

# OpenRAN Lab Trial Report



TELECOM INFRA PROJECT

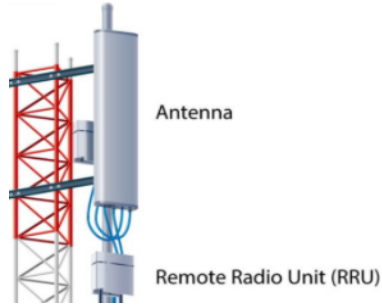


# Today's Discussion

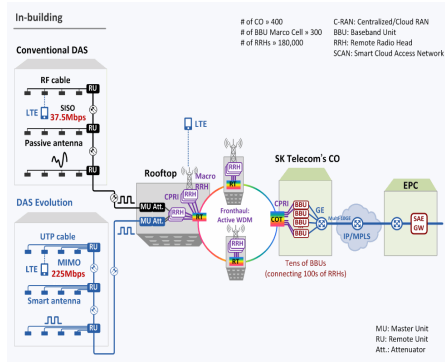
1 - OpenRAN Lab Results

2 - Next Steps: Field Trials

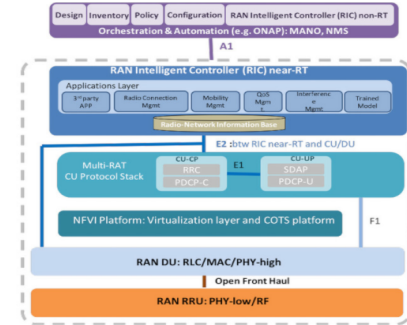
# OBJECTIVES



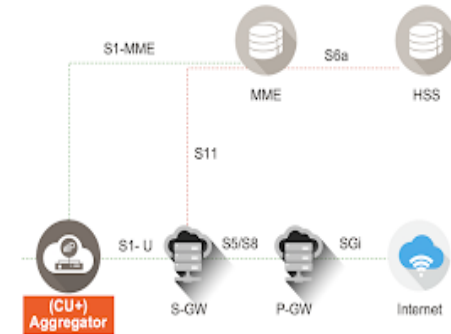
1 - To demonstrate 3GPP compliance of radio equipment



3 - To demonstrate E2E LTE Network with Macro / Indoor solution



2 - To demonstrate ORAN compliance design



4 - To demonstrate commercial EPC integration to vCU, with HPRU (B7)

# KEY STAKE HOLDERS

Edotco wishes to validate the concept of OpenRAN interfaces to support various deployment scenarios while supporting Multi-Band & Multi-Operator.



TIP, wishes to endorse through financial subsidies the adoption of open standard networks, including O-RAN where shared infrastructure contributes to lower network operating costs.



To integrate with Celcom's 4G test core network as to validate the Access to the Core functionalities.



Mavenir, as an approved vendor to TIP, supplies the virtualized network solutions in cooperation with various radio hardware manufacturers.



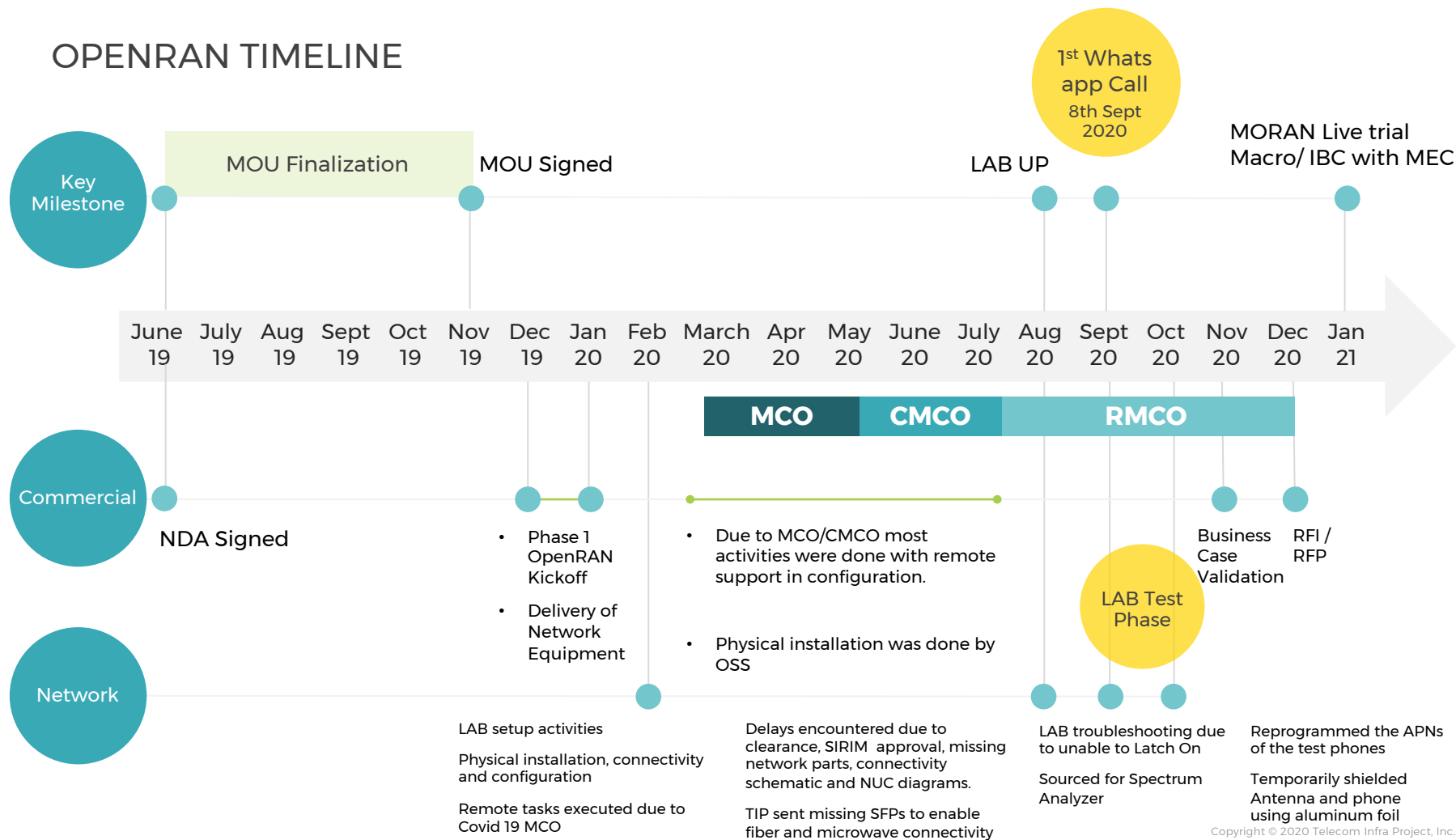
Sunwave, a Digital Radio equipment manufacturer, has been nominated by Mavenir as the optimal radio hardware provider to support the vRAN integration.



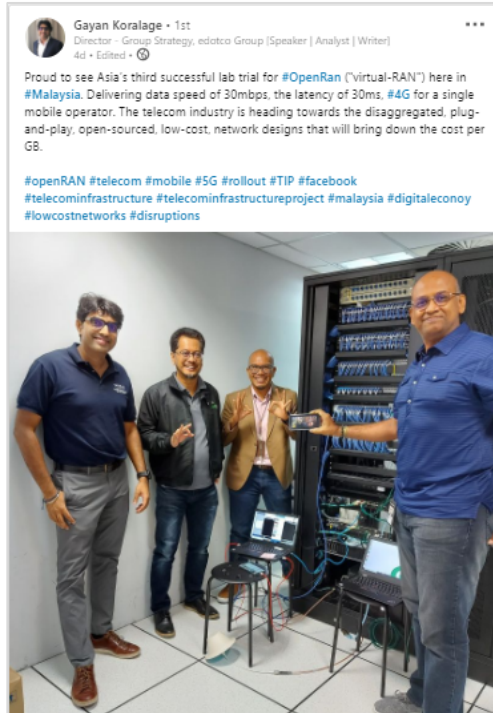
Edotco commissioned OSS to be the SI for this POC. Edotco is leasing space, power and cooling from OSS for this POC.



# OPENRAN TIMELINE



# SYSTEM UP AND WORKING - SEPT 8TH 2020



TELECOM INFRA  
PROJECT



Live Streaming of 4K & HD video

# What is OpenRAN?

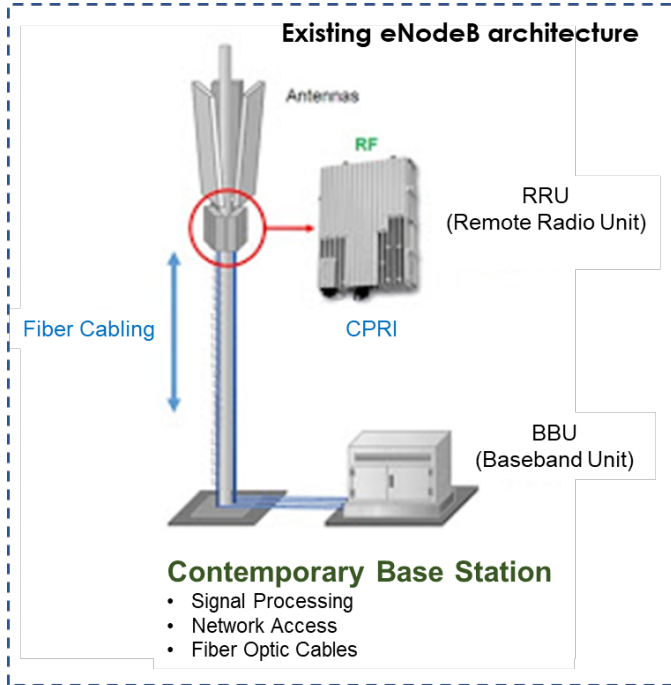


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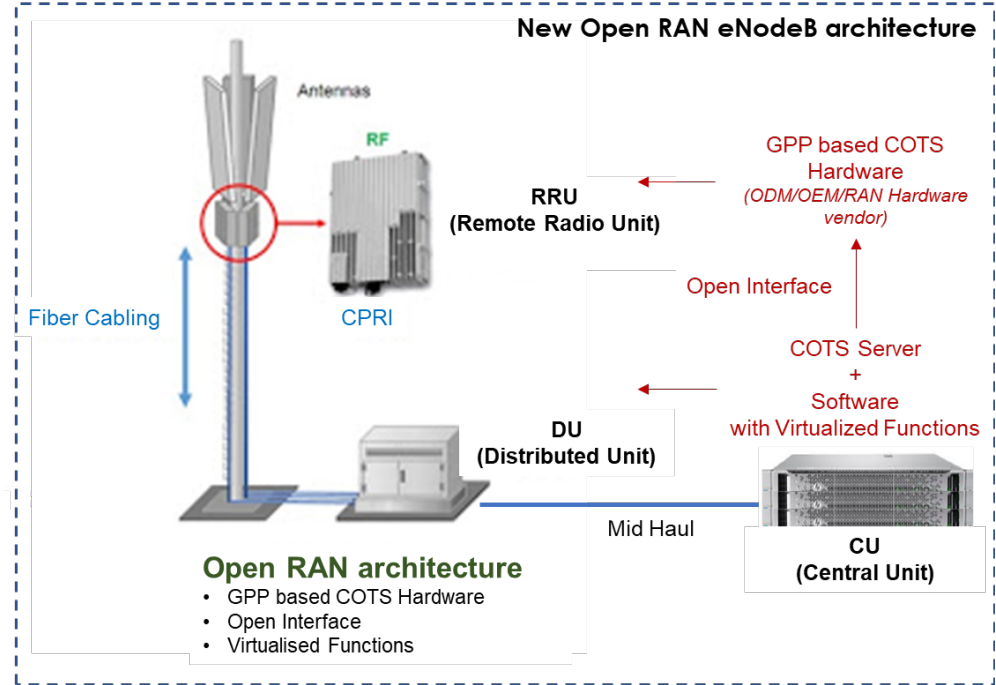


# WHAT IS OPENRAN?

OpenRAN is a vendor-neutral disaggregation of RAN at both the hardware and software levels on general purpose processor-based platforms.

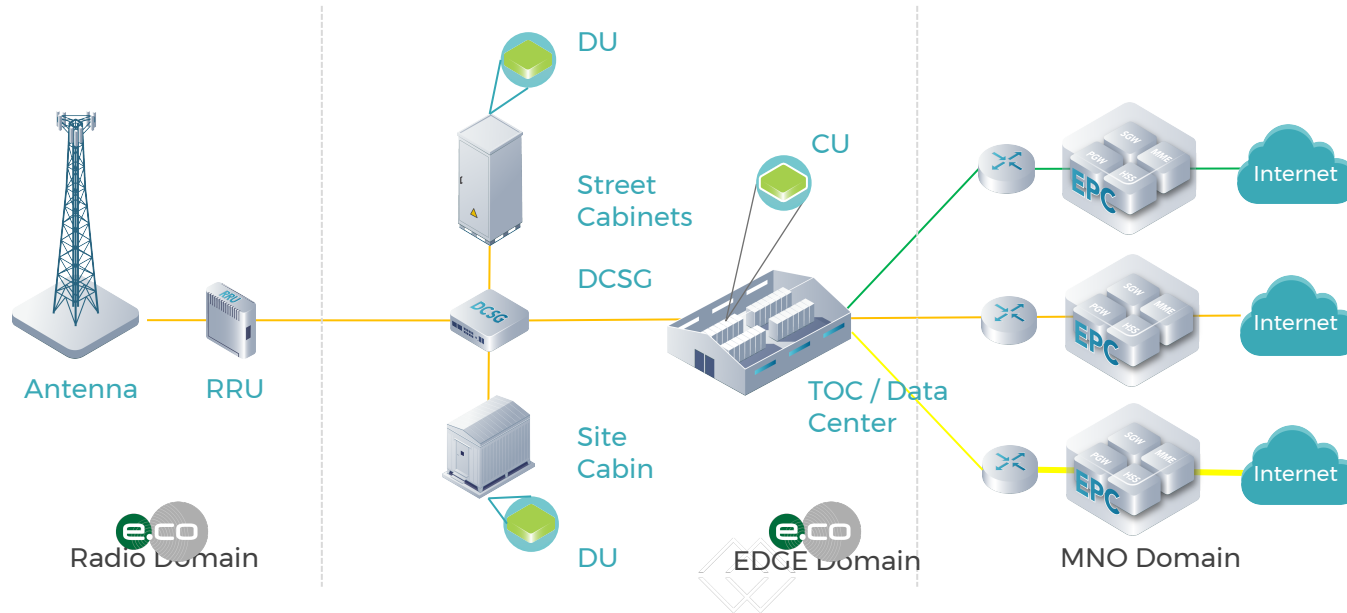


Traditional Architecture



OpenRAN Architecture

# E2E Openran network configuration



1. CU: logical node that consist of a part of protocol stack that are delay tolerant (non - real time) such as RRM, RRC, and PDCP.
2. DU: logical node that consist of a part of protocol stack that are time critical (real-time) such as L1 and MAC/RLC of L2. The distributed unit, depending on the deployment scenario, can be co-located at the site. The DU also contains the PCIe card that provides CPRI link as well
3. RRU : Macro RRUs supplied by Sunwave
4. CEM: Centralized Element Management system is the logical node to monitor Fault, Configuration & Performance for the installed eNBs.
5. DCSG: Disaggregated Cell Site Gateway

# OpenRAN Lab Trial Results



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# E2E OPENRAN NETWORK CONFIGURATION

Edotco being a Towerco Company was looking at ways to help MNO's expedite their network coverage/rollout and to do it based on current technology, a scalable and upgradeable network with a long term OPEX model.

Addressing the Government and Local Council's call to consolidate towers and Multiple MNOs to share towers, Edotco embarked on sourcing for a Multi Operator Neutral Hosted RAN Solution.

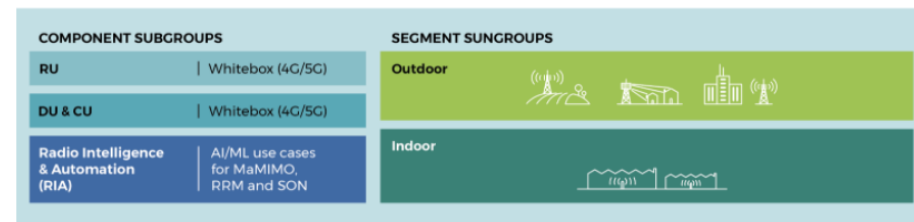
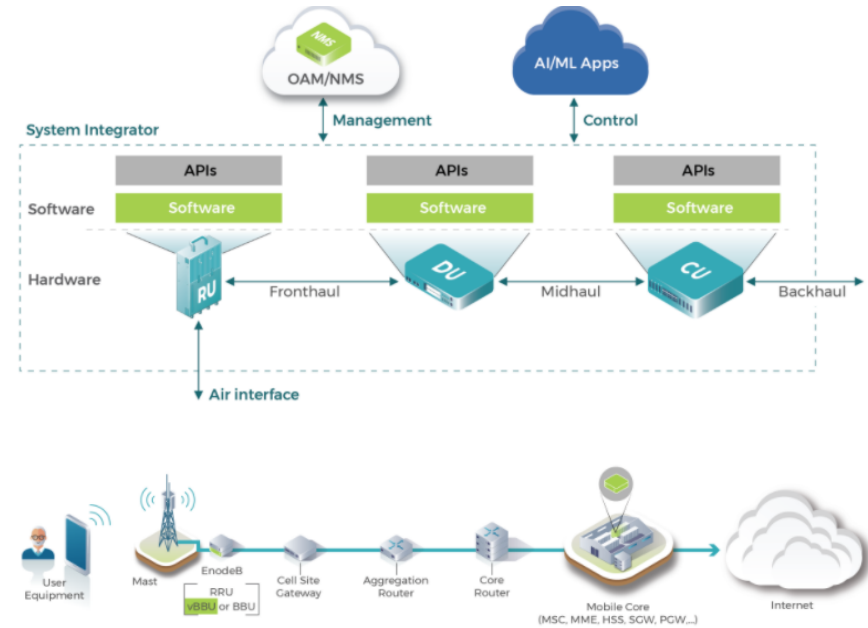
As such Edotco needed to find a solution that was Open, Software Defined, Able to be deployed on COTS, Agile, Scalable and most importantly Cost Effective

Edotco embarked on the trials by proposing 2 staged approach:

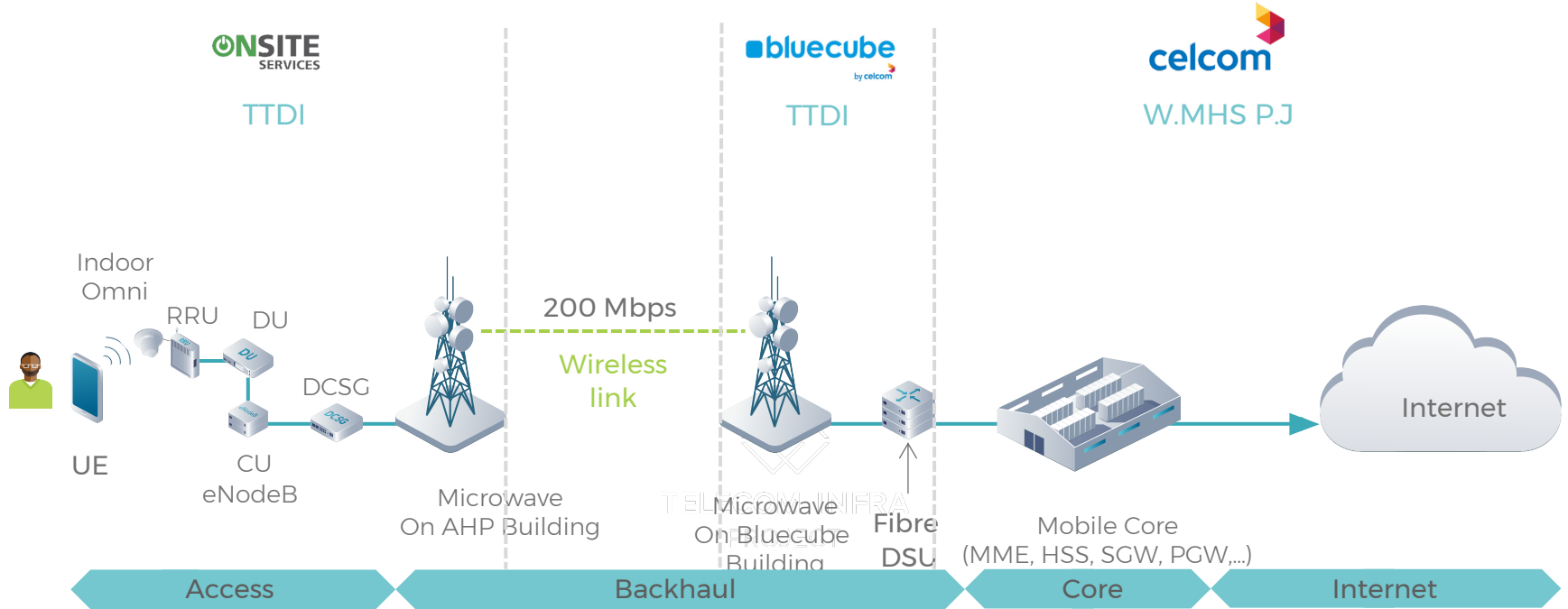
- Stage 1 LAB Trials
- Stage 2 Live Trials

Stage 1 – LAB Trial is to validate the following:

- Ease of Deployment
- Validate Open RAN Architecture
- Interoperability with non-standard Radio
- Interoperability with multi Vendor LTE core network
- Stability of the solution
- Measured Throughput

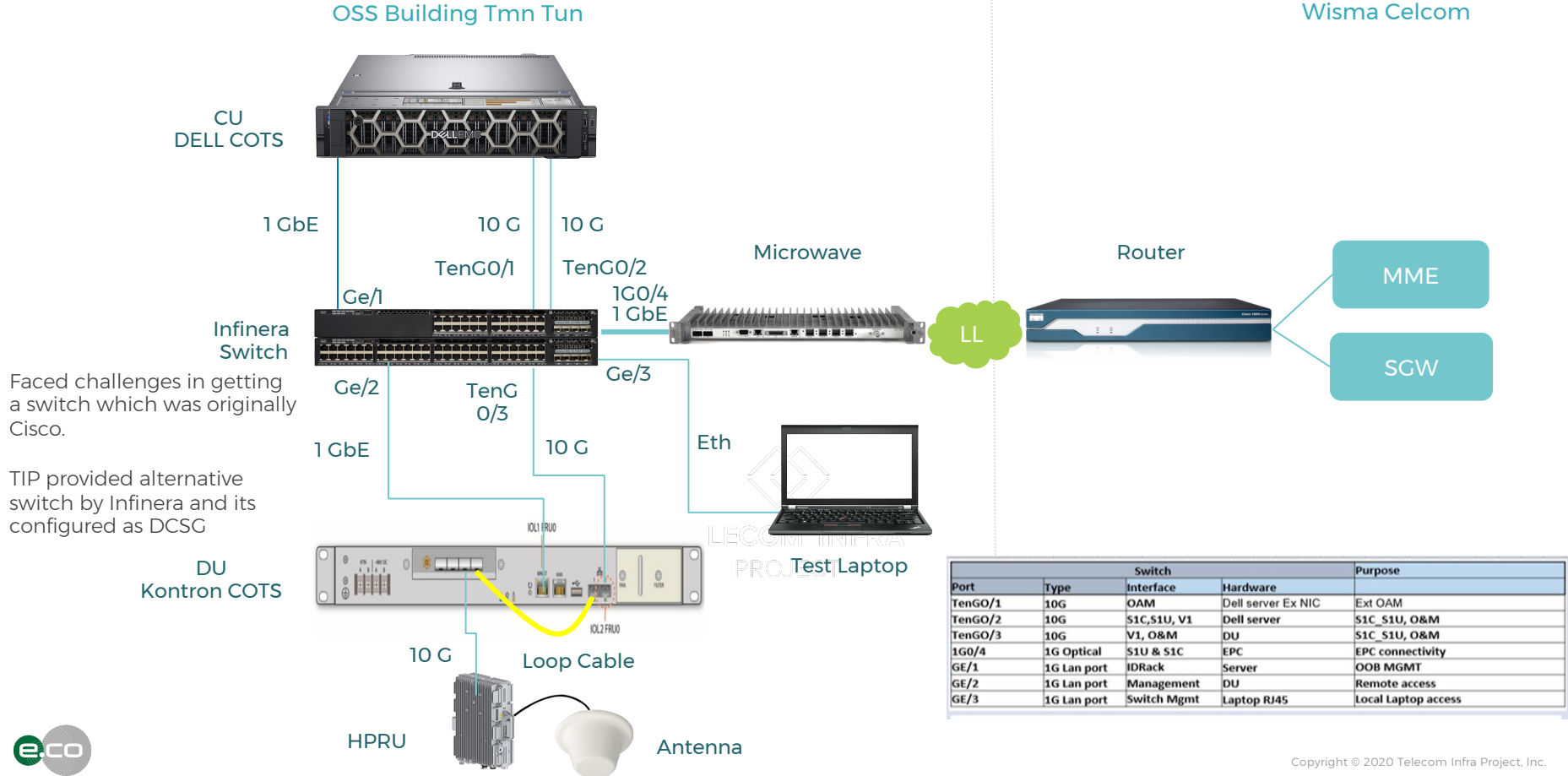


# OPENRAN TEST BED NETWORK CONNECTIVITY

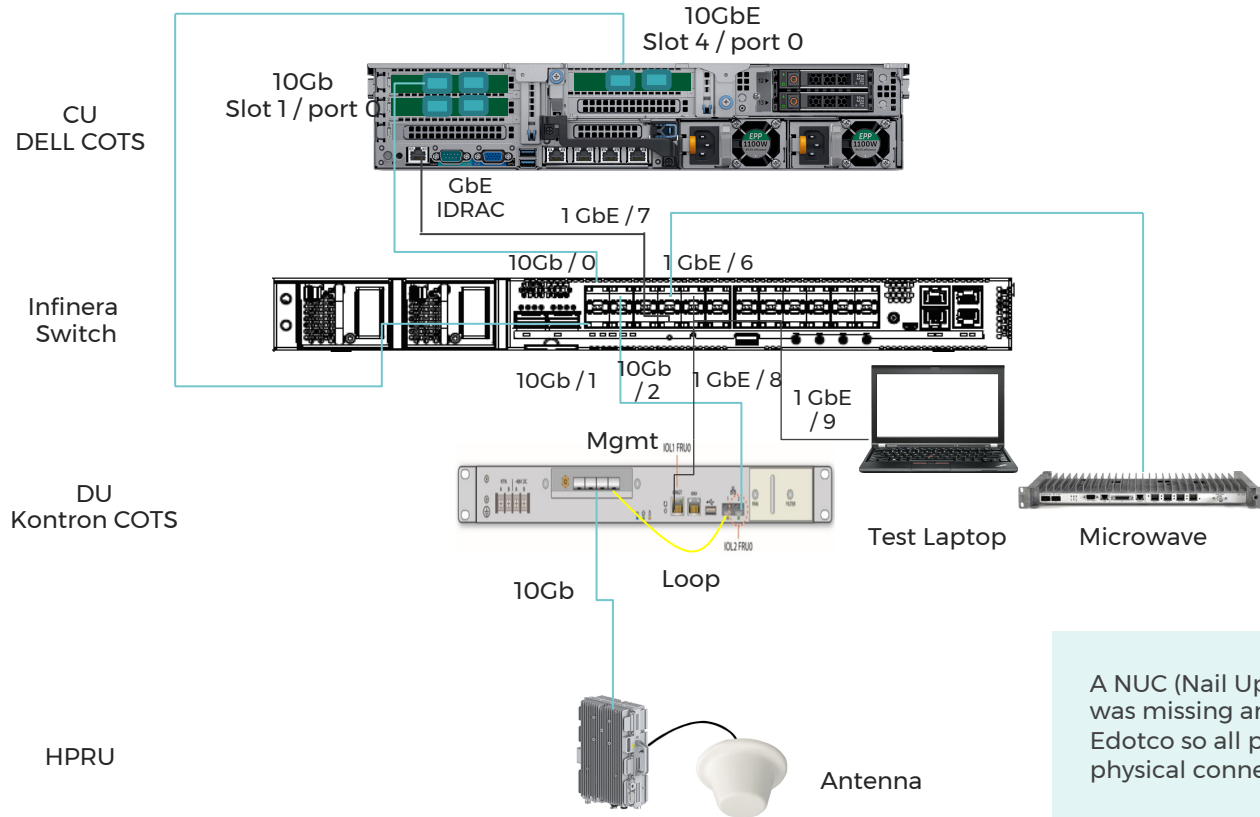




# Phase 1 - Lab POC Architecture



# Phase 1 - Lab connectivity schematic



A NUC (Nail Up Connection) schematic was missing and was made available by Edotco so all parties are aware on the physical connectivity between devices

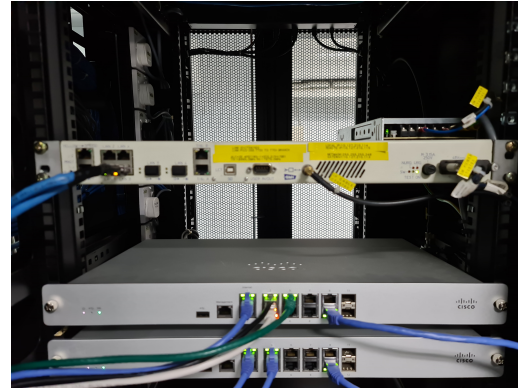
# Phase 1 - LAB INSTALL PHOTOS AS OF 30<sup>TH</sup> JUNE 2020



Infinera  
Switch

DU  
Kontron  
COTS

CU  
Dell COTS



CELCOM  
Microwave  
IDU



RRH



Antenna

# LAB HIGH LEVEL TEST CASES – 100% COMPLETED

## S1 AP Procedure

- S1 setup procedure between CU and MME
- Verify successful Attach/Detach

## SIBs Broadcast

- MIB, SIB1, SIB2, etc broadcast parameters

## RRC Procedure

- Validate successful Attach/Detach procedure

## Cell Throughput

- Verify single cell peak UL/DL throughput

## Stability

- Verify long run single UE UL/DL alone peak throughput

## Data Services eg WhatsApp call

S1 AP – S1 Application Protocol  
CU – Centralised Unit  
MME – Mobility Management Entity  
UL – Up Link  
DL – Down Link

SIB – System Information Block  
MIB – Master Information Block  
RRC – Radio Resource Control  
UE – User Equipment

Sl. #	Test Case Objective	Priority	Test Case Category	Test Case Sub-Category	Remarks
1	Verify successful 'S1 Setup' procedure between CU and MME	P1	Functional	S1AP Procedure	Done
2	Verify 'MIB, SIB1, SIB2' parameter broadcast	P1	Functional	MIB/SIB	Done
3	Verify SIB3 broadcast parameters	P1	Functional	SIBs	Done
4	Verify SIB4 broadcast parameters	P1	Functional	SIBs	Pending
5	Verify SIB5 broadcast parameters	P1	Functional	SIBs	Done
6	Verify SIB6 broadcast parameters	P1	Functional	SIBs	Done
7	Validate successful Attach procedure	P1	Functional	RRC Procedure	Done
8	Verify UE initiated Ping Traffic	P1	Functional	RRC Procedure	Done
9	Verify successful attach/detach by Airplane Mode	P1	Functional	S1AP Procedure	Done
10	Validate successful detach procedure when it is initiated by the UE due to 'UE switch off'	P1	Functional	RRC Procedure	Pending
11	Validate 'Idle to Active Mode' / successful 'Paging procedure' when CU-DU/RRH receives Paging from MME	P1	Functional	S1AP Procedure	Done
12	Validate the successful transfer from 'ECM-Idle mode to ECM-Connected' using UE initiated data	P1	Functional	S1AP Procedure	Pending
13	Verify 'Periodic Tracking are update' procedure	P2	Functional	S1AP Procedure	Pending
14	Verify Single Cell peak UDP 'DL Alone' throughput	P1	Functional	Cell Throughput	Pending
15	Verify Single Cell peak UDP 'UL Alone' throughput	P1	Functional	Cell Throughput	Pending
16	Verify Single Cell peak UDP bi directional throughput	P1	Functional	Cell Throughput	Pending
17	Verify Single Cell peak TCP 'DL Alone' throughput	P1	Functional	Cell Throughput	Pending
18	Verify Single Cell peak TCP 'UL Alone' throughput	P1	Functional	Cell Throughput	Pending
19	Verify Single Cell peak TCP bi directional throughput	P1	Functional	Cell Throughput	Pending
20	Verify Single Cell, 2 UE UDP bi directional throughput	P2	Functional	Cell Throughput	Pending
21	Verify Single Cell, 2 UE TCP bi directional throughput	P2	Functional	Cell Throughput	Pending
22	Verify Single Cell, VOLTE Call	P1	Functional	VOLTE	NA
23	Verify Single Cell, VILTE call	P1	Functional	VOLTE	NA
24	Verify Single Cell, Volte Call along with ongoing data on UE1	P2	Functional	VOLTE	NA
25	Verify RRC Connection Re-establishment procedure without ongoing data	P1	Functional	Re-establishment	Done
26	Verify RRC Connection Re-establishment procedure with ongoing data	P1	Functional	Re-establishment	Pending
27	Verify long run single UE DL alone peak throughput	P2	Stability	Cell Throughput	Pending
28	Verify long run single UE UL alone peak throughput	P2	Stability	Cell Throughput	Pending
29	Verify long run single UE bi directional peak throughput	P2	Stability	Cell Throughput	Pending
30	Verify long run two UE DL alone peak throughput	P3	Stability	Cell Throughput	Pending
31	Verify long run two UE UL alone peak throughput	P3	Stability	Cell Throughput	Pending
32	Verify long run two UE bi directional peak throughput	P3	Stability	Cell Throughput	Pending

# BASIC LAB SETUP TEST CASES

Sl. No.	Test Case Objective	Priority	Test Case Category	Test Case Sub-Category	Remarks
1	Verify successful 'S1 Setup' procedure between CU and MME	P1	Functional	S1AP Procedure	Done
2	Verify 'MIB, SIB1, SIB2' parameter broadcast	P1	Functional	MIB/SIB	Done
3	Verify SIB3 broadcast parameters	P1	Functional	SIBs	Done
4	Verify SIB4 broadcast parameters	P1	Functional	SIBs	NA / Due to 2 RRH required
5	Verify SIB5 broadcast parameters	P1	Functional	SIBs	Done
6	Verify SIB6 broadcast parameters	P1	Functional	SIBs	Done
7	Validate successful Attach procedure	P1	Functional	RRC Procedure	Done
8	Verify UE initiated Ping Traffic	P1	Functional	RRC Procedure	Done
9	Verify successful attach/detach by Airplane Mode	P1	Functional	S1AP Procedure	Done
10	Validate successful detach procedure when it is initiated by the UE due to 'UE switch off'	P1	Functional	RRC Procedure	Done
11	Validate 'Idle to Active Mode'/'successful 'Paging procedure' when CU-DU/RRH receives Paging from MME	P1	Functional	S1AP Procedure	Done
12	Validate the successful transfer from 'ECM-Idle mode to ECM-Connected' using UE initiated data	P1	Functional	S1AP Procedure	Done
13	Verify 'Periodic Tracking area update' procedure	P2	Functional	S1AP Procedure	GPS Connectivity is required.
14	Verify Single Cell peak UDP 'DL Alone' throughput	P1	Functional	Cell Throughput	NA
15	Verify Single Cell peak UDP 'UL Alone' throughput	P1	Functional	Cell Throughput	NA
16	Verify Single Cell peak UDP bi directional throughput	P1	Functional	Cell Throughput	NA

17	Verify Single Cell peak TCP 'DL Alone' throughput	P1	Functional	Cell Throughput	Done
18	Verify Single Cell peak TCP 'UL Alone' throughput	P1	Functional	Cell Throughput	Done
19	Verify Single Cell peak TCP bi directional throughput	P1	Functional	Cell Throughput	Done
20	Verify Single Cell, 2 UE UDP bi directional throughput	P2	Functional	Cell Throughput	NA
21	Verify Single Cell, 2 UE TCP bi directional throughput	P2	Functional	Cell Throughput	Done
22	Verify Single Cell, VOLTE Call	P1	Functional	VOLTE	IMS Required
23	Verify Single Cell, VILTE call	P1	Functional	VOLTE	IMS Required
24	Verify Single Cell, Volte Call along with ongoing data on UE1	P2	Functional	VOLTE	IMS Required
25	Verify RRC Connection Re-establishment procedure without ongoing data	P1	Functional	Re-establishment	Done
26	Verify RRC Connection Re-establishment procedure with ongoing data	P1	Functional	Re-establishment	Done
27	Verify long run single UE DL alone peak throughput	P2	Stability	Cell Throughput	Verified by Mahesan
28	Verify long run single UE UL alone peak throughput	P2	Stability	Cell Throughput	Verified by Mahesan
29	Verify long run single UE bi directional peak throughput	P2	Stability	Cell Throughput	Verified by Mahesan
30	Verify long run two UE DL alone peak throughput	P3	Stability	Cell Throughput	Verified by Mahesan
31	Verify long run two UE UL alone peak throughput	P3	Stability	Cell Throughput	Verified by Mahesan
32	Verify long run two UE bi directional peak throughput	P3	Stability	Cell Throughput	Verified by Mahesan

# Verify test serving cell info

## Intent of test

To verify that the tested UE latches to the correct Cell

## Test gears / software used

G - Net Track / Wireshark

## Test procedure

- Turn UE on
- Enable G-Net Track software on the UE
- Check for Cell latching and if the UE latches to the correct cell site

## Expected Results

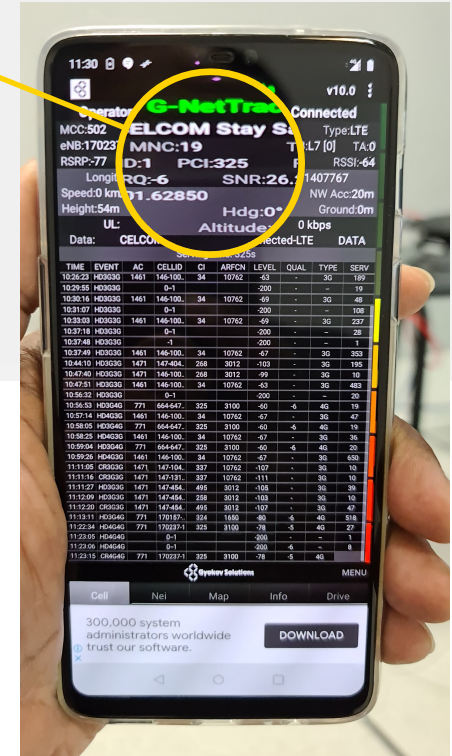
On successful latch Cell ID 325 should be seen on G-Net Track

## Measured Result seen

Cell ID 325 seen on G-Net Track upon successful UE latch

2020 Sep 11 13:44:02.882 [82] 0xB0C2 LTE RRC Serving Cell Info Log Pkt

Subscription ID = 1  
Version = 3  
Physical cell ID = 325  
DL FREQ = 3100  
UL FREQ = 21100  
DL Bandwidth = 10 MHz  
UL Bandwidth = 10 MHz  
Cell Identity = 43580673  
Tracking area code = 771  
Freq Band Indicator = 7  
MCC = 502  
Number of MNC digits = 2  
MNC = 19  
Allowed Access = Full



# Verify successful 'S1 Setup Request' between CU and MME

## Intent of test

Verify successful 'S1 Setup Request' between CU and MME

## Test gears / software used

Wireshark

## Test procedure

- Turn CU on
- Bring CU into service
- Monitor CU S1 interface towards MME

## Expected Results

When CU comes up it should establish connection with MME  
CU to send Setup Request to MME

## Measured Result seen

S1 Setup Request was sent from CU to MME and MME responded to the S1 setup request successfully

Time	Source	Destination	Protocol	Length	Info
1751.310.576676	10.156.152.11	10.223.174.128	S1AP	116	S1SetupRequest
1753.310.580048	10.223.174.128	10.156.152.11	S1AP	100	S1SetupResponse
2213.462.277507	10.156.152.11	10.223.174.128	S1AP/NAS-EPS	216	InitialUEMessage, Attach request, PDN connectivity request
2215.462.284540	10.223.174.128	10.156.152.11	S1AP/NAS-EPS	96	DownlinkNASTransport, Identity request
2223.462.308328	10.156.152.11	10.223.174.128	S1AP/NAS-EPS	148	UplinkNASTransport, Identity response
2227.462.372722	10.223.174.128	10.156.152.11	S1AP/NAS-EPS	128	DownlinkNASTransport, Authentication request
2237.462.488084	10.156.152.11	10.223.174.128	S1AP/NAS-EPS	156	UplinkNASTransport, Authentication failure (Synch failure)
2241.462.554670	10.223.174.128	10.156.152.11	S1AP/NAS-EPS	128	DownlinkNASTransport, Authentication request
2251.462.688271	10.156.152.11	10.223.174.128	S1AP/NAS-EPS	148	UplinkNASTransport, Authentication response
2253.462.704422	10.223.174.128	10.156.152.11	S1AP/NAS-EPS	108	DownlinkNASTransport, Security mode command

Wireshark - Packet 1751 - enb-2020\_09\_10-14\_35\_45.pcap

```
S1SetupRequest
  protocolIEs: 4 items
    Item 0: id-Global-ENB-ID
      ProtocolIE-Field
        id: id-Global-ENB-ID (59)
        criticality: reject (0)
        value
          Global-ENB-ID
            pUINrity: 05f291
            Mobile Country Code (MCC): Malaysia (502)
            Mobile Network Code (MNC): Celcom (Malaysia) Berhad (19)
            eNB-ID: macroENB-ID (0)
            macroENB-ID: 298f00 [bit-length 20, 4 LSB pad bits, 0001 1001 1000 1111 1101 .... decimal value 170237]
    Item 1: id-eNBName
      ProtocolIE-Field
        id: id-eNBName (60)
        criticality: ignore (1)
```

# Verify successful 'S1 Setup Response' between CU and MME

## Intent of test

Verify successful 'S1 Setup Response' between CU and MME

## Test gears / software used

Wireshark

## Test procedure

- Turn CU on
- Bring CU into service
- Monitor CU S1 interface towards MME
- Monitor for the connection response messages

## Expected Results

When CU comes up it should establish connection with MME

Connection between CU & MME should establish

## Measured Result seen

S1 Setup Request was sent from CU to MME and MME responded to the S1 setup request successfully with a S1 Setup Response protocol

	Time	Source	Destination	Protocol	Length	Info
123	94.287163	10.223.174.128	10.156.152.11	S1AP	108	Paging
130	100.278082	10.223.174.128	10.156.152.11	S1AP	108	Paging
137	106.274107	10.223.174.128	10.156.152.11	S1AP	108	Paging
146	113.508888	10.223.174.128	10.156.152.11	S1AP	108	Paging
161	118.559433	10.156.152.11	10.223.174.128	S1AP	116	S1SetupRequest
163	118.562461	10.223.174.128	10.156.152.11	S1AP	100	S1SetupResponse
167	125.504080	10.223.174.128	10.156.152.11	S1AP	108	Paging

Wireshark - Packet 163 - enbcu\_2020\_09\_10-14\_35\_45.pcap

```

  S1AP-PDU: successfulOutcome (1)
    successfulOutcome
      procedureCode: id-S1Setup (17)
      criticality: reject (0)
      value
        S1SetupResponse
          protocolIEs: 2 items
            Item 0: id-ServedGUMMEIs
              ProtocolIE-Field
                id: id-ServedGUMMEIs (105)
                criticality: reject (0)
                value
                  ServedGUMMEIs: 1 item
                    Item 0
                      ServedGUMMEIsItem
                        servedPLMNs: 1 item
                          Item 0

```



# Verify 'MIB' parameter broadcast

## Intent of test

Verify successful 'SI Setup Request' between CU and MME

## Test gears / software used

Wireshark

## Test procedure

- Turn UE on
- Wait for UE to identify Test Network
- UE Latches to the correct Test Network
- UE attached successfully


## Expected Results

UE should attach to network & send & receive Measurement report regarding MIB/SIB

## Measured Result seen

UE successfully attached to the Network and MIB/SIB messages exchanged with no errors

Time	Source	Destination	Protocol	Length	Info
32 20.507153	10.156.152.18	192.168.110.9	SCTP	64	SACK
33 20.508255	localhost	localhost	LTE RRC BCCH_BCH	51	MasterInformationBlock (SFN=0)
34 20.508298	localhost	localhost	LTE RRC DL_SCH	65	SystemInformationBlockType1
35 20.508365	localhost	localhost	LTE RRC DL_SCH	74	SystemInformation [ SIB2 ]
36 20.508409	localhost	localhost	LTE RRC DL_SCH	59	SystemInformation [ SIB3 ]
37 20.508533	10.156.152.18	192.168.110.9	LTE RRC BCCH_BCH	96	MasterInformationBlock (SFN=0)
38 20.510603	192.168.110.9	10.156.152.18	DU -> CU	104	SACK EVT_SCH_SI_CFG_RESP
39 20.510618	10.156.152.18	192.168.110.9	CUDU HEADER	464	SACK , SystemInformationBlockType1, SystemInformation [ SIB2 ], SystemInformation

 Packet Text

☐ Hex Dump

**2020 Sep 11 06:07:33.503 [01] 0xB0C1 LTE RRC MIB Message Log Packet**  
Subscription ID = 1  
Version = 2  
Physical cell ID = 325  
FREQ = 3100  
SFN = 504  
Number of TX Antennas = 2  
DL Bandwidth = 10 MHz (50)

# Verify 'SIB 1' parameter broadcast

## Intent of test

Verify 'MIB, SIB1, SIB2' parameter broadcast

## Test gears / software used

Wireshark

## Test procedure

- Turn UE on
- Wait for UE to identify Test Network
- UE Latches to the correct Test Network
- UE attached successfully
- Monitor the reply messages from the Network

## Expected Results

When UE attaches to the Network, Network sends all information regarding MCC, MNC, Bandwidth, ARFCN to UE

## Measured Result seen

UE successfully attached to the Network and SIB1 messages exchanged with no errors

Time	Source	Destination	Protocol	Length	Info
33.20.508255	127.0.0.1	127.0.0.1	LTE RRC BCCH_BCH	51	MasterInformationBlock (SFN=0)
34.20.508298	127.0.0.1	127.0.0.1	LTE RRC DL_SCH	65	SystemInformationBlockType1
35.20.508365	127.0.0.1	127.0.0.1	LTE RRC DL_SCH	74	SystemInformation [ SIB2 ]
36.20.508409	127.0.0.1	127.0.0.1	LTE RRC DL_SCH	59	SystemInformation [ SIB3 ]
37.20.508533	10.156.152.18	192.168.110.9	LTE RRC BCCH_BCH	96	MasterInformationBlock (SFN=0)
38.20.510603	192.168.110.9	10.156.152.18	DU -> CU	104	SACK EVT_SCH_SI_CFG_RESP

2020 Sep 11 06:07:33.510 [72] 0xB0C0 LTE RRC OTA Packet -- BCCH\_DL\_SCH / SystemInformationBlockType1

Subscription ID = 1  
Pkt Version = 20  
RRC Release Number.Major.minor = 14.3.0  
Radio Bearer ID = 0. Physical Cell ID = 325  
Freq = 3100  
SysFrameNum = 508. SubFrameNum = 5  
PDU Number = BCCH\_DL\_SCH Message. Msg Length = 18  
SIB Mask in SI = 0x02

Interpreted PDU:

```
value BCCH-DL-SCH-Message ::=
{
  message c1 : systemInformationBlockType1 :
  {
    cellAccessRelatedInfo
    {
      plmn-identityList
      {
        {
          plmn-identity
          {
            mcc
            {
              5,
              0,
              2
            },
            mnc
            {
              1,
              9
            }
          }
        },
        cellReservedForOperatorUse notReserved
      }
    }
  }
}
```

Time	Source	Destination	Protocol	Length	Info
34.20.508298	localhost	localhost	LTE RRC DL_SCH	65	SystemInformationBlockType1
35.20.508365	localhost	localhost	LTE RRC DL_SCH	74	SystemInformation [ SIB2 ]
36.20.508409	localhost	localhost	LTE RRC DL_SCH	59	SystemInformation [ SIB3 ]
37.20.508533	10.156.152.18	192.168.110.9	LTE RRC BCCH_BCH	96	MasterInformationBlock (SFN=0)
38.20.510603	192.168.110.9	10.156.152.18	DU -> CU	104	SACK EVT_SCH_SI_CFG_RESP
39.20.510618	10.156.152.18	192.168.110.9	CU DU HEADER	464	SACK , SystemInformationBlockType1, SystemInformation [ SIB2 ], SystemInformation [ SIB3 ] EVT
40.20.510628	10.156.152.18	192.168.110.9	CU DU	104	SACK EVT_SCH_SI_CFG_RESP

Wireshark: Packet 35 - enbu\_2020.09.10-14.35.45.pcap

```

message: c1 (0)
  c1: systemInformation (0)
    systemInformation
      criticalExtensions: systemInformation-r8 (0)
        systemInformation-r8
          sib-TypeAndInfo: 1 item
            Item 0
              sib-TypeAndInfo item: sib2 (0)
                sib2
                  radioResourceConfigCommon
                    rach-ConfigCommon
                      preambleInfo
                        numberOfRA-Preambles: n52 (12)
                        preamblesGroupAConfig
                          sizeOfRA-PreamblesGroupA: n28 (6)
                          messageSizeGroupA: b56 (0)
                          messagePowerOffsetGroupB: dB10 (4)

```

#### 2020 Sep 11 06:07:33.545 [5B] 0xB0C0 LTE RRC OTA Packet -- BCCH\_DL\_SCH / SystemInformation

```

Subscription ID = 1
Pkt Version = 20
RRC Release Number.Major.minor = 14.3.0
Radio Bearer ID = 0. Physical Cell ID = 325
Freq = 3100
SysFrameNum = 512. SubFrameNum = 0
PDU Number = BCCH_DL_SCH Message. Msg Length = 26
SIB Mask in SI = 0x04

```

Interpreted PDU:

```

value BCCH-DL-SCH-Message ::=
{
  message c1 : systemInformation :
  {
    criticalExtensions systemInformation-r8 :
    {
      sib-TypeAndInfo
      {
        sib2
        {
          radioResourceConfigCommon
          {
            rach-ConfigCommon
            {
              preambleInfo
              {
                numberOfRA-Preambles n52.
                preamblesGroupAConfig
                {
                  sizeOfRA-PreamblesGroupA n28.
                  messageSizeGroupA b56.
                  messagePowerOffsetGroupB dB10
                }
              }
            }
          }
        }
      }
    }
  }
}

```

Activate Windows

## Verify 'SIB 2' parameter broadcast

### Intent of test

Verify 'MIB, SIB1, SIB2' parameter broadcast

### Test gears / software used

Wireshark

### Test procedure

- Turn UE on
- Wait for UE to identify Test Network
- UE Latches to the correct Test Network
- UE attached successfully
- Monitor the reply messages from the Network

### Expected Results

SIB2 is not specifically included in the scheduling information in SIB1 but it is always mapped to the SI message that corresponds to the first entry in the list of SI messages in schedulingInfoList in SIB1

### Measured Result seen

UE successfully attached to the Network and SIB2 messages exchanged with no errors

# Verify 'SIB 3' parameter broadcast

## Intent of test

Verify 'SIB3' parameter broadcast

## Test gears / software used

Wireshark

## Test procedure

- Turn UE on
- Wait for UE to identify Test Network
- UE Latches to the correct Test Network
- UE attached successfully
- Monitor the reply messages from the Network

## Expected Results

SIB3 is carried in SystemInformation (SI) messages, which are transmitted on the DL-SCH.

SIB1 contains scheduling information for SI-message carrying SIB3

## Measured Result seen

UE successfully attached to the Network and SIB3 messages exchanged with no errors

No.	Time	Source	Destination	Protocol	Length	Info
34	28.588298	localhost	localhost	LTE RRC DL_SCH	65	SystemInformationBlockType1
35	28.588365	localhost	localhost	LTE RRC DL_SCH	74	SystemInformation [ SIB2 ]
36	28.588409	localhost	localhost	LTE RRC DL_SCH	59	SystemInformation [ SIB3 ]
37	28.588533	10.156.152.18	192.168.110.9	LTE RRC BCCH_BCH	96	MasterInformationBlock (SFN=0)

**2020 Sep 11 06:07:33.551 [B8] 0xB0C0 LTE RRC OTA Packet -- BCCH\_DL\_SCH / SystemInformation**

Subscription ID = 1  
Pkt Version = 20  
RRC Release Number.Major.minor = 14.3.0  
Radio Bearer ID = 0, Physical Cell ID = 325  
Freq = 3100  
SysFrameNum = 512, SubFrameNum = 6  
PDU Number = BCCH\_DL\_SCH Message, Msg Length = 11  
SIB Mask in SI = 0x08

Interpreted PDU:

```
value BCCH-DL-SCH-Message ::=
{
  message c1 : systemInformation :
  {
    criticalExtensions systemInformation-r8 :
    {
      sib-TypeAndInfo
      {
        sib3 :
        {
          cellReselectionInfoCommon |
          {
            q-Hyst dB4,
            speedStateReselectionPars
            {
              mobilityStateParameters
              {
                t-Evaluation s30,
                t-HystNormal s30,
                n-CellChangeMedium 10,
                n-CellChangeHigh 16
              },
              q-HystSF
              {
                sf-Medium dB-4,
                sf-High dB-4
              }
            }
          }
        }
      }
    }
  }
}
```

Activate Windows

# Verify 'SIB 5' parameter broadcast

## Intent of test

Verify 'SIB5' parameter broadcast

## Test gears / software used

Wireshark

## Test procedure

- Turn UE on
- Wait for UE to identify Test Network
- UE Latches to the correct Test Network
- UE attached successfully
- Monitor the reply messages from the Network

## Expected Results

SIB5 capability for HO & cell reselection should show in measurement information

Measurement report to UE should show SIB5 capability for HO & cell reselection

## Measured Result seen

UE successfully attached to the Network and SIB5 messages exchanged with no errors

```

☐ Hex Dump
2020 Sep 11 12:51:45.514 [D4] 0xB0C0 LTE RRC OTA Packet -- BCCH_DL_SCH / SystemInformation
Subscription ID = 1
Pkt Version = 20
RRC Release Number.Major.minor = 14.3.0
Radio Bearer ID = 0, Physical Cell ID = 325
Freq = 3100
SysFrameNum = 769, SubFrameNum = 5
PDU Number = BCCH_DL_SCH Message,   Msg Length = 18
SIB Mask in SI = 0x20

Interpreted PDU:

value BCCH-DL-SCH-Message ::=
{
  message c1 : systemInformation :
  {
    criticalExtensions systemInformation-r8 :
    {
      sib-TypeAndInfo
      {
        sib5 :
        {
          interFreqCarrierFreqList
          {
            {
              dl-CarrierFreq 1580,
              q-RxLevMin -60,
              p-Max 23,
              t-ReselectionEUTRA 4,
              threshX-High 6,
              threshX-Low 0,
              allowedMeasBandwidth mbw50,
              presenceAntennaPort1 FALSE,
              cellReselectionPriority 7,
              neighCellConfig '01'B,
              q-OffsetFreq dB0,
              interFreqNeighCellList
            }
          }
        }
      }
    }
  }
}

```

# Verify 'SIB 6' parameter broadcast

## Intent of test

Verify 'SIB6' parameter broadcast

## Test gears / software used

Wireshark

## Test procedure

- Turn UE on
- Wait for UE to identify Test Network
- UE Latches to the correct Test Network
- UE attached successfully
- Monitor the reply messages from the Network

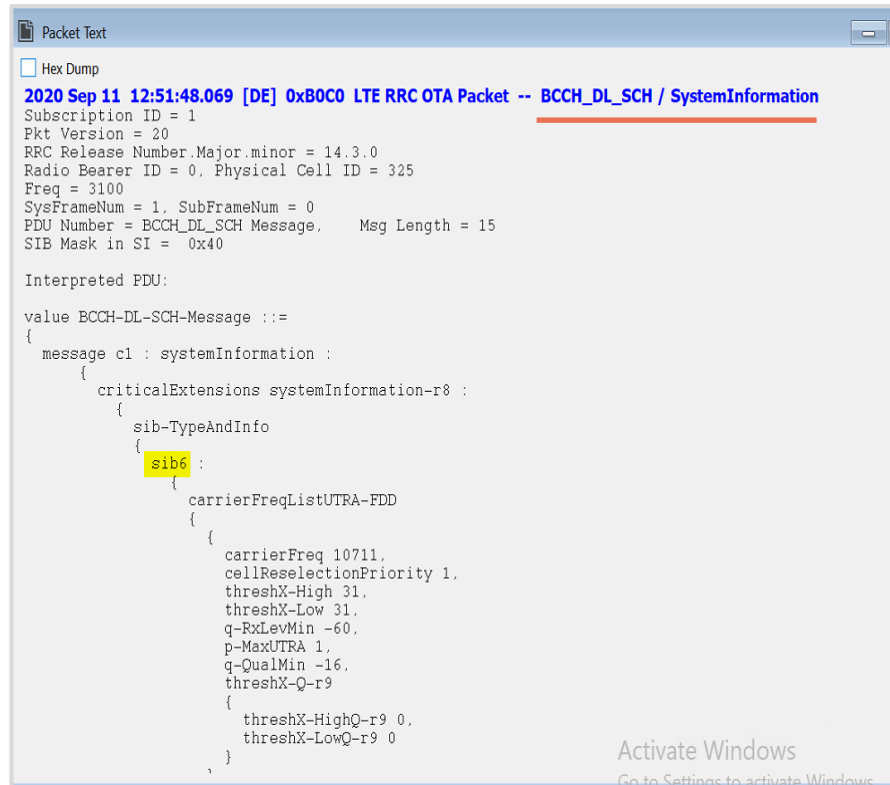
## Expected Results

On 1st start-up UE gets information related to WCDMA neighbor relation

SIB6 message should show WCDMA neighbor relationship

## Measured Result seen

UE successfully attached to the Network and SIB6 messages exchanged with no errors



The image shows a Wireshark Packet Text window for an LTE RRC OTA Packet. The packet is identified as '2020 Sep 11 12:51:48.069 [DE] 0x80C0 LTE RRC OTA Packet -- BCCH\_DL\_SCH / SystemInformation'. The details pane shows the following fields:

- Subscription ID = 1
- Pkt Version = 20
- RRC Release Number.Major.minor = 14.3.0
- Radio Bearer ID = 0, Physical Cell ID = 325
- Freq = 3100
- SysFrameNum = 1, SubFrameNum = 0
- PDU Number = BCCH\_DL\_SCH Message, Msg Length = 15
- SIB Mask in SI = 0x40

The 'Interpreted PDU' section shows the structure of the BCCH-DL-SCH-Message:

```
value BCCH-DL-SCH-Message ::=
{
  message c1 : systemInformation :
  {
    criticalExtensions systemInformation-r8 :
    {
      sib-TypeAndInfo
      {
        sib6 :
        {
          carrierFreqListUTRA-FDD
          {
            {
              carrierFreq 10711,
              cellReselectionPriority 1,
              threshX-High 31,
              threshX-Low 31,
              q-RxLevMin -60,
              p-MaxUTRA 1,
              q-QualMin -16,
              threshX-Q-r9
              {
                threshX-HighQ-r9 0,
                threshX-LowQ-r9 0
              }
            }
          }
        }
      }
    }
  }
}
```

The 'sib6' field is highlighted in yellow. The bottom right corner of the window displays 'Activate Windows' and 'Go to Settings to activate Windows'.

2020 Sep 11 06:07:33.646 [BE] 0xB0ED LTE NAS EMM Plain OTA Outgoing Message -- Attach request Msg

```
Subscription ID = 1
pkt_version = 1 (0x1)
rel_number = 9 (0x9)
rel_version_major = 5 (0x5)
rel_version_minor = 0 (0x0)
security_header_or_skip_ind = 0 (0x0)
prot_disc = 7 (0x7) (EPS mobility management messages)
msg_type = 65 (0x41) (Attach request)
lte_emm_msg
  emm_attach_request
    tsc = 0 (0x0) (cached sec context)
    nas_key_set_id = 1 (0x1)
    att_type = 2 (0x2) (combined EPS/IMSI attach)
    eps_mob_id
      id_type = 6 (0x6) (GUTI)
      odd_even_ind = 0 (0x0)
      GutI_l111 = 15 (0xf)
      mcc_1 = 5 (0x5)
      mcc_2 = 0 (0x0)
      mcc_3 = 2 (0x2)
      mnc_3 = 15 (0xf)
      mnc_1 = 1 (0x1)
      mnc_2 = 9 (0x9)
      MME_group_id = 32769 (0x8001)
      MME_code = 16 (0x10)
      n_tmsi = 3230497472 (0xc08d7ac0)
    ue_netwk_cap
      EEA0 = 1 (0x1)
      EEA1_128 = 1 (0x1)
      EEA2_128 = 1 (0x1)
      EEA3_128 = 1 (0x1)
      EEA4 = 0 (0x0)
      EEA5 = 0 (0x0)
      EEA6 = 0 (0x0)
      EEA7 = 0 (0x0)
      EIA0 = 0 (0x0)
      EIA1_128 = 1 (0x1)
```

2020 Sep 11 06:07:34.076 [22] 0xB0ED LTE NAS EMM Plain OTA Outgoing Message -- Attach complete Msg

```
Subscription ID = 1
pkt_version = 1 (0x1)
rel_number = 9 (0x9)
rel_version_major = 5 (0x5)
rel_version_minor = 0 (0x0)
security_header_or_skip_ind = 0 (0x0)
prot_disc = 7 (0x7) (EPS mobility management messages)
msg_type = 67 (0x43) (Attach complete)
lte_emm_msg
  emm_attach_complete
    esm_msg_container
      eps_bearer_id_or_skip_id = 5 (0x5)
      prot_disc = 2 (0x2) (EPS session management messages)
      trans_id = 0 (0x0)
      msg_type = 194 (0xc2) (Activate default EPS bearer context accept)
      lte_esm_msg
        act_def_eps_bearer_context_accept
          prot_config_incl = 0 (0x0)
          ext_prot_config_incl = 0 (0x0)
```

# Validate successful Attach procedure

## Intent of test

Verify the UE attaches to the Network Successfully

## Test gears / software used

Wireshark

## Test procedure

- Turn UE on
- Enable Airplane mode on UE
- UE should disconnect from Network
- Disable Airplane mode on UE
- UE should attach to the Test Network

## Expected Results

UE should connect with home network.

## Measured Result seen

UE successfully attached to the Network

# Validate successful detach by Airplane Mode

## Intent of test

Verify the UE detaches from the Network Successfully

## Test gears / software used

Wireshark

## Test procedure

- Turn UE on
- Enable Airplane mode on UE
- UE should disconnect from Network
- Disable Airplane mode on UE
- UE should attach to the Test Network

## Expected Results

UE should disconnect with home network.

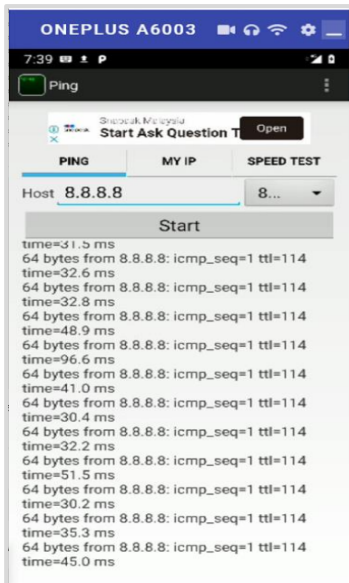
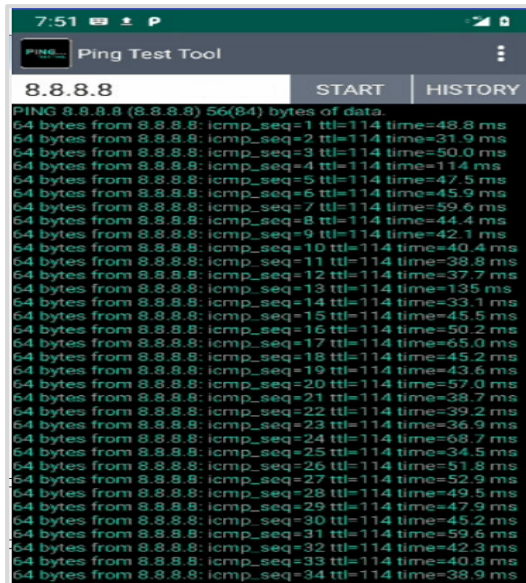
## Measured Result seen

UE successfully detached from the Network

2020 Sep 11 06:08:24.902 [A5] 0xB0ED LTE NAS EMM Plain OTA Outgoing Message -- Detach request Msg

```
Subscription ID = 1
pkt_version = 1 (0x1)
rel_number = 9 (0x9)
rel_version_major = 5 (0x5)
rel_version_minor = 0 (0x0)
security_header_or_skip_ind = 0 (0x0)
prot_disc = 7 (0x7) (EPS mobility management messages)
msg_type = 69 (0x45) (Detach request)
lte_emm_msg
  emm_detach_request
    tsc = 0 (0x0) (cached sec context)
    nas_key_set_id = 1 (0x1)
    switch_off = 1 (0x1) (switch off)
    detach_type = 1 (0x1) (EPS detach)
    eps_mob_id
      id_type = 6 (0x6) (GUTI)
      odd_even_ind = 0 (0x0)
      GutI_1111 = 15 (0xf)
      mcc_1 = 5 (0x5)
      mcc_2 = 0 (0x0)
      mcc_3 = 2 (0x2)
      mnc_3 = 15 (0xf)
      mnc_1 = 1 (0x1)
      mnc_2 = 9 (0x9)
      MME_group_id = 32769 (0x8001)
      MME_code = 16 (0x10)
      m_tmsi = 3237028416 (0xc0f12240)
```





# Validate successful UE initiated Ping Traffic

## Intent of test

Verify the network latency

## Test gears / software used

Ping Test Tool

## Test procedure

- Turn UE on
- Enable Ping Test Tool
- Enter destination test IP 8.8.8.8
- Observe latency recorded
- UE should be able to ping test Network

## Expected Results

UE should be able to ping an external server successfully with latency of 40ms or lower

## Measured Result seen

UE managed to ping Google server successfully with measured latency of 30.2 ms

# Validate successful detach procedure when it is initiated by the UE due to 'UE switch off'

## Intent of test

Verify the UE detaches from the Network Successfully

## Test gears / software used

Wireshark

## Test procedure

- Turn UE on
- Power UE down
- UE should disconnect from Network
- UE should detach from the Test Network

## Expected Results

UE should detach from home network.

## Measured Result seen

Network returns cause code "1" which represents "true" to the detach request due to power down.

```
2020 Sep 11 10:16:20.719 [6A] 0xB0ED LTE NAS EMM Plain OTA Outgoing Message -- Detach request Msg
Subscription ID = 1
pkt_version = 1 (0x1)
rel_number = 9 (0x9)
rel_version_major = 5 (0x5)
rel_version_minor = 0 (0x0)
security_header_or_skip_ind = 0 (0x0)
prot_disc = 7 (0x7) (EPS mobility management messages)
msg_type = 69 (0x45) (Detach request)
lte_emm_msg
  emm_detach_request
    tsc = 0 (0x0) (cached sec context)
    nas_key_set_id = 1 (0x1)
    switch_off = 1 (0x1) (switch off)
    detach_type = 1 (0x1) (EPS detach)
    eps_mob_id
      id_type = 6 (0x6) (GUTI)
      odd_even_ind = 0 (0x0)
      GutI_1111 = 15 (0xf)
      mcc_1 = 5 (0x5)
      mcc_2 = 0 (0x0)
      mcc_3 = 2 (0x2)
      mnc_3 = 15 (0xf)
      mnc_1 = 1 (0x1)
      mnc_2 = 9 (0x9)
      MME_group_id = 32769 (0x8001)
      MME_code = 16 (0x10)
      m_tmsi = 3235905536 (0xc0e00000)
```

# Validate 'Idle to Active Mode'/ successful 'Paging procedure' when CU-DU/RRH receives Paging from MME

## Intent of test

Verify the UE changes from 'idle to active' mode when CU - DU - RRH received "Paging" from MME

## Test gears / software used

Wireshark

## Test procedure

- Turn UE on
- Ping UE using the DL path
- Paging from CU - DU - RRH been seen at the UE
- UE should respond accordingly

## Expected Results

UE should respond to the ping request

## Measured Result seen

UE responded to the Paging Request

Time	Source	Destination	Protocol	Length	Info
214.9.767894	10.156.152.11	10.223.174.128	SIAP/NAS-EPS	136	UplinkNASTransport, Ciphered message
6703.322.173845	127.0.0.1	127.0.0.1	LTE RRC UL_DCCH/NL	161	RRCConnectionSetupComplete, Tracking area update request
6704.322.173228	10.156.152.11	10.223.174.128	SIAP/NAS-EPS	236	InitialUEMessage, Tracking area update request

Wireshark - Packet 6703 - enbca\_2020\_09\_16-05\_19\_12.pcap

▼ registeredMME

mme1: 0505 [bit length 16, 0000 0101 1011 0101 decimal value 1461]  
mme2: 2b [bit length 8, 0010 1011 decimal value 43]

▼ dedicatedInfoNAS: 17bfd6affdb00748120bf085f29105b52bc1814231821969...

▼ Non-Access-Stratum (NAS)PDU

0001 .... = Security header type: Integrity protected (1)  
.... 0111 = Protocol discriminator: EPS mobility management messages (0x7)  
Message authentication code: 0xbfd6affd  
Sequence number: 176  
0000 .... = Security header type: Plain NAS message, not security protected (0)  
.... 0111 = Protocol discriminator: EPS mobility management messages (0x7)  
NAS EPS Mobility Management Message Type: Tracking area update request (0x48)  
0... .... = Type of security context flag (TSC): Native security context (for KSIasme)  
1.001 .... = NAS key set identifier: (1) ASME  
.... 0... = Active flag: No bearer establishment requested  
.... .010 = EPS update type value: Combined TA/LA updating with IMSI attach (2)

▼ EPS mobile identity - Old GUTI

Length: 11  
.... 0... = Odd/even indication: Even number of identity digits  
.... .110 = Type of identity: GUTI (6)  
Mobile Country Code (MCC): Malaysia (502)  
Mobile Network Code (MNC): Celcom (Malaysia) Berhad (19)  
MME Group ID: 1461

Activate Window  
Go to Settings to activate

# Validate the successful transfer from 'ECM-Idle mode to ECM-Connected' using UE initiated data

## Intent of test

Initialize a procedure that requires Service Request to be started via uplink signalling.

## Test gears / software used

Wireshark

## Test procedure

- Turn UE on
- Select the test network to latch on
- Ensure successful Test Network Latch on

## Expected Results

An ECM-IDLE state indicates that no connection for NAS signalling has been setup between the UE and the core.

An UE in ECM-IDLE needs to perform PLMN and cell selection and reselection in order to become ECM-CONNECTED.

## Measured Result seen

Initial UE Message should read "Service Request" as captured

Time	Source	Destination	Protocol	Length	Info
350...	1558.5605...	10.223.174.128	10.156.152.11	S1AP	88 UEContextReleaseCommand [NAS-cause=detach]
350...	1558.5611...	10.156.152.11	10.223.174.128	S1AP	104 UEContextReleaseComplete
609...	2812.0810...	10.156.152.11	10.223.174.128	S1AP/NAS-EPS	124 InitialUEMessage, Service request
609...	2815.0839...	10.223.174.128	10.156.152.11	S1AP/NAS-EPS	96 DownlinkNASTransport, Service reject (Implicitly detached)
609...	2815.0840...	10.223.174.128	10.156.152.11	S1AP	88 UEContextReleaseCommand [NAS-cause=normal-release]

Wireshark · Packet 60922 · enbcu\_2020\_09\_11-12\_12\_30.pcap

Item 3: id-EUTRAN-CGI

ProtocolIE-Field

id: id-EUTRAN-CGI (100)

criticality: ignore (1)

value

EUTRAN-CGI

plmnIdentity: 05f291

Mobile Country Code (MCC): Malaysia (502)

Mobile Network Code (MNC): Celcom (Malaysia) Berhad (19)

cell-ID: 0x0298fd01

Item 4: id-RRC-Establishment-Cause

ProtocolIE-Field

id: id-RRC-Establishment-Cause (134)

criticality: ignore (1)

value

RRC-Establishment-Cause: no-Data (4)

# Verify RRC Connection Re-establishment procedure without ongoing data

## Intent of test

The purpose of this procedure is to re-establish the RRC connection

## Test gears / software used

Wireshark

## Test procedure

- Turn UE on
- A UE in RRC\_CONNECTED, for which AS security has been activated with SRB2 and at least one DRB setup, may initiate the procedure in order to continue the RRC connection

## Expected Results

The connection re-establishment succeeds if the network is able to find and verify a valid UE context or, if the UE context cannot be retrieved, and the network responds with an RRCSetup

## Measured Result seen

RRC Reestablishment Connection Request - RRC Reestablishment Connection - RRC Reestablishment Complete

No.	Time	Source	Destination	Protocol	Length	Info
188	06:30:31.478445	127.0.0.1	127.0.0.1	LTE RRC UL_DCH	52	MeasurementReport
189	06:30:31.478487	127.0.0.1	127.0.0.1	LTE RRC UL_DCH	52	MeasurementReport
190	06:30:31.478502	127.0.0.1	127.0.0.1	LTE RRC UL_DCH	52	MeasurementReport
193	06:30:31.678353	127.0.0.1	127.0.0.1	LTE RRC UL_DCH	52	MeasurementReport
198	06:30:32.079369	127.0.0.1	127.0.0.1	LTE RRC UL_DCH	52	MeasurementReport
201	06:30:32.288338	127.0.0.1	127.0.0.1	LTE RRC UL_DCH	52	MeasurementReport
204	06:30:32.488369	127.0.0.1	127.0.0.1	LTE RRC UL_DCH	52	MeasurementReport
209	06:30:32.881334	127.0.0.1	127.0.0.1	LTE RRC UL_DCH	52	MeasurementReport
274	06:30:39.096490	127.0.0.1	127.0.0.1	LTE RRC UL_CCH	54	RRCConnectionReestablishmentRequest
281	06:30:39.380553	127.0.0.1	127.0.0.1	LTE RRC DL_CCH	85	RRCConnectionReestablishment
293	06:30:39.546496	127.0.0.1	127.0.0.1	LTE RRC UL_DCH	50	RRCConnectionReestablishmentComplete
294	06:30:39.546647	127.0.0.1	127.0.0.1	LTE RRC UL_DCH	67	RRCConnectionReconfiguration
304	06:30:39.979544	127.0.0.1	127.0.0.1	LTE RRC UL_DCH	50	RRCConnectionReconfigurationComplete
321	06:30:41.583372	127.0.0.1	127.0.0.1	LTE RRC UL_CCH	54	RRCConnectionRequest
326	06:30:41.587391	127.0.0.1	127.0.0.1	LTE RRC DL_CCH	82	RRCConnectionSetup
334	06:30:41.629491	127.0.0.1	127.0.0.1	LTE RRC UL_DCH/UL	180	RRCConnectionSetupComplete, Attach request, PDN connectivity request
335	06:30:41.629599	192.168.0.9	192.168.0.10	SIAP/NAS-SPS	252	InitialUEMessage, Attach request, PDN connectivity request
336	06:30:41.631342	192.168.0.10	192.168.0.9	SIAP/NAS-FPS	116	DownlinkNASTransmit, FQI information request

User Datagram Protocol, Src Port: 64659, Dst Port: 9999		0000 00 00 03 04 00 06 00	.....
▼ Haverir LTE Radio Resource Control (RRC) protocol		0010 45 00 00 22 5a e6 40 00 40 11 a1 e2 7f 00 00 01	E...@
0000 0010 = Message Type: UL_DCH (2)		0020 7f 00 00 01 fc 93 27 0f 00 0e fe 21 02 01 02 70	...@...p
Cell Id: 1		0030 1a c0	..
UE Id / Rnti: 624			
▼ LTE Radio Resource Control (RRC) protocol			
UL-DCH-Message			
▼ message: c1 (0)			
▼ c1: rrcConnectionReestablishmentComplete (3)			
▼ rrcConnectionReestablishmentComplete			
▼ rrc-TransactionIdentifier: 1			
▼ criticalExtensions: rrcConnectionReestablishmentComplete-r8 (0)			
▼ rrcConnectionReestablishmentComplete-r8			
▼ nonCriticalExtension			
▼ rrcInfoAvailable-r9: true (0)			

# Verify RRC Connection Re-establishment procedure with ongoing data

## Intent of test

The purpose of this procedure is to re-establish the RRC connection

## Test gears / software used

Wireshark

## Test procedure

- Turn UE on
- A UE in RRC\_CONNECTED, for which AS security has been activated with SRB2 and at least one DRB setup, may initiate the procedure in order to continue the RRC connection.

## Expected Results

The connection re-establishment succeeds if the network is able to find and verify a valid UE context or, if the UE context cannot be retrieved, and the network responds with an RRCSetup

## Measured Result seen

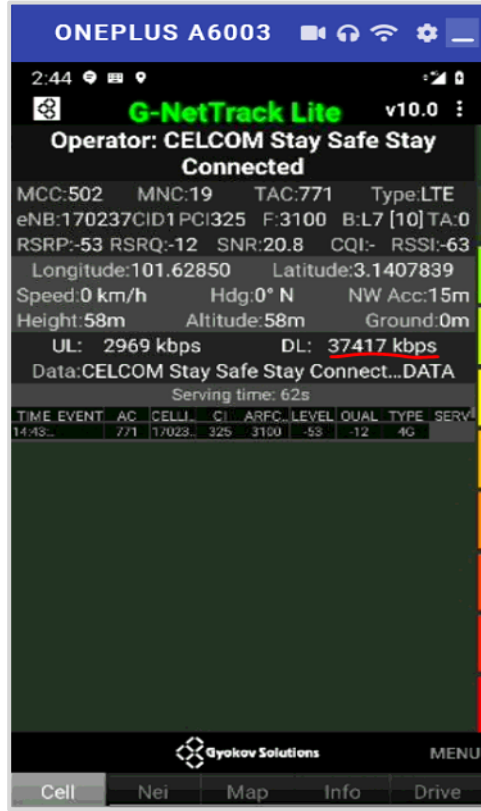
Initial UE Message should read “Service Request” as captured

2020 Sep 15 12:16:53.623 [26] 0xB0C0 LTE RRC OTA Packet -- UL\_DCCH / RRCConnectionReconfigurat

```
Subscription ID = 1
Pkt Version = 20
RRC Release Number.Major.minor = 14.3.0
Radio Bearer ID = 1, Physical Cell ID = 325
Freq = 3100
SysFrameNum = N/A, SubFrameNum = 0
PDU Number = UL_DCCH Message,    Msg Length = 2
SIB Mask in SI = 0x00
```

Interpreted PDU:

```
value UL-DCCH-Message ::=
{
  message c1 : rrcConnectionReconfigurationComplete :
  {
    rrc-TransactionIdentifier 0,
    criticalExtensions rrcConnectionReconfigurationComplete-r8 :
    {
    }
  }
}
```



## Verify Single Cell, single UE ' peak DL ' throughput

### Intent of test

The purpose of this procedure is to establish the Peak Download Throughput, Single UE

### Test gears / software used

G-Net Track

### Test procedure

- Turn UE on
- Download a large file from the cloud server
- Observe the DL speed

### Expected Results

Based on SISO setup with 10 MHz bandwidth and 64 QAM modulation, the expected throughput is 40 Mbps

### Measured Result seen

38 Mbps  
Peak DL throughput - 37417 Kbps  
Attenuation - 30db  
RSRP - 53

RSRQ - 12  
RSSI - 63  
SNR - 20.8

# Verify Single Cell, single UE 'peak UL' throughput

## Intent of test

The purpose of this procedure is to establish the Peak Upload Throughput

## Test gears / software used

G-Net Track

## Test procedure

- Turn UE on
- Upload a large file from the UE to the cloud server
- Observe the UL speed

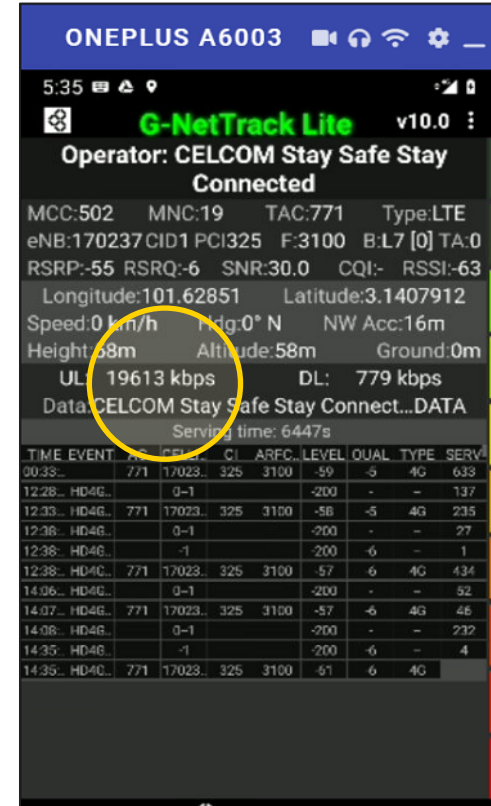
## Expected Results

Based on SISO setup with 10 MHz bandwidth and 64 QAM modulation, the expected throughput is 20 Mbps

## Measured Result seen

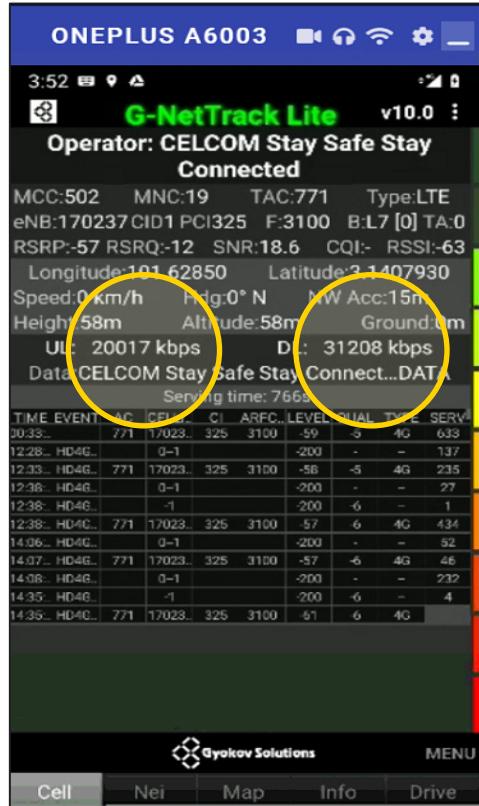
19.6 Mbps  
Peak UL throughput - 19613 Kbps  
Attenuation - 30db  
RSRP - 55

RSRQ - 6  
RSSI - 63  
SNR - 30.0



Note: Industry best practise is 20% of Downlink Speed





Note: Industry best practise is 20% of Downlink Speed

## Verify Single Cell, single UE peak TCP bi-directional throughput

### Intent of test

The purpose of this procedure is to establish the Peak Upload & Download Throughput

### Test gears / software used

G-Net Track

### Test procedure

- Turn UE on
- Upload a large file from the UE to the cloud and concurrently download a large file from the server
- Observe the UL / DL speed

### Expected Results

Based on SISO setup with 10 MHz bandwidth and 64 QAM modulation, the expected throughput is 20 Mbps

### Measured Result seen

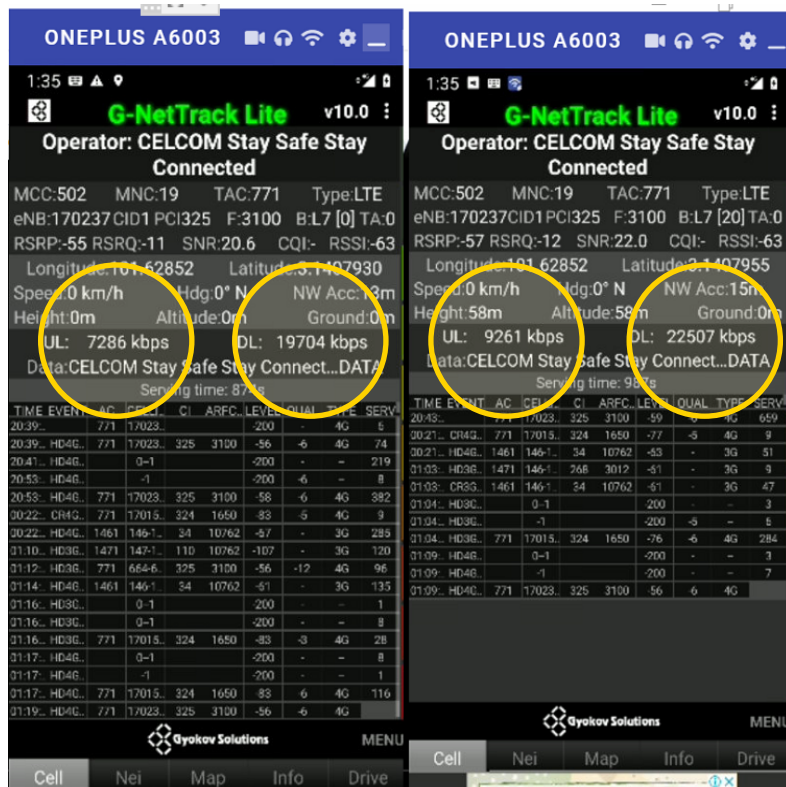
20 Mbps UL & 31 Mbps DL  
 UL throughput - 20017 Kbps  
 DL throughput - 31208 Kbps  
 Attenuation - 30db  
 RSRP - 57

RSRQ - 12  
 RSSI - 63  
 SNR - 18.6

# Verify Single Cell, 2 UE TCP bi-directional throughput

## UE 1

1st UE UL throughput – 7286 Kbps  
1st UE DL throughput – 19704 Kbps  
Attenuation – 30db  
RSRP – 55  
RSRQ – 11  
RSSI – 63  
SNR – 20.6



## UE 2

2nd UE UL throughput – 9262 Kbps  
2nd UE DL throughput – 22507 Kbps  
Attenuation – 30db  
RSRP – 57  
RSRQ – 12  
RSSI – 63  
SNR – 22.0

# LESSONS LEARNED DURING DEPLOYMENT AND TEST

ORGANIZATION	NODE	TYPE	ISSUE	RESOLUTION
Edotco / celcom	UE Attach	RACH	UE RACH messages NOT coming; In OnePlus QXDM log, we could see RACH messages but the same were not seen on DU cli	Changed the RACH parameter value in DU phycfg.xml from 280 to 150  Note: In mCMS based setup, this is taken care automatically
Edotco / celcom	UE Attach	Msg3 failures	100% Msg3 failures were observed	Hardware team changed the 'delay parameter' values for DL and UL on CPRI
Edotco / celcom	UE	Data Browsing	UE attached successfully but was unable to browse the data	Different interfaces are defined for S1-U/S1-C on CU as per standard configuration. Here, we had a common S1-U/S1-C interface. Changed the same on CU in platform.xml file
Edotco / celcom	UE attach	RF latching	Unable to latch to the broadcasted test RF. No RF isolation box available to use	As a temporary measure wrapped the antenna and the test mobile together using aluminium foil and grounded the foil
TIP DCSG Project Group	DCSG	Unable to physically connect to any equipments	Missing SFPs for 10 Gbps, 1 Gbps Optical & 1 Gbps Electrical	Edotco liaised with TIP to provide the missing SFPs and installed the SFPs accordingly into the DCSG and connected all equipment as per design
TIP DCSG Project Group	DCSG	Unable to configure DCSG	Missing MMI (Serial cable)	Managed to source for a Serial Cable and plugged it in so configuration can happen
Mavenir	RRU / DU	Unable to see broadcasted RF	RF Spectrum analyser was needed to view the broadcasted RF	Loaned a RF Spectrum Analyser so it can be used to troubleshoot the issue with no cost to Edotco
Mavenir	UE	Unable to perform test	No UE provided to perform test	Managed to get Mavenir to provide 2 handsets with the needed tracing software to perform the tests
Mavenir	CU	Unable to log into node	Server down and no power	Found power cord loose and not inserted properly. Reinserted the power cord and connected a secondary power cord so the server has 1 + 1 availability for incoming power
Edotco / Mavenir / TIP	NA	NA	Miscommunications	Edotco created a whatsapp group so all communications pertaining to the test lab activities and kept on a common platform and all are updated
Edotco / Celcom	UE	RF Latching	Attach Rejection	Rechecked both handsets APN and reconfigured APN AUTH to PA, Reconfigured Server IP

# Next Steps



TELECOM INFRA PROJECT



# SUMMARY

In summary Edotco was able to execute the Lab trials successfully with some caveats:

- No CS Voice could be tested
- No VoLTE could be tested due to the absence on IMS
- No Handover test as the Lab environment was a SISO configured Network with 1 Omni antenna
- No 2T2R could be tested due to trial RRU was a single carrier configured RRU

Edotco together with Mavenir was able to test, quantify, qualify and confirm:

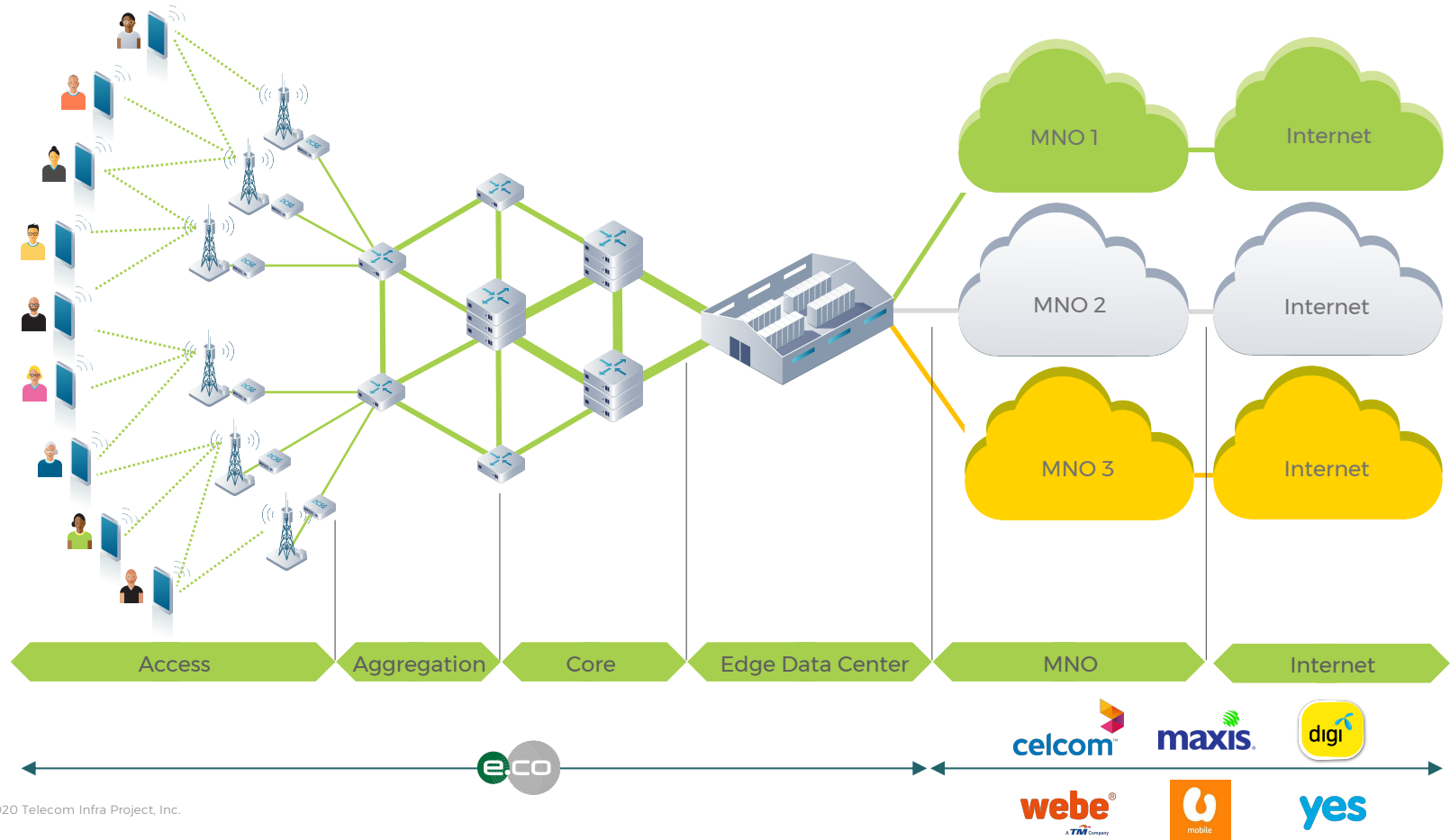
- Integration to 3<sup>rd</sup> party L2/L3 SD switch was possible
- Integration to Huawei LTE Core was successful
- Integration to SUNWAVE RRU was successful
- Ease of Deployment (with initial Hiccups)
- Validate Open RAN Architecture works
- Stability of the solution seems fine throughout the trial
- Acceptable Data Throughput based on certain limitation within the Lab

## Next Steps

- To embark on multi MNO Live Network Trials with Voice and Data tested



# LONG TERM EVOLUTION - SITE AS A SERVICE + EDGE COMPUTE





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