

# O-RAN Plug Fest

## LIONS RANathon 5G O-RAN Solution

Sub-system & End-to-End System Testing  
with  
Lions O-RU, FHGW, O-DU & O-CU

## Headquarters Hsinchu, Taiwan

### LIONS Taiwan Technology Inc.

Business operation/ R&D/ Technical Services/  
Supplier Chain/ Procurement/ Manufacture PM

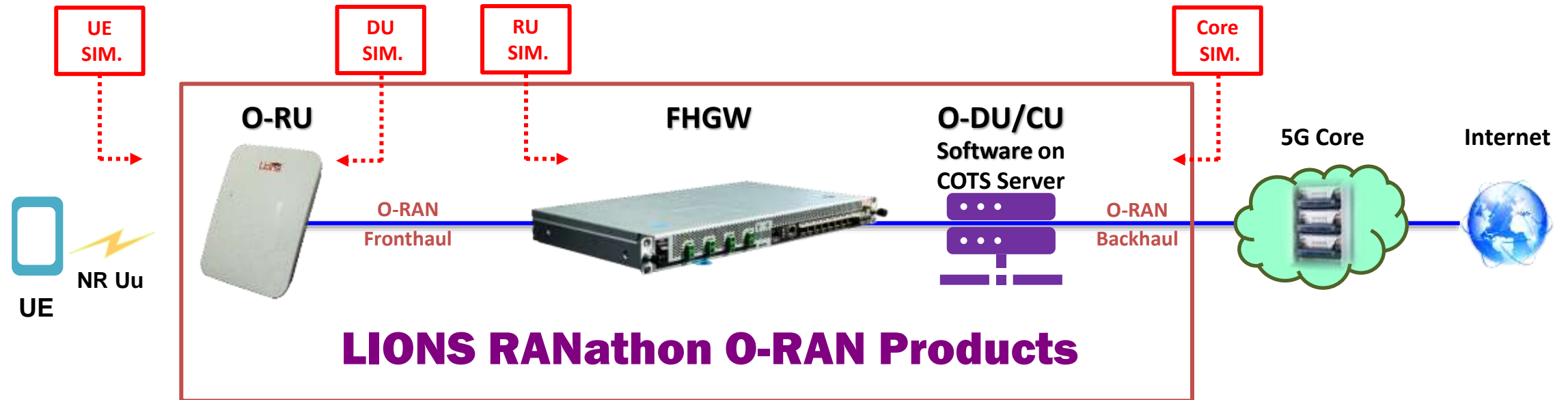


## Los Angeles, USA

### LIONS USA Technology, INC.

5G technology research/ 5G market  
analysis/ 5G product line design and  
management (PLM)/ Technical  
service/ RMA

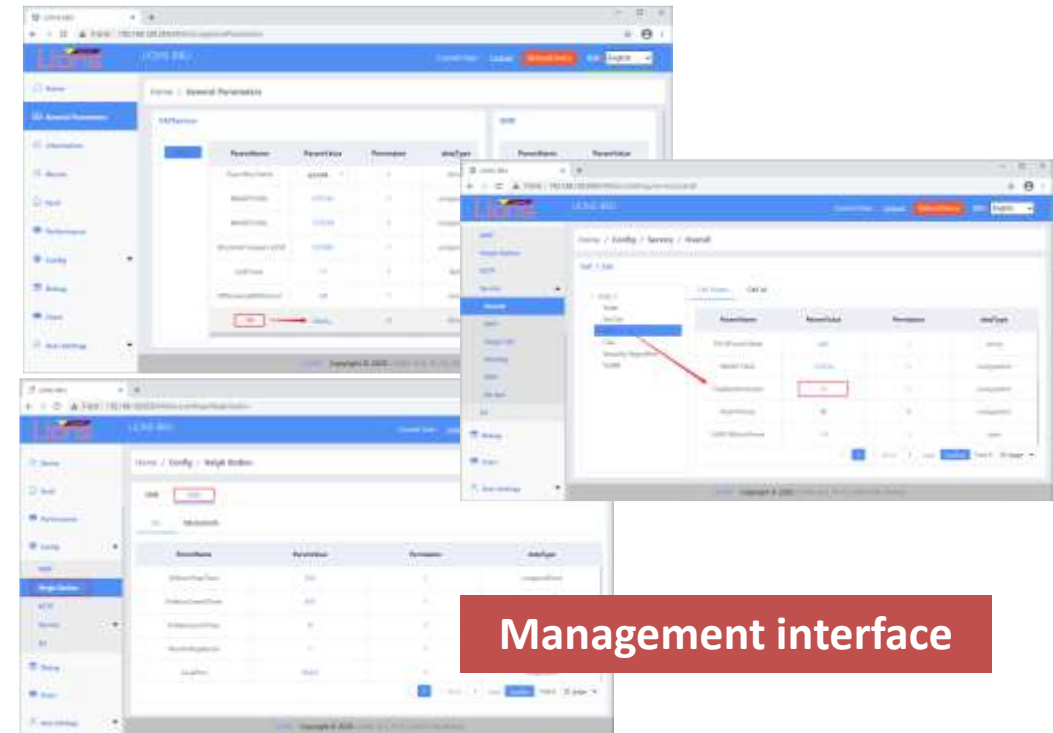
- LIONS Technology, established in July 2019, is dedicating to wireless SmallCell base stations and RF technology development, manufacturing, marketing, sales, and customer support.
- LIONS team was established with core competencies in 2G/3G/4G all-RAT and all-bands SmallCell products, LIONS team takes all experiences to participate in the 5G wireless communication market.
- Unlike other O-RAN suppliers, LIONS is not only developing base stations software, but also design and fine tune RF technologies from bottom up. The integration of the end-to-end O-RAN function is guaranteed.
- LIONS strategically partners with a Fortune 500 company in manufacturing, supply chain, and quality assurance to ensure its products meet the world-class standards.



Case	Device	Venue	Test Standard	Test Result
A	LIONS RANathon O-RU	Auray	O-RAN.WG4.CONF	Complete and pass
B	LIONS RANathon O-DU O-CU	Auray	O-RAN.WG8.IOT+ O-RAN.WG4.IOT	Complete and pass
C	O-RAN	Auray	O-RAN.WG8.IOT	Complete and pass
D	O-RAN	Auray	Performance & Stress Test	Complete and pass
E	O-RAN	Auray	Network Security	Complete and pass

## LIONS RANathon O-CU and O-DU

- 3GPP R15/ R16 compliance
- O-RAN CU+DU architecture/eCPRI Fronthaul Sync
- Max. 400 UEs per cell
- NETCONF/YANG management
- PDCP duplication
- CSI-RS measurement
- Mini-slot Schedule
- Bandwidth – 100MHz/200MHz
- Numerology 3 [120KHz]
- MU-MIMO
- URLLC Basics
- Network function virtualization



Management interface



Xilinx acceleration card



## LIONS RANathon FHGW

- Deployment: Indoor, near O-DU
- Function: Uplink aggregation, downlink relay
- O-DU interface: Open Fronthaul (Option 7-2x)/ 10G eCPRI interfaces
- O-RU interface: Open Fronthaul (Option 7-2x)/ 10G eCPRI interfaces/ Max. 8xO-RUs per FHGW
- Timing: 1588v2, SyncE, and GPS GNSS/ active GPS antenna
- Dimension: 428mm x 316mm x 137mm
- Weight: 4.35 Kg
- Level of protection: IP30
- Atmospheric pressure: 81 to 106Kpa.
- Operating temperature: -5°C ~ +45°C
- Operating humidity: 5%~95%
- Cooling mode: Fan
- Power supply: 100~240V AC
- Power consumption: 60W FHGW
- RU remote power: AnyTek terminal plug, 60W per port



FHGW

## LIONS RANathon 5G O-RU Outdoor

### Outdoor (RS8602/ RS8600)

Frequency Bands	n78 (RS8602), n79 (RS8600)
Occupied Bandwidth	Up to 100MHz
MIMO	4T4R
Max. Tx Power	5W/ch (RS8602), 250mW/ch (RS8600)
Fronthaul Split	O-RAN 7-2x
Dimension	428X316X137mm
Weight	15 Kg / 10.5Kg
Mounting method	Wall and pole mounting
Atmospheric pressure	81 to 106Kpa.
Level of protection	IP65
Temperature and Humidity	-40°C to +55°C; 5%~95%
Cooling	Passive
Power Consumption	150W/ 60W
Power supply	100~240V AC



**Outdoor: 428X316X137mm**

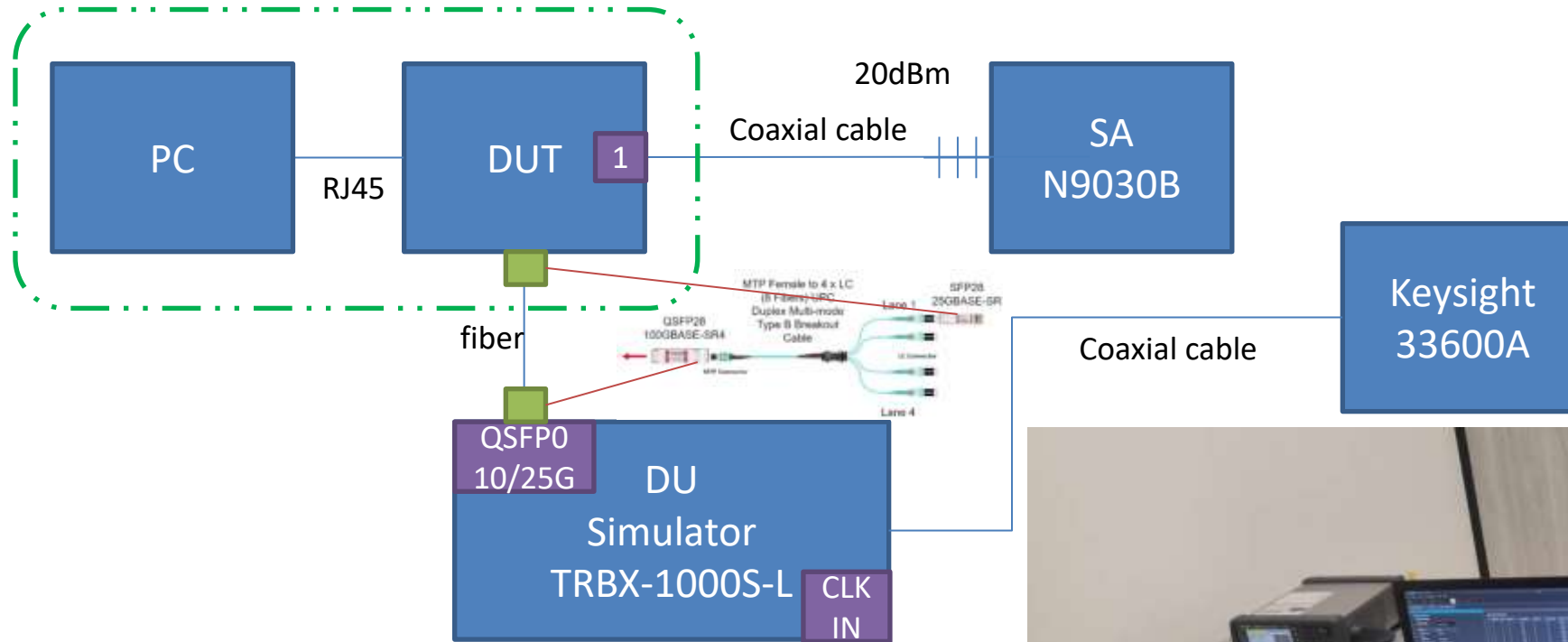
## LIONS RANathon 5G O-RU Indoor

### Indoor (RS8601)

Fronthaul Split	O-RAN 7-2x
n78 SKUs	3,300~3,600MHz, 3,550~3,800MHz
n79 SKUs	4,800~4,900MHz, 4,600~4,900MHz
Occupied Bandwidth	Up to 100MHz
MIMO	4T4R
Max. Tx Power	250mW/ch
Dimension	260X205X55mm
Weight	1.4 Kg
Mounting method	Wall and ceiling mounting
Atmospheric pressure	81 to 106Kpa.
Level of protection	IP30
Temperature and Humidity	0°C to +45°C; 5%~95%
Cooling	Fan
Power Consumption	60W
Power supply	19~48V DC



**Indoor: 260X205X55mm**



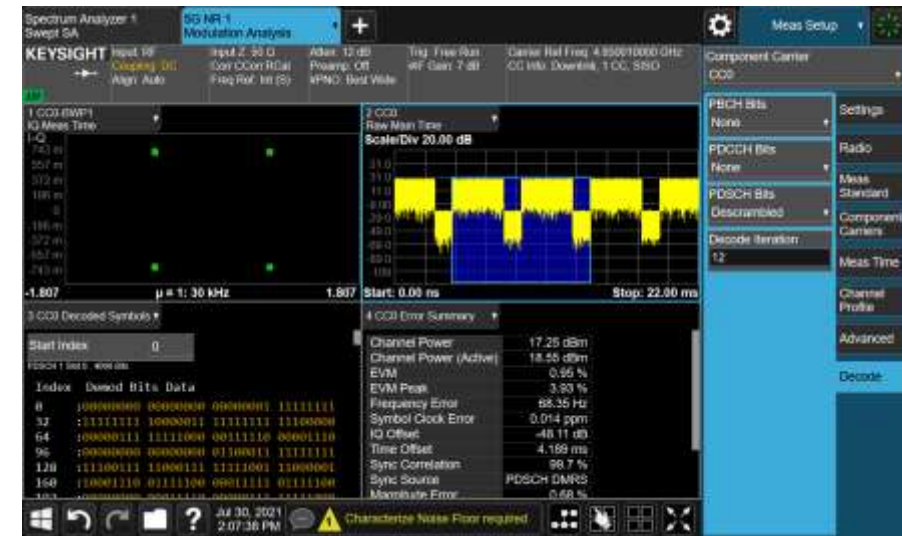
## ■ Test Equipment

- Keysight U5040A open RAN Studio
- Keysight SA N9030B

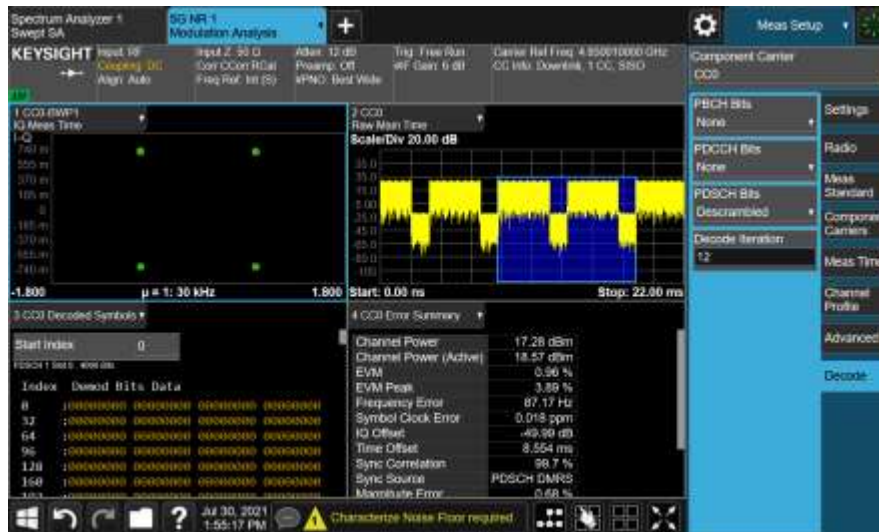


Case	Device	Test Result
3.2.5.1.1	O-RU Scenario Class Base 3GPP DL	Compliance
3.2.5.1.2	O-RU Scenario Class Extended 3GPP DL – Resource allocation	Compliance
3.2.3.4.1	O-RU Scenario Class DLM Test #1: Downlink – Positive testing	Compliance

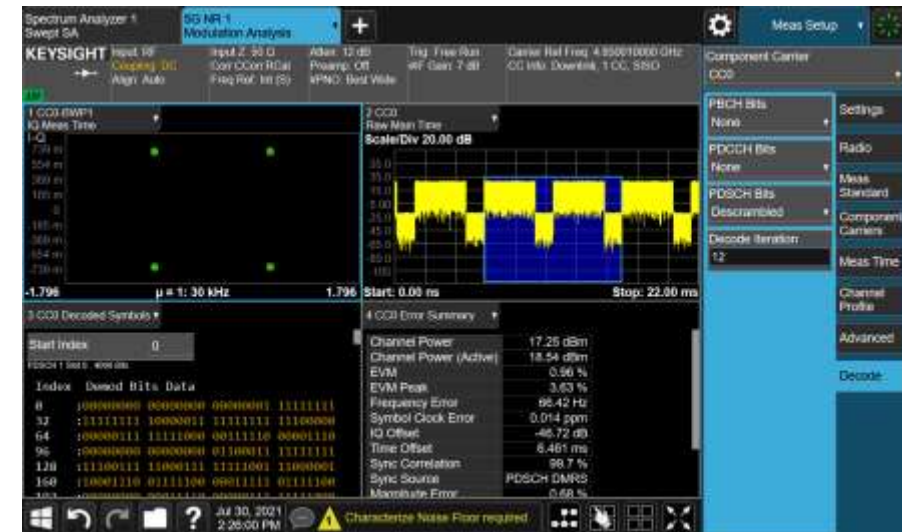
## 3.2.5.1.2 EVM

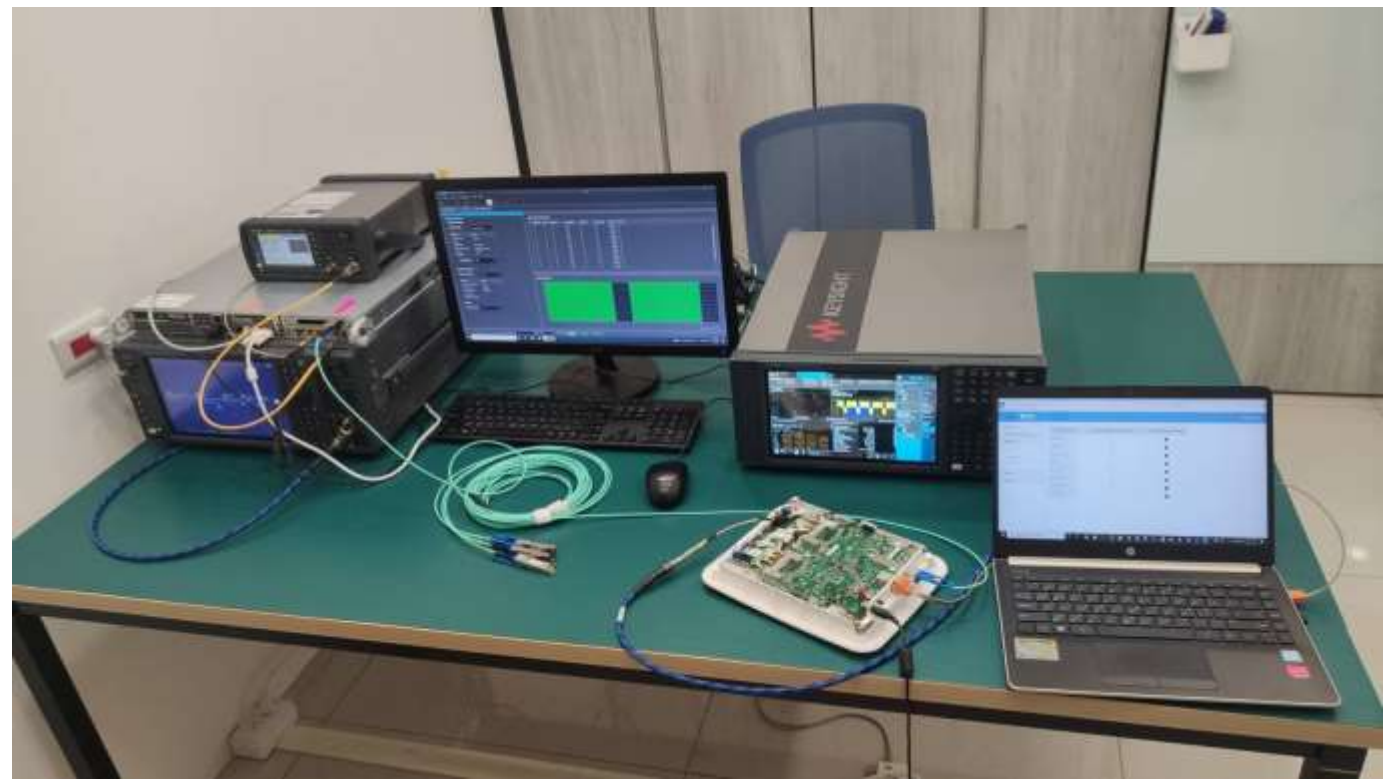
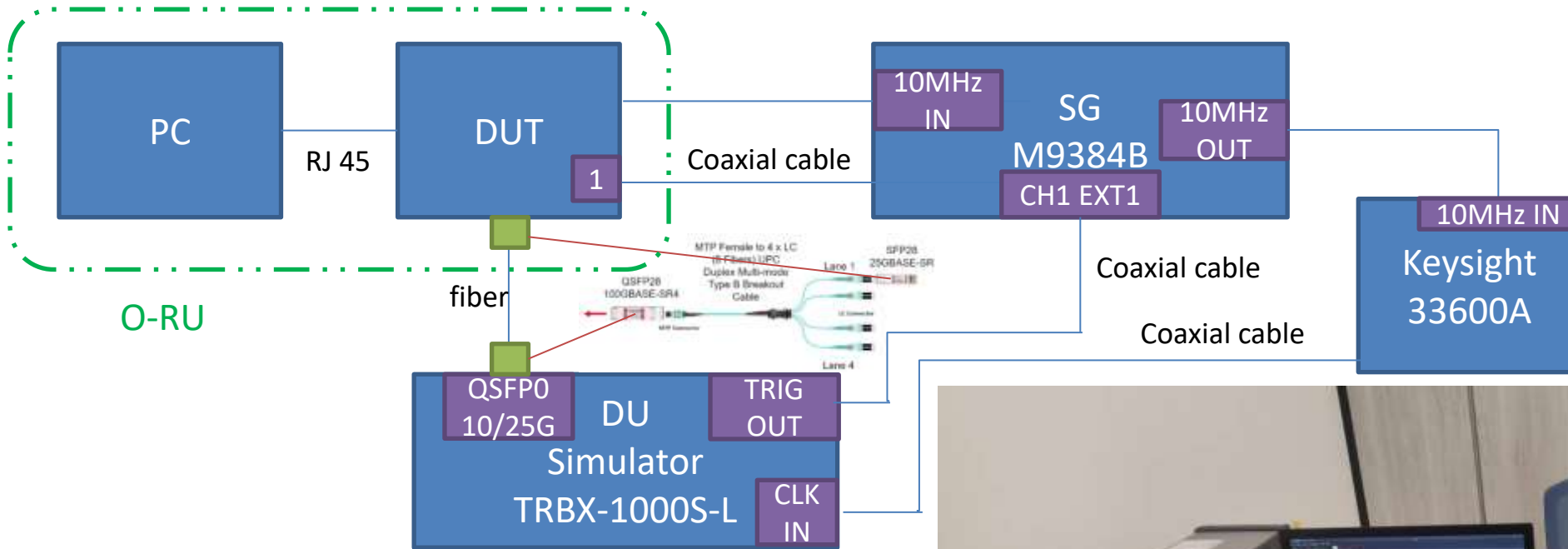


## 3.2.5.1.1 EVM



## 3.2.3.4.1 EVM



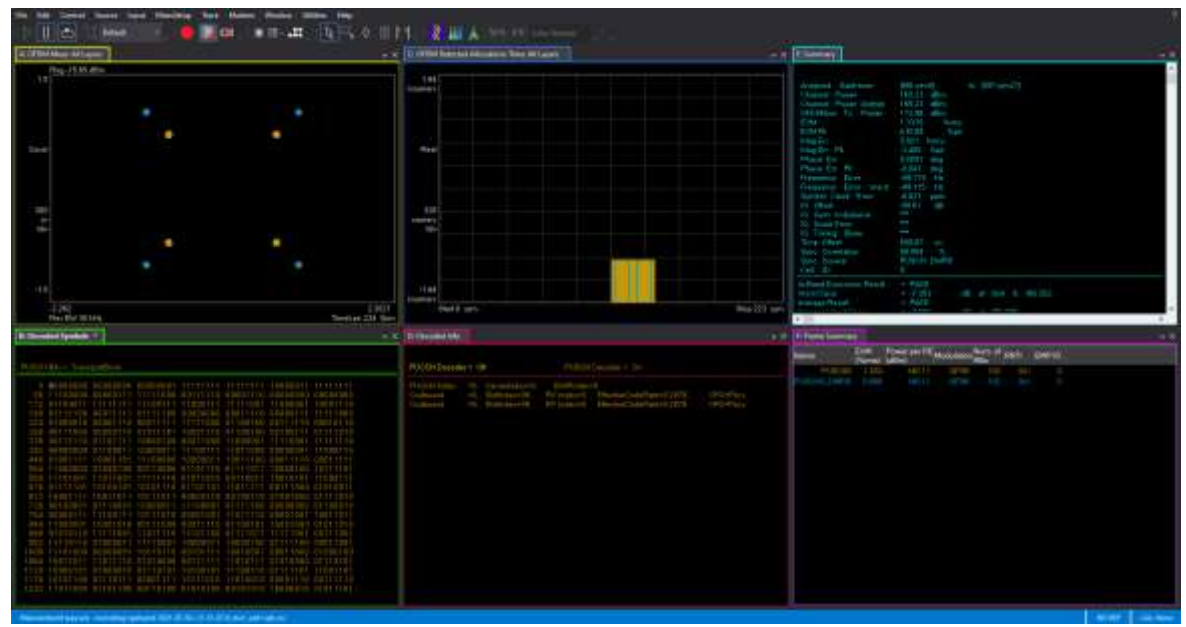


## ■ Test Equipment

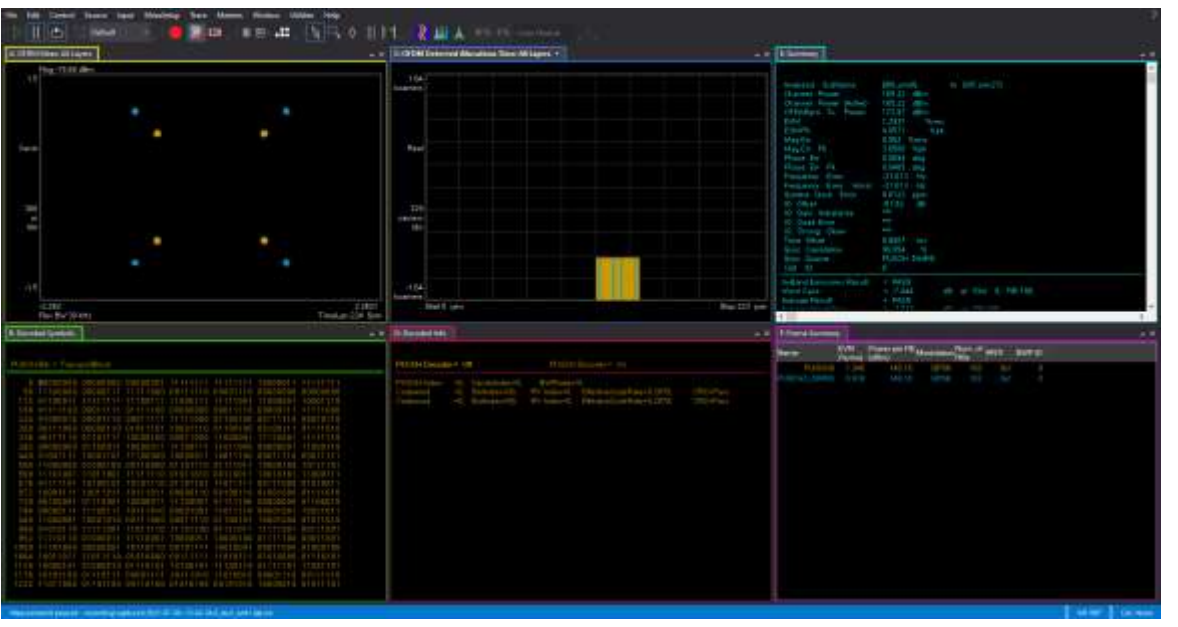
- Keysight U5040A open RAN Studio
- Keysight SG M9384B

Case	Device	Test Result
3.2.5.1.3	O-RU Base Class TDD Test UL	Compliance
3.2.3.4.2	O-RU Scenario Class DLM Test #2: Uplink – Positive testing	Compliance

### ■ 3.2.5.1.3 EVM



### ■ 3.2.3.4.2 EVM





Case	Device	Test Result
3.2	Cell Setup	Compliance
3.3~3.6	SystemInformation-MIB/SIB1/SIB2/SIB3	Compliance

### 3.3 MIB

Frame 2658: 56 bytes on wire (448 bits), 56 bytes captured (448 bits)

Line Server Unit, Port:1, downlink, NR-5G, NR5G Radio interface, Pp:0 Chn:0, Downlink Frame, Err: None (0), Lost:0

NR5G (2.0) - DL PDCP

NR Packet Data Convergence Protocol (3GPP 38.323/16.2.0 (2020-09) Rel.16) - PDCP Data PDU for SRBs

NR Radio Resource Control (RRC) protocol V16.2.0 (2020-09)

BCCH-BCH-Message

message: mib (0)

mib

- systemFrameNumber: 54 [bit length 6, 2 LSB pad bits, 0101 01.. decimal value 21]
- subCarrierSpacingCommon: scs300r120 (1)
- ssb-SubcarrierOffset: 14
- dmsr-TypeA-Position: pos2 (0)
- pdccch-ConfigSIB1
  - controlResourceSetZero: 5
  - searchSpaceZero: 0
  - cellBarred: notBarred (1)
  - intraFreqReselection: allowed (0)
  - spare: 00 [bit length 1, 7 LSB pad bits, 0... .... decimal value 0]

### 3.4~3.6 SIB1/SIB2/SIB3

Frame 2831: 171 bytes on wire (1368 bits), 171 bytes captured (1368 bits)

Line Server Unit, Port:1, downlink, NR-5G, NR5G Radio interface, Pp:0 Chn:0, Downlink Frame, Err: None (0), Lost:0

NR5G (2.0) - DL PDCP

NR Packet Data Convergence Protocol (3GPP 38.323/16.2.0 (2020-09) Rel.16) - PDCP Data PDU for SRBs

NR Radio Resource Control (RRC) protocol V16.2.0 (2020-09)

BCCH-DL-SCH-Message

message: c1 (0)

c1: systemInformationBlockType1 (1)

- systemInformationBlockType1
  - cellSelectionInfo
    - q-RxLevMin: -140dBm (-70)
    - q-QualMin: -120
  - cellAccessRelatedInfo
    - plmn-IdentityList: 1 item
    - si-SchedulingInfo
      - schedulingInfoList: 1 item
      - si-WindowLength: s5 (0)
      - si-RequestConfig
    - servicingCellConfigCommon
      - downlinkConfigCommon
        - uplinkConfigCommon
        - ssb-PositionsInBurst
        - ssb-PeriodicityServingCell: ms20 (2)
        - tds-Ul-DL-ConfigurationCommon
        - ss-PBCH-BlockPower: -11dBm
      - ue-TimersAndConstants
        - T300: ms1000 (5)
        - T301: ms200 (1)
        - T310: ms1000 (5)
        - n310: n0 (0)
        - T311: ms10000 (1)
        - n311: n1 (0)
        - T319: ms1000 (5)
- sib-TypeAndInfo item: sib2 (0)
  - sib2
    - cellReselectionInfoCommon
    - cellReselectionServingFreqInfo
    - intraFreqCellReselectionInfo
  - Item 1
  - Item 2
- sib-TypeAndInfo item: sib3 (1)
  - sib3
    - intraFreqBlackCellList: 1 item
      - Item 0
        - PCI-Range
          - start: 56
    - Item 2

Case	Device	Test Result
3.10	PDU session establishment procedure	Compliance
3.11	PDU Session Modification with Multiple Flow	Compliance
3.13	Downlink UDP data transfer	Compliance

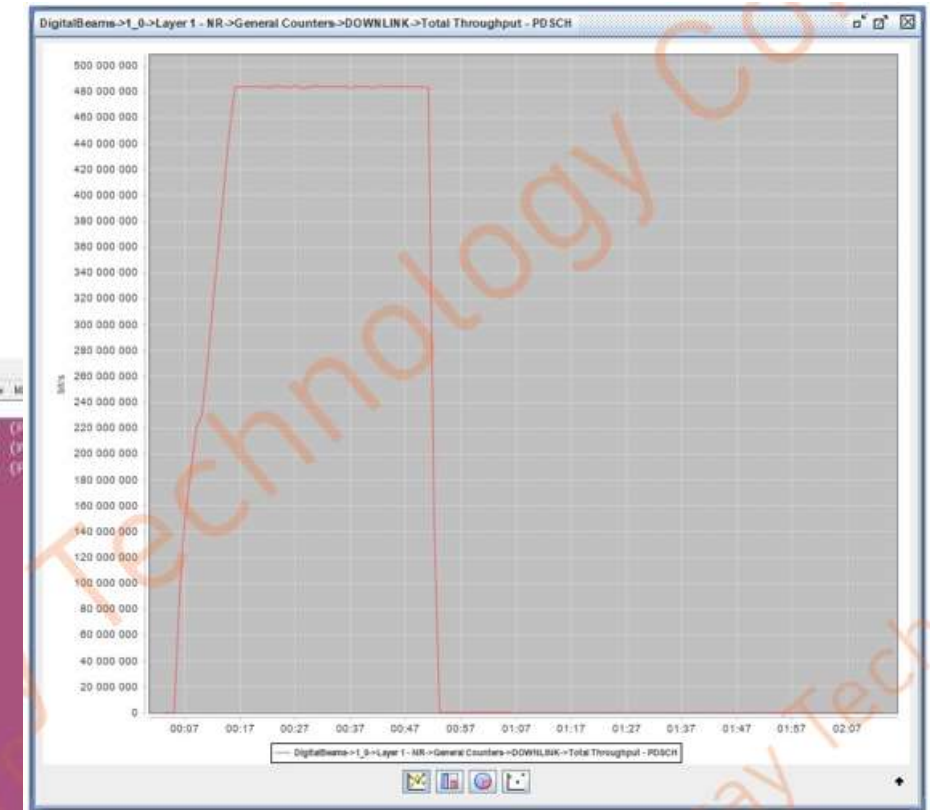
## 3.11 PDU Session Modification with Multiple Flow

Wireshark packet capture showing NR RRC and NR MAC frames. The 'QoS' column is highlighted with a red box for the first three frames.

No.	Time	Protocol	Source	Destination	Raw Data	QoS	Flow ID	Flow Priority	Flow Label	Info
9643	2021-11-03 15:40:35.989820	NR RRC	5G5-NAS	downlink		0	1,1			RRCReconfiguration (DL NAS transport) (P
41255	2021-11-03 15:46:51.176594	NR RRC	5G5-NAS	downlink		0	1,1			RRCReconfiguration (DL NAS transport) (P
31207	2021-11-03 15:46:46.189663	NR RRC	5G5-NAS	downlink		0	1,1			RRCReconfiguration (DL NAS transport) (P
105219	2021-11-03 15:47:21.215532	NR MAC	NR MAC	uplink			2,2			DL RRC (RRC PDU)
105218	2021-11-03 15:47:21.215320	NR MAC	NR MAC	downlink						DL RRC (RRC PDU)
105217	2021-11-03 15:47:21.214316	NR MAC	NR MAC	uplink						DL RRC (RRC PDU)
105216	2021-11-03 15:47:21.214313	NR MAC	NR MAC	downlink						DL RRC (RRC PDU)
105212	2021-11-03 15:47:21.212831	NR MAC	NR MAC	uplink						DL RRC (RRC PDU)
105211	2021-11-03 15:47:21.212829	NR MAC	NR MAC	downlink						DL RRC (RRC PDU)
105210	2021-11-03 15:47:21.210311	NR MAC	NR MAC	uplink						DL RRC (RRC PDU)
105209	2021-11-03 15:47:21.210308	NR MAC	NR MAC	downlink						DL RRC (RRC PDU)
105208	2021-11-03 15:47:21.209328	NR MAC	NR MAC	uplink						DL RRC (RRC PDU)
105207	2021-11-03 15:47:21.209324	NR MAC	NR MAC	downlink						DL RRC (RRC PDU)
105206	2021-11-03 15:47:21.207014	NR MAC	NR MAC	uplink						DL RRC (RRC PDU)
105205	2021-11-03 15:47:21.207010	NR MAC	NR MAC	downlink						DL RRC (RRC PDU)
105204	2021-11-03 15:47:21.205727	NR MAC	NR MAC	uplink						DL RRC (RRC PDU)
105203	2021-11-03 15:47:21.205727	NR MAC	NR MAC	downlink						DL RRC (RRC PDU)
105202	2021-11-03 15:47:21.205311	NR MAC	NR MAC	uplink						DL RRC (RRC PDU)
105201	2021-11-03 15:47:21.205308	NR MAC	NR MAC	downlink						DL RRC (RRC PDU)
105200	2021-11-03 15:47:21.205308	NR MAC	NR MAC	downlink						DL RRC (RRC PDU)

Frame 9322: 54 bytes on wire (432 bits), 54 bytes captured (432 bits) on interface 0  
 Line Server Unit, Port:1, uplink, NR-5G, NR5G Radio interface, Pdu:0 Chn:0, Uplink Frame, Err: None (0), Lost:0  
 NR5G (2.0) - UL PDCP  
 NR Packet Data Convergence Protocol (3GPP 38.323/15.2.0 (2020-09) Rel.15) - PDCP Data PDU for SRBs  
 NR Radio Resource Control (RRC) protocol V16.2.0 (2020-09)

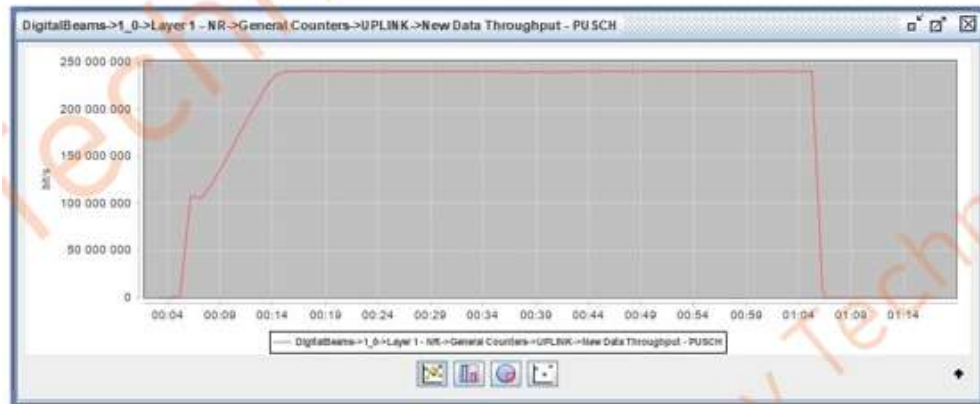
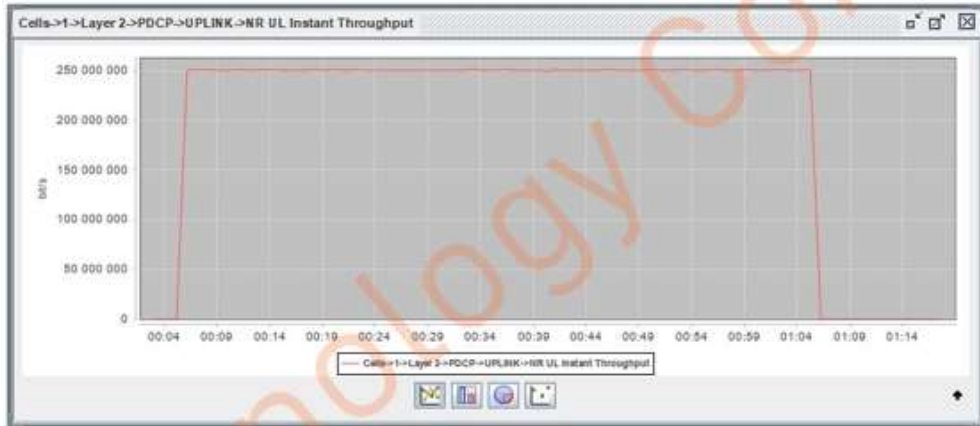
## 3.13 Downlink UDP data transfer (DL 2 layers)



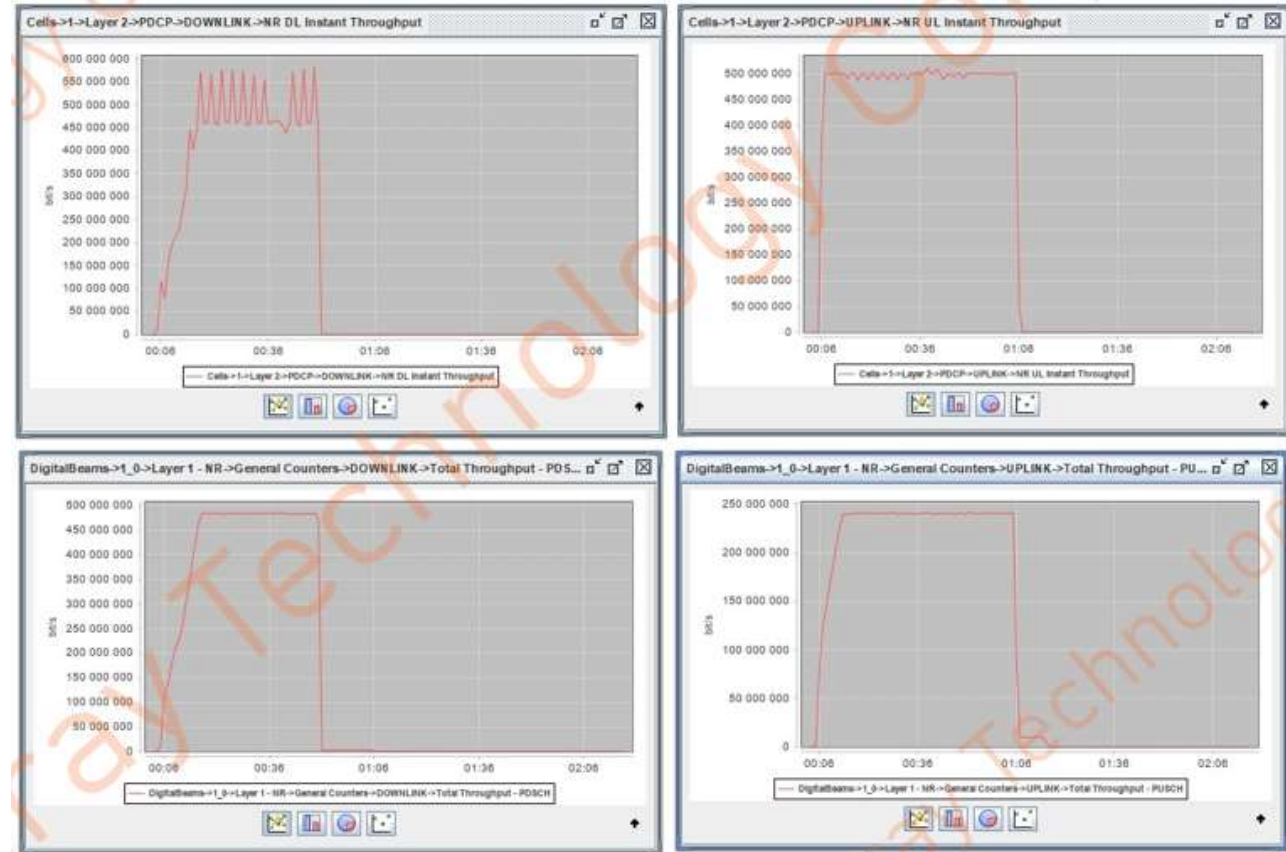


Case	Device	Test Result
3.14	Uplink UDP data transfer	Compliance
3.15	Bidirectional UDP data transfer	Compliance

## 3.14 Uplink UDP data transfer ( UL 2 layers)



## 3.15 Bidirection UDP data transfer ( DL 2 layers, UL 2 layers)



Case	Device	Test Result
3.2	Cell Setup	Compliance
3.3~3.6	SystemInformation-MIB/SIB1/SIB2/SIB3	Compliance

## 3.3 MIB

Frame 3381: 56 bytes on wire (448 bits), 56 bytes captured (448 bits) on interface 0, eth0

Line Server Unit, Port:1, downlink, NR-5G, NR5G Radio interface, Ppu:0 Chn:0, Downlink Frame, Err: None (0), Lost:0

NR5G (2.0) - DL PDCP

NR Packet Data Convergence Protocol (3GPP 38.323/16.2.0 (2020-09) Rel.16) - PDCP Data PDU for SRBs

NR Radio Resource Control (RRC) protocol V16.2.0 (2020-09)

BCCCH-BCH-Message

message: mib (0)

mib

- systemFrameNumber: 28 [bit length 6, 2 LSB pad bits, 0010 10.. decimal value 10]
- subCarrierSpacingCommon: scs30or120 (1)
- ssb-SubcarrierOffset: 14
- dmrs-TypeA-Position: pos2 (0)
- pdccch-ConfigsI81
- cellBarred: notBarred (1)
- intraFreqReselection: allowed (0)
- spare: 00 [bit length 1, 7 LSB pad bits, 0... .. decimal value 0]

## 3.4~3.6 SIB1/SIB2/SIB3

Frame 2314: 171 bytes on wire (1368 bits), 171 bytes captured (1368 bits) on interface 0, eth0

Line Server Unit, Port:0, downlink, NR-5G, NR5G Radio interface, Ppu:4 Chn:0, Downlink Frame, Err: None (0), Lost:0

NR5G (2.0) - DL PDCP

NR Packet Data Convergence Protocol (3GPP 38.323/16.2.0 (2020-09) Rel.16) - PDCP Data PDU for SRBs

NR Radio Resource Control (RRC) protocol V16.2.0 (2020-09)

BCCCH-DL-SCH-Message

message: c1 (0)

c1: systemInformationBlockType1 (1)

systemInformationBlockType1

- cellSelectionInfo
  - q-RxlevMin: -140dBm (-70)
  - q-QualMin: -12dB
- cellAccessRelatedInfo
  - plmn-IdentityList: 1 item
  - si-SchedulingInfo
    - schedulingInfoList: 1 item
    - si-WindowLength: s5 (0)
    - si-RequestConfig
  - servicingCellConfigCommon
    - downlinkConfigCommon
    - uplinkConfigCommon
    - ssb-PositionsInBurst
    - ssb-PeriodicityServingCell: ms20 (2)
    - tdl-UL-DL-ConfigurationCommon
    - ss-PBCH-BlockPower: -110dBm
    - ue-TimersAndConstants
      - t300: ms1000 (5)
      - t301: ms200 (1)
      - t302: ms1000 (5)
      - t320: s10 (6)
      - t311: ms1000 (3)
      - t312: s1 (0)
      - t313: ms1000 (5)

Frame 2475: 159 bytes on wire (1272 bits), 159 bytes captured (1272 bits) on interface 0, eth0

Line Server Unit, Port:0, downlink, NR-5G, NR5G Radio interface, Ppu:4 Chn:0, Downlink Frame, Err: None (0), Lost:0

NR5G (2.0) - DL PDCP

NR Packet Data Convergence Protocol (3GPP 38.323/16.2.0 (2020-09) Rel.16) - PDCP Data PDU for SRBs

NR Radio Resource Control (RRC) protocol V16.2.0 (2020-09)

BCCCH-DL-SCH-Message

message: c1 (0)

c1: systemInformationBlockType2 (0)

systemInformationBlockType2

- cellReselectionInfoCommon
  - nrofSS-BlocksToAverage: 8
  - absThreshSS-BlocksConsolidation
  - rangeOfBestCell: dm3 (10)
  - q-Hyst: dm4 (4)
- cellReselectionServingFreqInfo
  - s-NonIntraSearchP: 6dB (3)
  - s-NonIntraSearchQ: 5dB
  - threshServingLowP: 1400 (7)
  - cellReselectionPriority: 2
  - intraFreqCellReselectionInfo
    - q-RxlevMin: -128dBm (-64)
    - q-QualMin: -30dB
    - s-IntraSearchP: 58dB (20)
    - s-IntraSearchQ: 15dB
    - t-ReselectionRA: 1s
    - p-Max: 130dBm
    - ssb-ToMeasure: mediumBitmap (1)
    - ..1. .... deriveSSB-IndexFromCell: True

Frame 2475: 159 bytes on wire (1272 bits), 159 bytes captured (1272 bits) on interface 0, eth0

Line Server Unit, Port:0, downlink, NR-5G, NR5G Radio interface, Ppu:4 Chn:0, Downlink Frame, Err: None (0), Lost:0

NR5G (2.0) - DL PDCP

NR Packet Data Convergence Protocol (3GPP 38.323/16.2.0 (2020-09) Rel.16) - PDCP Data PDU for SRBs

NR Radio Resource Control (RRC) protocol V16.2.0 (2020-09)

BCCCH-DL-SCH-Message

message: c1 (0)

c1: systemInformationBlockType3 (0)

systemInformationBlockType3

- criticalExtensions: systemInformationBlockType3 (0)
- systemInformationBlockType3
  - si-TypeAndInfo: 3 items
  - Item 0
  - Item 1
    - si-TypeAndInfo: si-TypeAndInfo (1)
    - si-TypeAndInfo: si-TypeAndInfo (1)
    - si-TypeAndInfo: si-TypeAndInfo (1)
      - intraFreqBlackCellList: 1 item
      - Item 0
        - PCI-Range
        - start: 56
      - Item 2

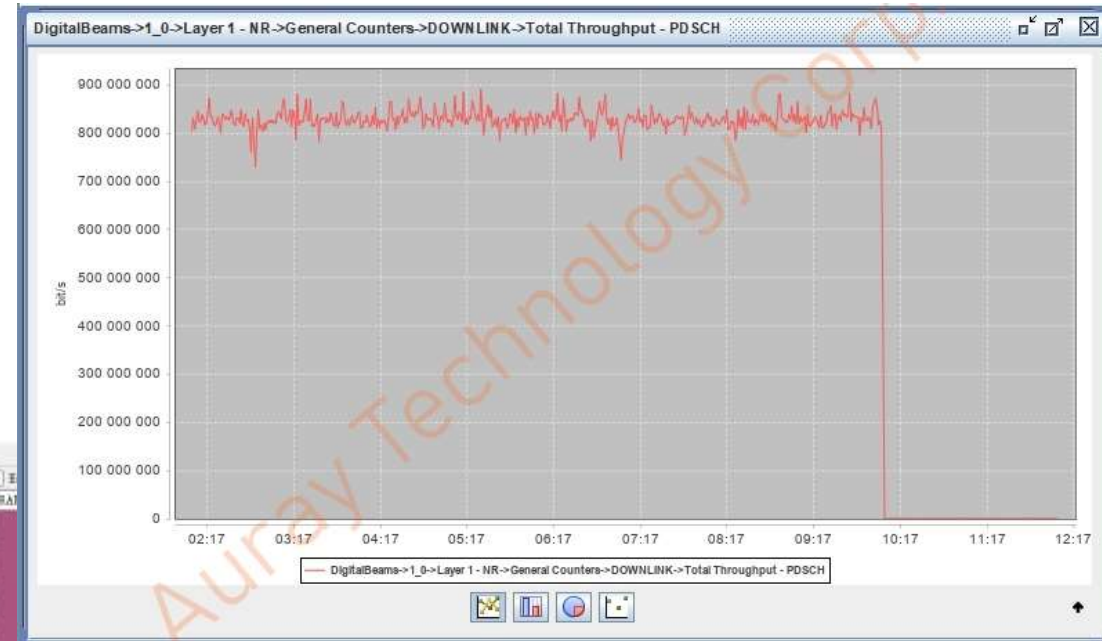


Case	Device	Test Result
3.10	PDU session establishment procedure	Compliance
3.11	PDU Session Modification with Multiple Flow	Compliance
3.13	Downlink UDP data transfer	Compliance

## 3.13 Downlink UDP data transfer ( DL 2 layers)

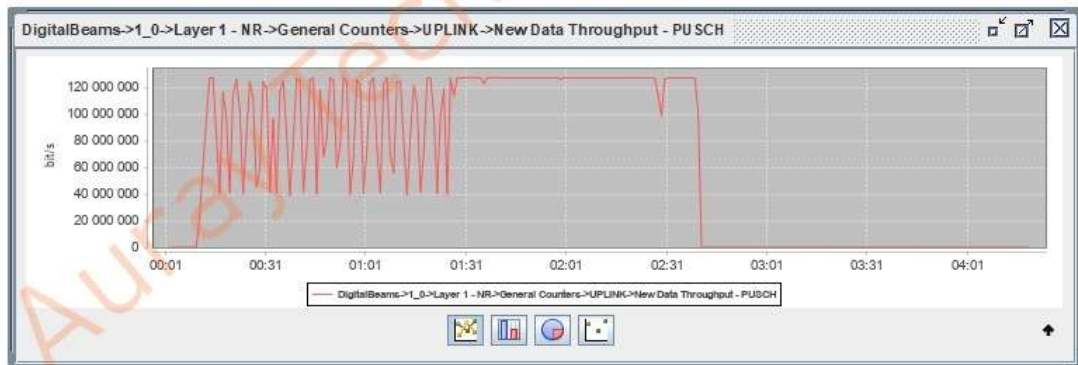
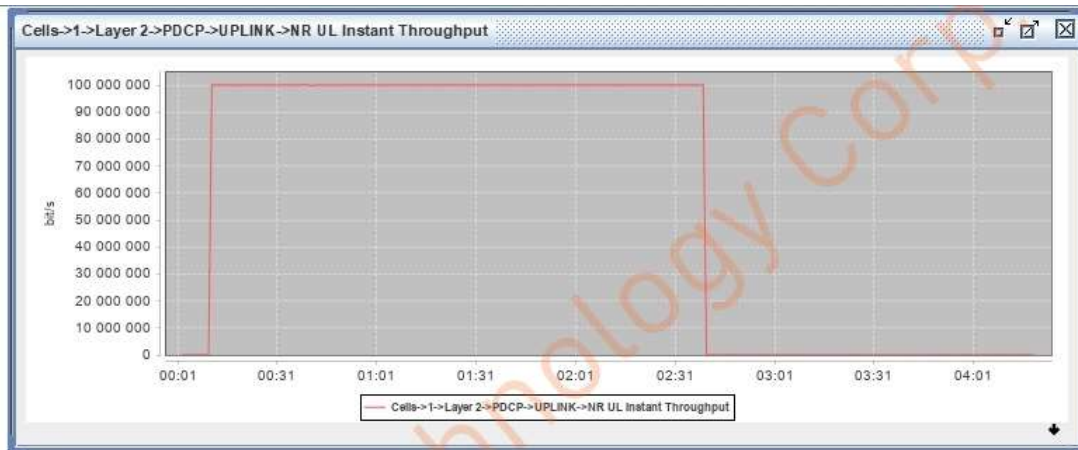
## 3.11 PDU Session Modification with Multiple Flow

No	Date	Protocol	User Label	RF	FlowLabel	FlowControl	Label	FlowLabel	FlowLabel	FlowLabel	FlowLabel	User control id	User control id	RAI
2477	2021-05	5GS NAS	downlink				DLInfor_					1	1	
2484	2021-05	5GS NAS	uplink				ULInfor_					1	1	
2493	2021-05	5GS NAS	downlink				DLInfor_					1	1	
2494	2021-05	5GS NAS	uplink				ULInfor_					1	1	
2509	2021-05	NR RRC D.	downlink				Securit_					1	1	
2516	2021-05	NR RRC U.	uplink				Securit_					1	1	
2525	2021-05	NR RRC D.	downlink				UECapab_					1	1	
2529	2021-05	5GS NAS	downlink				DLInfor_					1	1	
2538	2021-05	NR RRC U.	uplink				UECapab_					1	1	
2539	2021-05	5GS NAS	uplink				ULInfor_					1	1	
2798	2021-05	5GS NAS	uplink				ULInfor_					1	1	
2818	2021-05	5GS NAS	downlink		9		RRCReco_					1	1	9,9
2827	2021-05	NR RRC U.	uplink				RRCReco_					1	1	
2864	2021-05	NR RRC U.	uplink				Measure_					1	1	
2966	2021-05	NR RRC U.	uplink				Measure_					1	1	
5414	2021-05	5GS NAS	downlink		3		RRCReco_					1	1	3,3
5421	2021-05	NR RRC U.	uplink				RRCReco_					1	1	
5424	2021-05	5GS NAS	uplink				ULInfor_					1	1	
7869	2021-05	5GS NAS	uplink				ULInfor_					1	1	
7884	2021-05	5GS NAS	downlink		6		RRCReco_					1	1	6,6
7885	2021-05	NR RRC U.	uplink				RRCReco_					1	1	

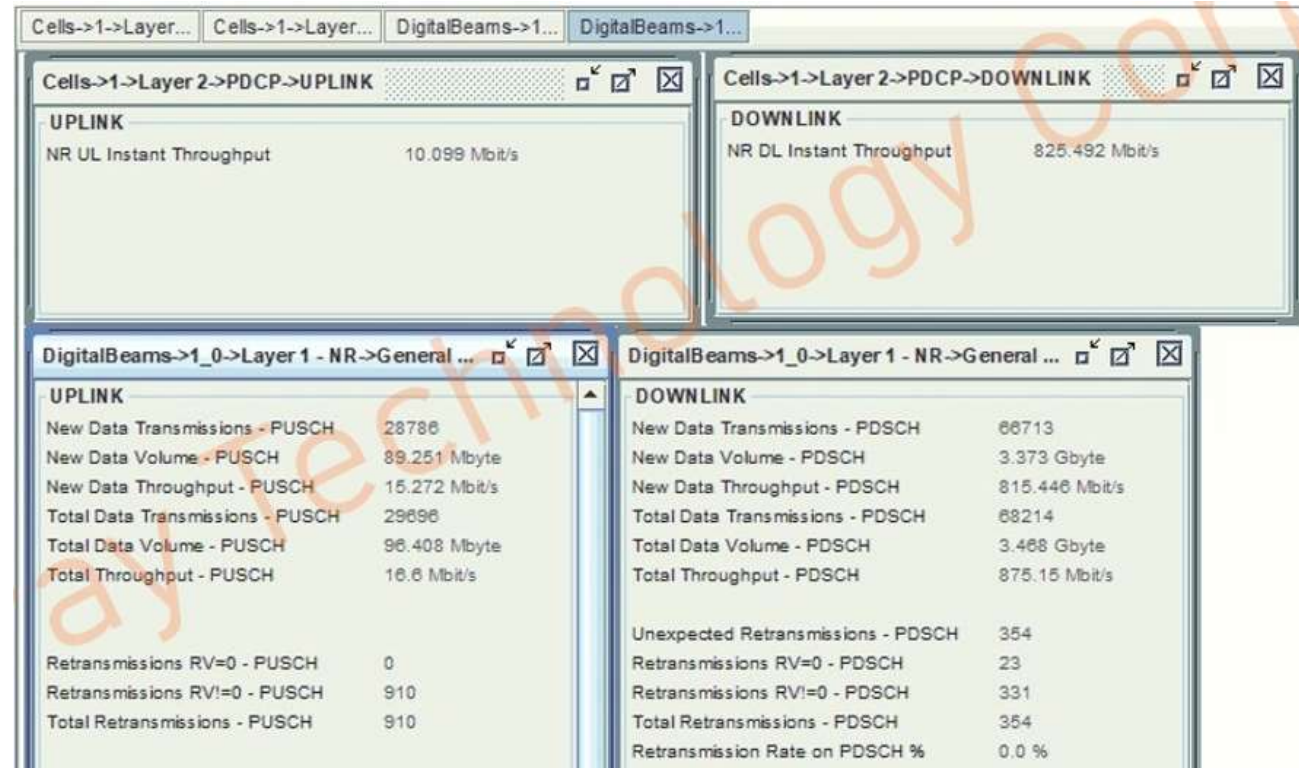


Case	Device	Test Result
3.14	Uplink UDP data transfer	Compliance
3.15	Bidirectional UDP data transfer	Compliance

## 3.14 Uplink UDP data transfer ( UL 2 layers)

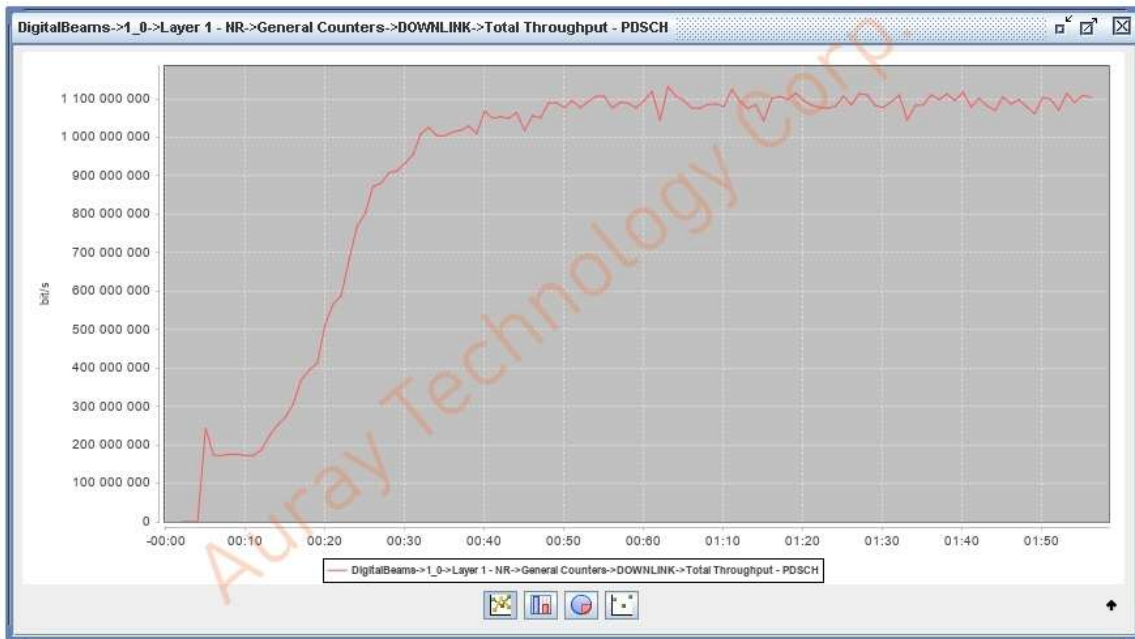


## 3.15 Bidirection UDP data transfer ( DL 2 layers, UL 2 layers)

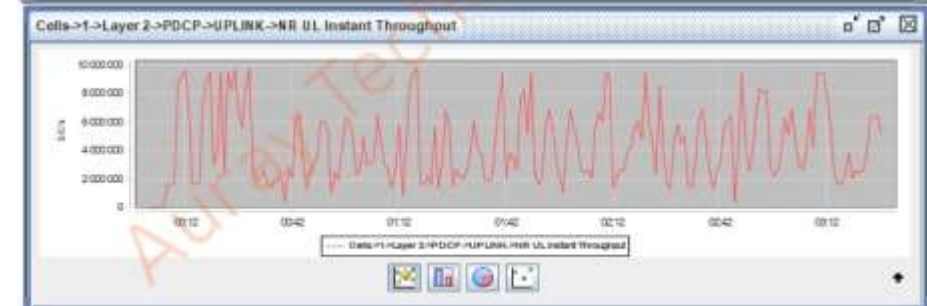
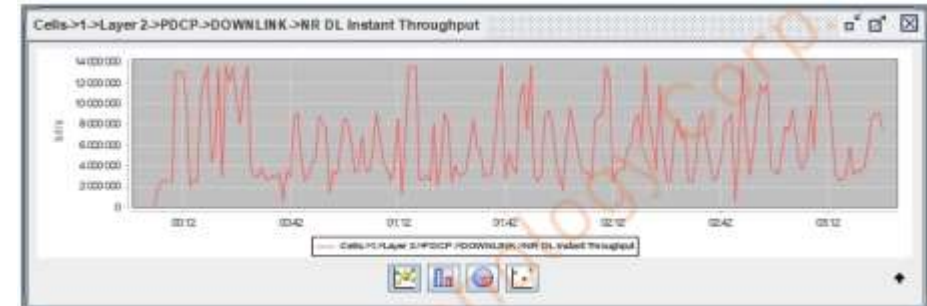
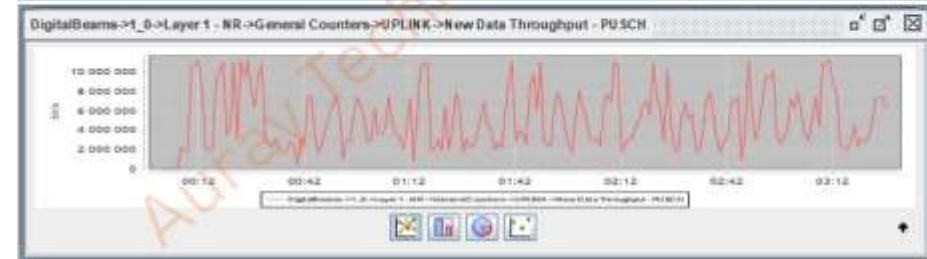
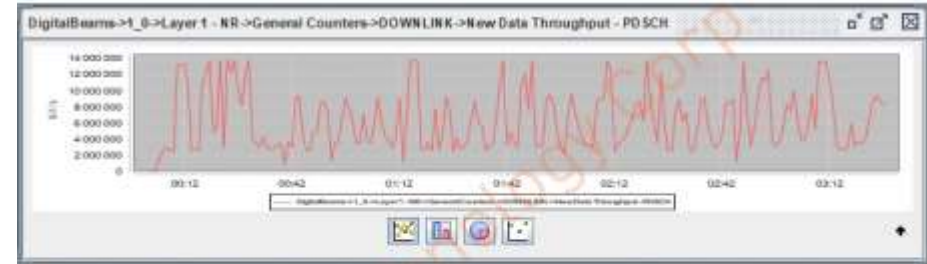


Case	Device	Test Result
1	Downlink stress test under 1Gbps	Pass
2	DL & UL UDG throughput by HTTP & FTP	Pass

## 1. Downlink stress test under 1Gbps



## 2. DL & UL UDG throughput by HTTP & FTP





Case	Device	Test Result
3	Two PDU sessions establishing	Pass
4	Stress test of multi-UEs	Pass
5	UDG latency	Recorded

### 3. Two PDU sessions establishing

The screenshot shows a test execution interface with a menu bar (File, Edit, Run, View, Tools, Window, Help) and a toolbar. The main window displays 'Scenario Elements' and 'Trace 0'. The 'Scenario Elements' pane shows a test scenario with 200 subscribers and one group 'g1'. Under 'g1', there is 'Static 5G NR Mobility (Cells: 1)', 'Subscriber List (200)', and 'Session List (1)'. The 'Session List' shows 'New session 3 - Status: success'. The 'Trace 0' pane shows a list of events with their completion percentages:

Time	Event	Completion
0	1 0 1 Registration	100%
1	1 0 1 Delay	100%
2	1 0 1 PDU Session Establish	100%
3	1 0 1 Delay	100%
4	1 0 1 PDU Session Establish	100%
5	1 0 1 Delay	100%
6	1 0 1 PDU Session Release	100%
7	1 0 1 Delay	100%
8	1 0 1 PDU Session Release	100%
9	1 0 1 Deregistration	100%

### 4. Stress test of multi-UEs

The screenshot shows a test execution interface for a stress test scenario. The 'Scenario Elements' pane shows 'Test Scenario: Subscribers: (300), Groups: (1)'. Under 'Groups', there is 'Static 5G NR Mobility (Cells: 1)' and 'Subscriber List (300)'. The 'Session List' shows 'New session 3 - Status: stopped'. The 'Trace 0' pane shows a list of events with their completion percentages:

Time	Event	Completion
0	204 0 300 Registration	98%
1	204 0 204 Delay	100%
2	204 0 204 PDU Session Establish	100%
3	204 0 204 Delay	100%
4	204 0 204 ICMP Ping	100%
5	207 7 204 PDU Session Release	97.62%
6	204 0 204 Deregistration	100%

The 'Subscribers' pane shows a list of 300 subscribers, each with a 'New' button and various status indicators. The 'Delay' pane shows 'Trace 0: Delay' and 'Cell Status: X'.

### 5. UDG latency

The screenshot shows a table of UDG latency test results. The table is titled 'Subscribers->New Subscriber->Application->UDG->UDG Latency' and has four columns representing different latency ranges. Each cell in the table shows the number of DL and UL packets received for that range.

UDG Latency	LDB -> [0-5]ms	LDB -> [5-10]ms	LDB -> [10-20]ms	LDB -> [20-40]ms
	DL Packets - Received 0 UL Packets - Received 0	DL Packets - Received 0 UL Packets - Received 0	DL Packets - Received 0 UL Packets - Received 0	DL Packets - Received 0 UL Packets - Received 0
	LDB -> [40-80]ms	LDB -> [80-100]ms	LDB -> [100-150]ms	LDB -> [150-200]ms
	DL Packets - Received 0 UL Packets - Received 22	DL Packets - Received 0 UL Packets - Received 11	DL Packets - Received 0 UL Packets - Received 28	DL Packets - Received 0 UL Packets - Received 29
	LDB -> [200-250]ms	LDB -> [250-500]ms	LDB -> [500-]	
	DL Packets - Received 0 UL Packets - Received 302	DL Packets - Received 0 UL Packets - Received 4443	DL Packets - Received 0 UL Packets - Received 38507	

Case	Device	Test Result
6.1.1.1	RRC ciphering & integrity	Compliance
6.1.1.2	User data ciphering & integrity	Compliance

## 6.1.1.2 User data ciphering & integrity

### 6.1.1.1 RRC ciphering & integrity

**6.1.1.1\_NIA1**

2026 2021-08-05 13:32:01.802541 NR RRC DL-DCCH  
downlink SecurityModeCommand

Frame 2026: 57 bytes on wire (456 bits), 57 bytes captured (456 bits)  
Line Server Unit, Port:0, downlink, NR-SG, NR5G Radio interface, Ppu4 Chn:0, Downlink Frame, Err: None (0), Lost:0  
NR5G (2.0) - DL PDCP  
NR Packet Data Convergence Protocol (3GPP 38.323/16.2.0 (2020-09) Rel.16) - PDCP Data PDU for SRBs  
NR Radio Resource Control (RRC) protocol V16.2.0 (2020-09)  
DL-DCCH-Message  
message: c1 (0)  
c1: securityModeCommand (4)  
securityModeCommand  
rrc-TransactionIdentifier: 0  
criticalExtensions: securityModeCommand (0)  
securityModeCommand  
securityConfigSM  
securityAlgorithmConfig  
cipheringAlgorithm: ne0 (0)  
integrityProtAlgorithm: nia1 (1)

4971 2021-08-05 13:07:41.044331 NR RRC DL-DCCH  
downlink SecurityModeCommand

Frame 4971: 57 bytes on wire (456 bits), 57 bytes captured (456 bits)  
Line Server Unit, Port:0, downlink, NR-SG, NR5G Radio interface, Ppu4 Chn:0, Downlink Frame, Err: None (0), Lost:0  
NR5G (2.0) - DL PDCP  
NR Packet Data Convergence Protocol (3GPP 38.323/16.2.0 (2020-09) Rel.16) - PDCP Data PDU for SRBs  
NR Radio Resource Control (RRC) protocol V16.2.0 (2020-09)  
DL-DCCH-Message  
message: c1 (0)  
c1: securityModeCommand (4)  
securityModeCommand  
rrc-TransactionIdentifier: 0  
criticalExtensions: securityModeCommand (0)  
securityModeCommand  
securityConfigSM  
securityAlgorithmConfig  
cipheringAlgorithm: ne0 (0)  
integrityProtAlgorithm: nia2 (2)

4034 2021-08-05 13:32:01.802541 NR RRC UL-DCCH  
uplink PDCP Info

Frame 4034: 156 bytes on wire (1248 bits), 156 bytes captured (1248 bits)  
Line Server Unit, Port:0, uplink, NR-SG, NR5G Radio interface, Ppu4 Chn:0, Uplink Frame, Err: None (0), Lost:0  
NR5G (2.0) - UL PDCP  
Packet Type: UL PDCP (12)  
Spare: 0000  
IE TLV: PDCP Info (9), length=40  
Node: Node Legacy (0)  
0010 .... = Radio Bearer Type: User Plane Radio Bearer (2)  
.... 0000 0001 .... = Radio Bearer Id: 1  
.... 0010 = RLC Node: Acknowledged Mode (3)  
0110 .... = Logical Channel Type: DTCH (6)  
.... 0010 = Sequence Number Size: 12 bits (2)  
.... 0010 = Ciphering Flag: Ciphered (1)  
.... 0010 = Integrity Flag: True (1)  
.... 0010 = SDAP Presence Flag: True (1)

4573 2021-08-05 13:32:01.802541 NR RRC DL-DCCH  
downlink RRCReconfiguration

rrc-TransactionIdentifier: 0  
criticalExtensions: rrcReconfiguration (0)  
rrcReconfiguration  
radioBearerConfig  
srb-ToAddModList: 1 item  
Item 0  
srb-ToAddMod  
drb-ToAddModList: 1 item  
Item 0  
DRB-ToAddMod  
cnAssociation: sdap-Config (1)  
sdap-Config  
pdu-Session: 1  
sdap-HeaderDL: absent (1)  
sdap-HeaderUL: present (0)  
..1. .... defaultTDM: true  
mappedQoS-FlowsToAdd: 1 item  
Item 0  
QFI: 9  
drb-Identity: 1  
pdcP-Config  
drb  
discardTimer: ms1500 (14)  
pdcP-SN-SizeUL: len18bits (1)  
pdcP-SN-SizeDL: len18bits (1)  
headerCompression: notused (0)  
notused: NULL  
integrityProtection: enabled (0)  
statusReportRequired: true (0)



Case	Device	Test Result
6.1.2.6	User data protection based on SMF security strategy	Compliance
6.1.3.1	AS security algorithm priority	Compliance

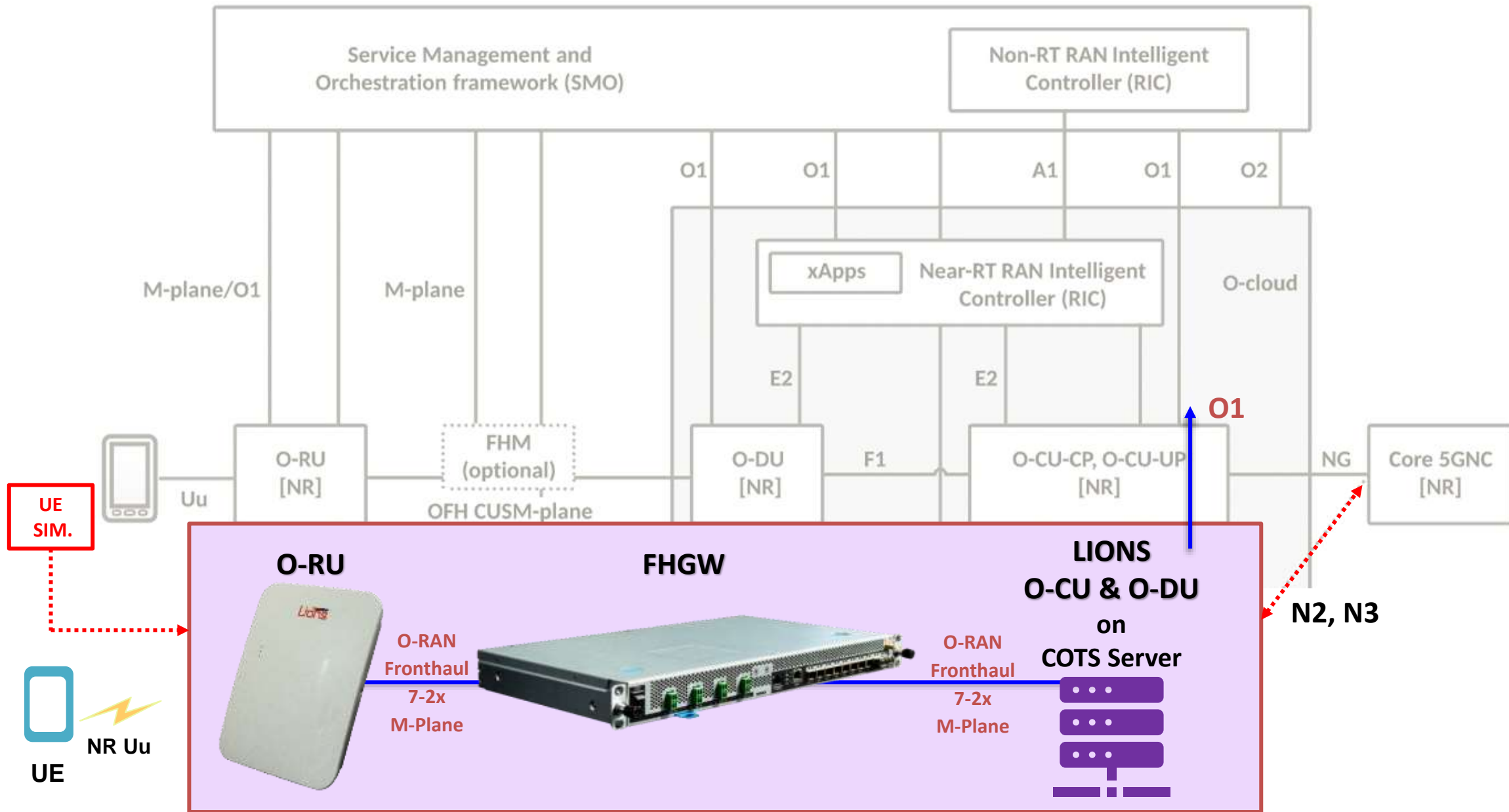
## 6.1.2.6 User data protection based on SMF security strategy

Wireshark capture of NGAP message. The message type is DL NAS transport (0x68). The payload container type is N1 SM information (1). The payload container length is 104. The message is a Plain NAS 5GS Message. The PDU session identity 2 - PDU session ID element ID is 0x12, and the PDU session identity is PDU session identity value 1 (1). The s-NSSAI sST is 01. The PDU Session Resource Setup Request Transfer contains 5 protocol IEs, including id-PDU Session Aggregate Maximum Bit Rate, id-UL-NGU-UP-TNL Information, id-PDU Session Type, and id-Security Indication. The id-Security Indication field has an id of id-Security Indication (138), a criticality of reject (0), and a value of SecurityIndication with integrityProtectionIndication: required (0) and confidentialityProtectionIndication: required (0).

## 6.1.3.1 AS security algorithm priority

Wireshark capture of NR RRC DL-DCCH message. The message is a SecurityModeCommand. The securityAlgorithmConfig field shows cipheringAlgorithm: nea1 (1) and integrityProtAlgorithm: nia1 (1).

Wireshark capture of NR RRC DL-DCCH message. The message is a SecurityModeCommand. The securityAlgorithmConfig field shows cipheringAlgorithm: nea2 (2) and integrityProtAlgorithm: nia2 (2).





- The real network test was executed in CHTTL.





- IoT with Four 5GC: Nokia, Ericsson, Cisco, & QCT
- Test UE: Samsung S21 or APAL MiFi.

TDD Config.: DDDSUDDSUU (DL: 4Layer, 64QAM; UL: 2Layer, 64QAM)					
Test Item		Nokia 5GC	Ericsson 5GC	Cisco 5GC	QCT
1. UE Registration		Pass	Pass	Pass	Pass
2. Service Request		Pass	Pass	Pass	Pass
3. Paging		Pass	Pass	Pass	Pass
4. PDU Session Establishment		Pass	Pass	Pass	Pass
5. RRC Encryption & Integrity. User Data Encryption		Pass	Pass	Pass	Pass
6. Performance	DL TCP Throughput (Mbps)	NA	805	784	786
	UL TCP Throughput (Mbps)	206 (UDP)	147	212	215
7. Latency: PING (ms)		24	14	30	13

## Register success.

Time	UE-NET	Channel	ID	Message
11:48:37.089	→	UL 5GMM	vF40	5GMR Registration request
11:48:37.089	→	UL CCCH	vF90	5GMR RRCSetupRequest
11:48:37.089		5GMR RACH	5GNF	5GMR MAC RACH Trigger - CONNECTION_REQUEST
11:48:37.094		5GMR RACH	5GNF	5GMR MAC RACH Attempt - SUCCESS
11:48:37.094	←	DL CCCH	vF90	5GMR RRCSetup
11:48:37.096	→	UL DCCH	vF90	5GMR RRCSetupComplete - 5GMR Security protected NAS Message / 5GMR Registration request
11:48:37.101	←	DL DCCH	vF90	5GMR securityModeCommand
11:48:37.101	→	UL DCCH	vF90	5GMR securityModeComplete
11:48:37.177	←	DL DCCH	vF90	5GMR dlInformationTransfer - 5GMR Security protected NAS Message / 5GMR Registration accept
11:48:37.178	←	DL 5GMM	vF40	5GMR Registration accept
11:48:37.179	→	UL 5GMM	vF40	5GMR Registration complete
11:48:37.179	→	UL DCCH	vF90	5GMR ulInformationTransfer - 5GMR Security protected NAS Message / 5GMR Registration complete

### 傳呼與服務請求程序

## Service Request & Paging.

Time	UE-NET	Channel	ID	Message
11:49:16.158		PCCH	vF90	5GMR paging → 傳呼訊息
11:49:16.160	→	UL 5GMM	vF40	5GMR Service request → Service Type: Mobile terminated services
11:49:16.160	→	UL CCCH	vF90	5GMR RRCSetupRequest → Establishment Cause: MT Access
11:49:16.160		5GMR RACH	5GNF	5GMR MAC RACH Trigger - CONNECTION_REQUEST
11:49:16.164		5GMR RACH	5GNF	5GMR MAC RACH Attempt - SUCCESS
11:49:16.164	←	DL CCCH	vF90	5GMR RRCSetup
11:49:16.166	→	UL DCCH	vF90	5GMR RRCSetupComplete - 5GMR Security protected NAS Message / 5GMR Service request
11:49:16.246	←	DL DCCH	vF90	5GMR securityModeCommand
11:49:16.246	→	UL DCCH	vF90	5GMR securityModeComplete
11:49:16.247	←	DL DCCH	vF90	5GMR dlInformationTransfer - 5GMR Security protected NAS Message / 5GMR Service accept
11:49:16.248	←	DL 5GMM	vF40	5GMR Service accept → 完成服務請求

### NAS/Service Request 訊息資訊

```

SERVICE_REQUEST:
Extended_protocol_discriminator: 126
Security_header_type:
  headerType: 0
Spare_half_octet: 0
Message_Type: 76
ngKSI:
  TSC: 0 (native security context (for KSIAMF))
  NASkeysetIdentifier: 0
Service_type:
  ServiceTypeValue: 2 (mobile terminated services)
L5G_S_TMSI:
  TypeOfIdentity: 4 (5G-S-TMSI)
AMF:
  AMFSetID: 1
  AMFPointer: 1
p5G TMSI: 3221732690
    
```

### RRC/RRCSetupRequest 訊息資訊

```

message c1 : RRCSetupRequest :
  RRCSetupRequest :
    ue-identity-ns5g-S-TMSI-Part1 : "10000011 10000000 00001111 01111010 1010010B"
    establishmentCause mt-Access
    spare U6
    
```

## ■ PDU Session Establish.

Uu介面的PDU Session建立程序

Time	UE-NET	Channel	ID	Message
11:48:37.457	→	UL 5GSM	vF40	5GMR PDU session establishment request
11:48:37.498	→	UL 5GMM	vF40	5GMR UL NAS transport
11:48:37.498	→	UL DICCH	vF90	5GMR ulInformationTransfer - 5GMR Security protected NAS Message / 5GMR UL NAS transport
11:48:37.604	←	DL DICCH	vF90	5GMR rrcReconfiguration - 5GMR Security protected NAS Message / 5GMR DL NAS transport
11:48:37.920	→	UL DICCH	vF90	5GMR rrcReconfigurationComplete
11:48:37.920	←	DL 5GMM	vF40	5GMR DL NAS transport
11:48:37.920	←	DL 5GSM	vF40	5GMR PDU session establishment accept

PDU Session建立結果

Timestamp	Message	PDU Session ID	PTI	PDU Session Type	S-NSSAI (SST)	S-NSSAI (SD)	QoS Rule	QPI	SQL	DNN	PDU Address
11:48:24.817	5GMR PDU session release request	1	8	-	-	-	-	-	-	-	-
11:48:24.905	5GMR PDU session release command	1	8	-	-	-	-	-	-	-	-
11:48:24.905	5GMR PDU session release complete	1	8	-	-	-	-	-	-	-	-
11:48:37.497	5GMR PDU session establishment request	1	9	IPv4	-	-	-	-	-	-	-
11:48:37.925	5GMR PDU session establishment accept	1	9	IPv4	s(eNB)	1	s>Create	s>Create	5QMR (signaling)	internet	22.1.0.2

## ■ RRC Encryption & Integrity.

```

message c1 : securityModeCommand :
  rrc-TransactionIdentifier 0,
  criticalExtensions securityModeCommand :
    securityConfigSMC
      securityAlgorithmConfig
        cipheringAlgorithm nea1,
        integrityProtAlgorithm nia2
  
```

加密演算法  
為NEA1



## Speed Test Result



## iPerf Test Result with QCT 5GC

```

C:\Windows\System32\cmd.exe
40] 0.00-90.00 sec 306 MBytes 28.5 Mbits/sec 128 sender
40] 0.00-90.00 sec 305 MBytes 28.4 Mbits/sec receiver
42] 0.00-90.00 sec 388 MBytes 36.2 Mbits/sec 113 sender
42] 0.00-90.00 sec 387 MBytes 36.1 Mbits/sec receiver
44] 0.00-90.00 sec 224 MBytes 20.9 Mbits/sec 94 sender
44] 0.00-90.00 sec 223 MBytes 20.8 Mbits/sec receiver
46] 0.00-90.00 sec 349 MBytes 32.5 Mbits/sec 112 sender
46] 0.00-90.00 sec 348 MBytes 32.4 Mbits/sec receiver
48] 0.00-90.00 sec 215 MBytes 20.1 Mbits/sec 85 sender
48] 0.00-90.00 sec 214 MBytes 20.0 Mbits/sec receiver
50] 0.00-90.00 sec 382 MBytes 35.6 Mbits/sec 110 sender
50] 0.00-90.00 sec 381 MBytes 35.6 Mbits/sec receiver
52] 0.00-90.00 sec 317 MBytes 29.6 Mbits/sec 163 sender
52] 0.00-90.00 sec 316 MBytes 29.5 Mbits/sec receiver
54] 0.00-90.00 sec 334 MBytes 31.1 Mbits/sec 133 sender
54] 0.00-90.00 sec 333 MBytes 31.0 Mbits/sec receiver
56] 0.00-90.00 sec 43.0 MBytes 4.01 Mbits/sec 798 sender
56] 0.00-90.00 sec 41.9 MBytes 3.90 Mbits/sec receiver
58] 0.00-90.00 sec 355 MBytes 33.1 Mbits/sec 85 sender
58] 0.00-90.00 sec 354 MBytes 33.0 Mbits/sec receiver
60] 0.00-90.00 sec 269 MBytes 25.0 Mbits/sec 113 sender
60] 0.00-90.00 sec 268 MBytes 25.0 Mbits/sec receiver
62] 0.00-90.00 sec 226 MBytes 21.1 Mbits/sec 98 sender
62] 0.00-90.00 sec 225 MBytes 21.0 Mbits/sec receiver
[SUM] 0.00-90.00 sec 8.26 GBytes 788 Mbits/sec 5988 sender
[SUM] 0.00-90.00 sec 8.23 GBytes 786 Mbits/sec receiver

iperf Done.
C:\iperf-3.1.3-win64>
    
```

**DL Throughput: 786Mbps**

```

48] 0.00-90.01 sec 73.2 MBytes 6.82 Mbits/sec receiver
50] 0.00-90.01 sec 74.0 MBytes 6.90 Mbits/sec sender
50] 0.00-90.01 sec 74.0 MBytes 6.89 Mbits/sec receiver
52] 0.00-90.01 sec 64.2 MBytes 5.99 Mbits/sec sender
52] 0.00-90.01 sec 64.2 MBytes 5.98 Mbits/sec receiver
54] 0.00-90.01 sec 73.2 MBytes 6.83 Mbits/sec sender
54] 0.00-90.01 sec 73.2 MBytes 6.82 Mbits/sec receiver
56] 0.00-90.01 sec 57.4 MBytes 5.35 Mbits/sec sender
56] 0.00-90.01 sec 57.4 MBytes 5.35 Mbits/sec receiver
58] 0.00-90.01 sec 69.4 MBytes 6.47 Mbits/sec sender
58] 0.00-90.01 sec 69.4 MBytes 6.47 Mbits/sec receiver
60] 0.00-90.01 sec 63.9 MBytes 5.95 Mbits/sec sender
60] 0.00-90.01 sec 63.8 MBytes 5.95 Mbits/sec receiver
62] 0.00-90.01 sec 77.0 MBytes 7.18 Mbits/sec sender
62] 0.00-90.01 sec 77.0 MBytes 7.18 Mbits/sec receiver
[SUM] 0.00-90.01 sec 2.25 GBytes 215 Mbits/sec sender
[SUM] 0.00-90.01 sec 2.25 GBytes 215 Mbits/sec receiver

iperf Done.
C:\iperf-3.1.3-win64>
    
```

**UL Throughput: 215Mbps**

## ■ Benefit

- Great opportunities to practice O-RAN standards and fronthaul interface through plug fest.
- Good exercise of IoT with different network elements in plug fest venue.

## ■ Learning

- To get the experience that the interpretation of specification detail may be varied and caused IoT gating.
- To have deeper understanding of O-RAN specifications through fine tuning parameters during IoT test.

**Thank you**