td><td>Outdoor</td><td>Indoor</td></tr>
<tr><td>Bottom 5% RSRP</td><td></td><td></td></tr>
<tr><td>50% RSRP</td><td></td><td></td></tr>
<tr><td>Top 50% RSRP</td><td></td><td></td></tr>
<tr><td>Standard Deviation of RSRP</td><td></td><td></td></tr>
</table>
</td></tr>
<tr><td>Test outcome</td><td>Following shall be the Test Outcomes – Averaged over all 5 points.
1. Average Indoor Penetration Loss = Outdoor RSRP – Indoor RSRP
2. Standard Deviation of RSRP in Outdoor =
3. Standard Deviation of RSRP in Indoor =</td></tr>
</table>

1.7 Energy Efficiency

Test Title	Energy Efficiency of 5G NR
Test Objective	To find out the Energy Efficiency Gain of 5G NR over LTE
Test Environment	5G gNB/5Gi Base Station, LTE eNB, EPC/5GC, UE
Test equipment and Tools	1. LTE eNB, 5G NB/5Gi Base Station on AIR 2. 5G/5Gi UE 3. Traffic generator (e.g. Iperf or FTP server) 4. UE logging tools (e.g. QXDM) or logs from the network 5. Throughput measurement applications (e.g. Ookla speed test, NetPerSec)
Pre-Condition	This test can be done in lab and results of lab testing can be shared. It is not required to perform the test in field as it does not require any field conditions and the main objective is to measure the Energy Efficiency. 1. LTE eNB is up and running (NSA mode) 2. 5G gNB/5Gi Base Station is up running, cell is on-air 3. EPC/5GC is up and running 4. X2 link is setup between LTE eNB and 5G gNB (NSA mode)

	5. 5G/5Gi cell is on.
Test Execution Steps	**Part 1: Measuring LTE Energy Consumption:** 1. Connect a UE in ideal RF condition of LTE cell and download 5 files of 1 GB one after the other in an automated manner using Filezilla FTP client. 2. Note down the time required to download all 5 files completely. Let this be called as T_{LTE}. 3. Let the Average Power Consumed by the LTE cell during this time be P_{LTE} 4. Then the Energy Consumed by the LTE cell will be $E_{LTE} = P_{LTE} \times T_{LTE}$ **Part 2: Measuring NR Cell Energy Consumption:** 1. Connect a UE in ideal RF condition of NR cell and download 5 files of 1 GB one after the other in an automated manner using Filezilla FTP client. 2. Note Down the time required to download all 5 files completely. Let this be called as T_{NR}. 3. Let the Average Power Consumed by the NR cell during this time be P_{NR} 4. Then the Energy Consumed by the NR cell will be $E_{NR} = P_{NR} \times T_{NR}$ **Part 3: Calculating the Energy Efficiency Gain** 1. As the radios used in LTE and NR might have different configurations (4T4R 8T8R, 32T32R 64T64R etc.) and also the Maximum RF Output Power specifications of both radios are likely to be different, exact comparison of Power Consumption of both radios is not appropriate. So for the sake of Energy Calculation we should assume the following: $P_{NR} = P_{LTE} = P$ 2. Energy Efficiency Gain of NR over LTE = T_{LTE} / T_{NR}
Test outcome	A baseline of Energy Efficiency Gain of NR over LTE is obtained for Single User MIMO. This is directly proportional to the capacity gain. This only represents the minimum gain and higher gain can be achieved with MU-MIMO as it improves the capacity.

1.8 UL Data Split in NSA 3.x

Test Title	**UL Data Split Functionality**
Test Objective	Showcase and verify the changes between the UL transmission modes in NSA 3.x 1. uplink NR only transmission 2. uplink LTE only transmission 3. uplink LTE + NR transmission

Test Environment	LTE eNB & 5G gNB/5Gi Base Station is configured for EN-DC support and active on air
Test parameter & tools	1. LTE eNB, 5G NB/5Gi Base Station on AIR 2. 5G/5Gi UE support for LTE + NR UL tranmission 3. 5G/5Gi interface tracing tools (Wireshark) 4. UE logging tools (e.g. QXDM)
Pre-Condition	1. 5G gNB/5Gi Base Station is up and running, cell on air 2. UE is EN-DC connected to both LTE & 5G/5Gi cell
Test Execution Steps	1. Start the UL & DL data transfer 2. Perform drive-test measurement in area of interest/select static locations to trigger uplink transmission mode as per the three options listed in the test objective 3. Collect UE logs or base station logs (LTE eNB & 5G gNB/5Gi Base Station)
Test outcome	From the UE or BTS logs check the uplink transmission modes are successfully switching between following modes based on operator configurable parameters 1. uplink NR only transmission 2. uplink LTE only transmission 3. uplink LTE + NR transmission

Appendix

End to end architecture

A sample diagram of the 5G E2E trial solution. This may change as per the actual deployment in 5G Trials in NSA/SA mode with 5G/5Gi base station.

The actual deployment architecture is to be provided.

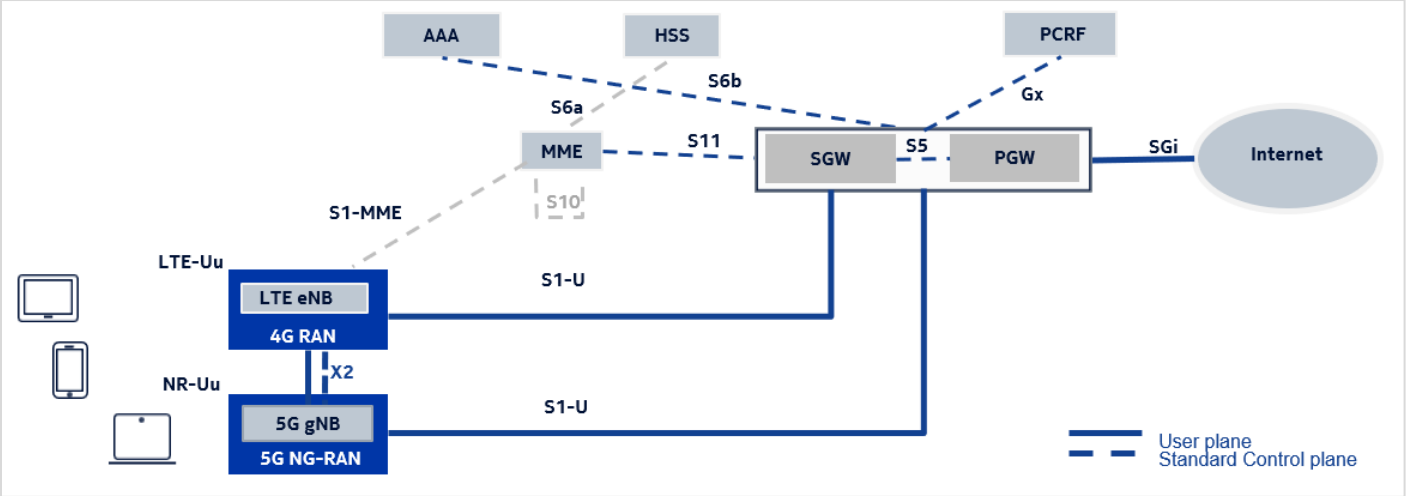

Figure 1 E2E Trial solution

In the 3.x architecture, the gNB (SgNB) has only S1-U link to the EPC, and no S1-C connection. It is controlled by an eNB (MeNB) that is responsible for signaling with the EPC, and establishment of 5G bearers between the S-GW and the gNB. Legacy X2 link (X2-C and X2-U) is used between the eNB and the gNB for the setting up of X2 links and establishment of 5G Bearers.