OpenRAN Lab Trial Report
Today’s Discussion

1 - OpenRAN Lab Results

2 - Next Steps: Field Trials
OBJECTIVES

1 - To demonstrate 3GPP compliance of radio equipment

2 - To demonstrate ORAN compliance design

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

4 - To demonstrate commercial EPC integration to vCU, with HPRU (B7)
Edotco wishes to validate the concept of OpenRAN interfaces to support various deployment scenarios while supporting Multi-Band & Multi-Operator.

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.

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.
**OPENRAN TIMELINE**

**MOU Finalization**
- June 19

**MOU Signed**
- July 19
- Aug 19
- Sept 19
- Oct 19
- Nov 19
- Dec 19
- Jan 20
- Feb 20
- March 20
- Apr 20
- May 20
- June 20
- July 20
- Aug 20
- Sept 20
- Oct 20
- Nov 20
- Dec 20
- Jan 21

**LAB UP**
- 8th Sept 2020

**MORAN Live trial**
- Macro/IBC with MEC

**MCO**
- Due to MCO/CMCO most activities were done with remote support in configuration.
- Physical installation was done by OSS
- Delays encountered due to clearance, SIRIM approval, missing network parts, connectivity schematic and NUC diagrams.
- TIP sent missing SFPs to enable fiber and microwave connectivity

**CMCO**
- LAB troubleshooting due to unable to Latch On
- Sourced for Spectrum Analyzer
- Temporarily shielded Antenna and phone using aluminum foil

**RMCO**
- Business Case Validation
- RFI/RFP
- Reprogrammed the APNs of the test phones
- MCO Live trial – Macro/IBC with MEC

**LAB Test Phase**
- 1st WhatsApp Call

**Key Milestone**
- MOU Finalization
- MOU Signed
- LAB UP

**Commercial**
- NDA Signed
- Phase 1 OpenRAN Kickoff
- Delivery of Network Equipment

**Network**
- LAB setup activities
- Physical installation, connectivity and configuration
- Remote tasks executed due to Covid 19 MCO

**MOU Signed**
- 8th Sept 2020

**1st WhatsApp Call**
- 8th Sept 2020

**LAB Test Phase**
- 8th Sept 2020
SYSTEM UP AND WORKING – SEPT 8TH 2020

Live Streaming of 4K & HD video
What is OpenRAN?
WHAT IS OPENRAN?

OpenRAN is a vendor-neutral disaggregation of RAN at both the hardware and software levels on general purpose processor-based platforms.
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 as provides hardware acceleration for certain L1 and L2 blocks.

3. RRU: Macro RRs 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
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, Edoco 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

ONSITE SERVICES

TTDI

Internet

Microwave
On Bluecube
Building

On AHP Building

Fibre
DSU

Mobile Core
(MME, HSS, SGW, PGW...)

200 Mbps

Wireless
link

DCSG

DU

CU

eNodeB

RRU

UE

Indoor
Omni

Access

Backhaul

Core

Internet
Phase 1 - Lab POC Architecture

Faced challenges in getting a switch which was originally Cisco. TIP provided alternative switch by Infinera and its configured as DCSG.
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 30TH JUNE 2020

- Infinera Switch
- DU Kontron COTS
- CU Dell COTS
- RRH
- CELCOM Microwave IDU
- Antenna

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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
<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Test Case Objective</th>
<th>Priorit</th>
<th>Test Case Category</th>
<th>Test Case Sub-Category</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Verify successful 'S1 Setup' procedure between CU and MME</td>
<td>P1</td>
<td>Functional</td>
<td>S1AP Procedure</td>
<td>Done</td>
</tr>
<tr>
<td>2</td>
<td>Verify 'MIB, SIB1, SIB2' parameter broadcast</td>
<td>P1</td>
<td>Functional</td>
<td>MIB/SIB</td>
<td>Done</td>
</tr>
<tr>
<td>3</td>
<td>Verify SIB3 broadcast parameters</td>
<td>P1</td>
<td>Functional</td>
<td>SIBs</td>
<td>Done</td>
</tr>
<tr>
<td>4</td>
<td>Verify SIB4 broadcast parameters</td>
<td>P1</td>
<td>Functional</td>
<td>SIBs</td>
<td>NA / Due to 2 RRH required</td>
</tr>
<tr>
<td>5</td>
<td>Verify SIB5 broadcast parameters</td>
<td>P1</td>
<td>Functional</td>
<td>SIBs</td>
<td>Done</td>
</tr>
<tr>
<td>6</td>
<td>Verify SIB6 broadcast parameters</td>
<td>P1</td>
<td>Functional</td>
<td>SIBs</td>
<td>Done</td>
</tr>
<tr>
<td>7</td>
<td>Validate successful Attach procedure</td>
<td>P1</td>
<td>Functional</td>
<td>RRC Procedure</td>
<td>Done</td>
</tr>
<tr>
<td>8</td>
<td>Verify UE initiated Ping Traffic</td>
<td>P1</td>
<td>Functional</td>
<td>RRC Procedure</td>
<td>Done</td>
</tr>
<tr>
<td>9</td>
<td>Verify successful attach/detach by Airplane Mode</td>
<td>P1</td>
<td>Functional</td>
<td>S1AP Procedure</td>
<td>Done</td>
</tr>
<tr>
<td>10</td>
<td>Validate successful detach procedure when it is initiated by the UE due to 'UE switch off'</td>
<td>P1</td>
<td>Functional</td>
<td>RRC Procedure</td>
<td>Done</td>
</tr>
<tr>
<td>11</td>
<td>Validate 'Idle to Active Mode'/ successful 'Paging procedure' when CU-DU/RRH receives Paging from MME</td>
<td>P1</td>
<td>Functional</td>
<td>S1AP Procedure</td>
<td>Done</td>
</tr>
<tr>
<td>12</td>
<td>Validate the successful transfer from 'ECM-Idle mode to ECM-Connected' using UE initiated data</td>
<td>P1</td>
<td>Functional</td>
<td>S1AP Procedure</td>
<td>Done</td>
</tr>
<tr>
<td>13</td>
<td>Verify 'Periodic Tracking area update' procedure</td>
<td>P2</td>
<td>Functional</td>
<td>S1AP Procedure</td>
<td>GPS Connectivity is required.</td>
</tr>
<tr>
<td>14</td>
<td>Verify Single Cell peak UDP 'DL Alone' throughput</td>
<td>P1</td>
<td>Functional</td>
<td>Cell Throughput</td>
<td>NA</td>
</tr>
<tr>
<td>15</td>
<td>Verify Single Cell peak UDP 'UL Alone' throughput</td>
<td>P1</td>
<td>Functional</td>
<td>Cell Throughput</td>
<td>NA</td>
</tr>
<tr>
<td>16</td>
<td>Verify Single Cell peak UDP bi directional throughput</td>
<td>P1</td>
<td>Functional</td>
<td>Cell Throughput</td>
<td>NA</td>
</tr>
<tr>
<td>17</td>
<td>Verify Single Cell peak TCP 'DL Alone' throughput</td>
<td>P1</td>
<td>Functional</td>
<td>Cell Throughput</td>
<td>Done</td>
</tr>
<tr>
<td>18</td>
<td>Verify Single Cell peak TCP 'UL Alone' throughput</td>
<td>P1</td>
<td>Functional</td>
<td>Cell Throughput</td>
<td>Done</td>
</tr>
<tr>
<td>19</td>
<td>Verify Single Cell peak TCP bi directional throughput</td>
<td>P1</td>
<td>Functional</td>
<td>Cell Throughput</td>
<td>Done</td>
</tr>
<tr>
<td>20</td>
<td>Verify Single Cell, 2 UE UDP bi directional throughput</td>
<td>P2</td>
<td>Functional</td>
<td>Cell Throughput</td>
<td>NA</td>
</tr>
<tr>
<td>21</td>
<td>Verify Single Cell, 2 UE TCP bi directional throughput</td>
<td>P2</td>
<td>Functional</td>
<td>Cell Throughput</td>
<td>Done</td>
</tr>
<tr>
<td>22</td>
<td>Verify Single Cell, VOLTE Call</td>
<td>P1</td>
<td>Functional</td>
<td>VOLTE</td>
<td>IMS Required</td>
</tr>
<tr>
<td>23</td>
<td>Verify Single Cell, VILTE call</td>
<td>P1</td>
<td>Functional</td>
<td>VOLTE</td>
<td>IMS Required</td>
</tr>
<tr>
<td>24</td>
<td>Verify Single Cell, Volte Call along with ongoing data on UE1</td>
<td>P2</td>
<td>Functional</td>
<td>VOLTE</td>
<td>IMS Required</td>
</tr>
<tr>
<td>25</td>
<td>Verify RRC Connection Re-establishment procedure without ongoing data</td>
<td>P1</td>
<td>Functional</td>
<td>Re-establishment</td>
<td>Done</td>
</tr>
<tr>
<td>26</td>
<td>Verify RRC Connection Re-establishment procedure with ongoing data</td>
<td>P1</td>
<td>Functional</td>
<td>Re-establishment</td>
<td>Done</td>
</tr>
<tr>
<td>27</td>
<td>Verify long run single UE DL alone peak throughput</td>
<td>P2</td>
<td>Stability</td>
<td>Cell Throughput</td>
<td>Verified by Mahesan</td>
</tr>
<tr>
<td>28</td>
<td>Verify long run single UE UL alone peak throughput</td>
<td>P2</td>
<td>Stability</td>
<td>Cell Throughput</td>
<td>Verified by Mahesan</td>
</tr>
<tr>
<td>29</td>
<td>Verify long run single UE bi directional peak throughput</td>
<td>P2</td>
<td>Stability</td>
<td>Cell Throughput</td>
<td>Verified by Mahesan</td>
</tr>
<tr>
<td>30</td>
<td>Verify long run two UE DL alone peak throughput</td>
<td>P3</td>
<td>Stability</td>
<td>Cell Throughput</td>
<td>Verified by Mahesan</td>
</tr>
<tr>
<td>31</td>
<td>Verify long run two UE UL alone peak throughput</td>
<td>P3</td>
<td>Stability</td>
<td>Cell Throughput</td>
<td>Verified by Mahesan</td>
</tr>
<tr>
<td>32</td>
<td>Verify long run two UE bi directional peak throughput</td>
<td>P3</td>
<td>Stability</td>
<td>Cell Throughput</td>
<td>Verified by Mahesan</td>
</tr>
</tbody>
</table>
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
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
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
Verify ‘MIB’ parameter broadcast

**Intent of test**
Verify successful ‘S1 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
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
Verify 'SIB 2' parameter broadcast

Intent of test
Verify 'MIB, SIB1, SIB2' parameter broadcast

Test gears / software used
Wireshark

Test procedure
1. Turn UE on
2. Wait for UE to identify Test Network
3. UE Latches to the correct Test Network
4. UE attached successfully
5. 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
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
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
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
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.
Validate 'Idle to Active Mode'/ successful 'Paging procedure' when CU-DU/RRH receives Paging from MME

**Intent of test**
Verifying 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
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
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
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
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
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

Note: Industry best practise is 20% of Downlink Speed
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

<table>
<thead>
<tr>
<th>Organization</th>
<th>Node</th>
<th>Type</th>
<th>Issue</th>
<th>Resolution</th>
</tr>
</thead>
<tbody>
<tr>
<td>Edotco / celcom</td>
<td>UE Attach</td>
<td>RACH</td>
<td>UE RACH messages NOT coming. In OnePlus QXDM log, we could see RACH messages but the same were not seen on DU CLI</td>
<td>Changed the RACH parameter value in DU phycfg.xml from 280 to 150. Note: In mCMS based setup, this is taken care automatically.</td>
</tr>
<tr>
<td>Edotco / celcom</td>
<td>UE Attach</td>
<td>Msg3 failures</td>
<td>100% Msg3 failures were observed</td>
<td>Hardware team changed the 'delay parameter' values for DL and UL on CPRI.</td>
</tr>
<tr>
<td>Edotco / celcom</td>
<td>UE</td>
<td>Data Browsing</td>
<td>UE attached successfully but was unable to browse the data</td>
<td>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.</td>
</tr>
<tr>
<td>Edotco / celcom</td>
<td>UE attach</td>
<td>RF latching</td>
<td>Unable to latch to the broadcasted test RF. No RF isolation box available to use</td>
<td>As a temporary measure wrapped the antenna and the test mobile together using aluminium foil and grounded the foil.</td>
</tr>
<tr>
<td>TIP DCSG Project Group</td>
<td>DCSG</td>
<td>Unable to physically connect to any equipments</td>
<td>Missing SFPs for 10 Gbps, 1 Gbps Optical &amp; 1 Gbps Electrical</td>
<td>Edotco liaised with TIP to provide the missing SFPs and installed the SFPs accordingly into the DCSG and connected all equipment as per design.</td>
</tr>
<tr>
<td>TIP DCSG Project Group</td>
<td>DCSG</td>
<td>Unable to configure DCSG</td>
<td>Missing MMI (Serial cable)</td>
<td>Managed to source for a Serial Cable and plugged it in so configuration can happen.</td>
</tr>
<tr>
<td>Mavenir</td>
<td>RRU / DU</td>
<td>Unable to see broadcasted RF</td>
<td>RF Spectrum analyser was needed to view the broadcasted RF</td>
<td>Loaned a RF Spectrum Analyser so it can be used to troubleshoot the issue with no cost to Edotco.</td>
</tr>
<tr>
<td>Mavenir</td>
<td>UE</td>
<td>Unable to perform test</td>
<td>No UE provided to perform test</td>
<td>Managed to get Mavenir to provide 2 handsets with the needed tracing software to perform the tests.</td>
</tr>
<tr>
<td>Mavenir</td>
<td>CU</td>
<td>Unable to log into node</td>
<td>Server down and no power</td>
<td>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.</td>
</tr>
<tr>
<td>Edotco / Mavenir / TIP</td>
<td>NA</td>
<td>NA</td>
<td>Miscommunications</td>
<td>Edotco created a whatsapp group so all communications pertaining to the test lab activities and kept on a common platform and all are updated.</td>
</tr>
<tr>
<td>Edotco / Celcom</td>
<td>UE</td>
<td>RF Latching</td>
<td>Attach Rejection</td>
<td>Rechecked both handsets APN and reconfigured APN AUTH to PA, Reconfigured Server IP.</td>
</tr>
</tbody>
</table>
Next Steps
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 3rd 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
Thank you

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