OpenRAN Lab Trial Report



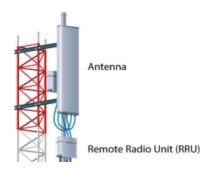


Today's Discussion

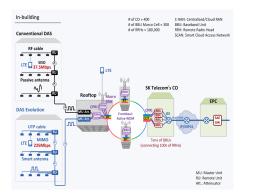
1 - OpenRAN Lab Results

2 - Next Steps: Field Trials

OBJECTIVES



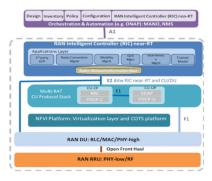
1 - To demonstrate 3GPP compliance of radio equipment



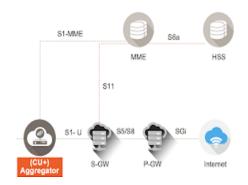
3 - To demonstrate E2E LTE Network with Macro / Indoor solution







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.

AVENIR

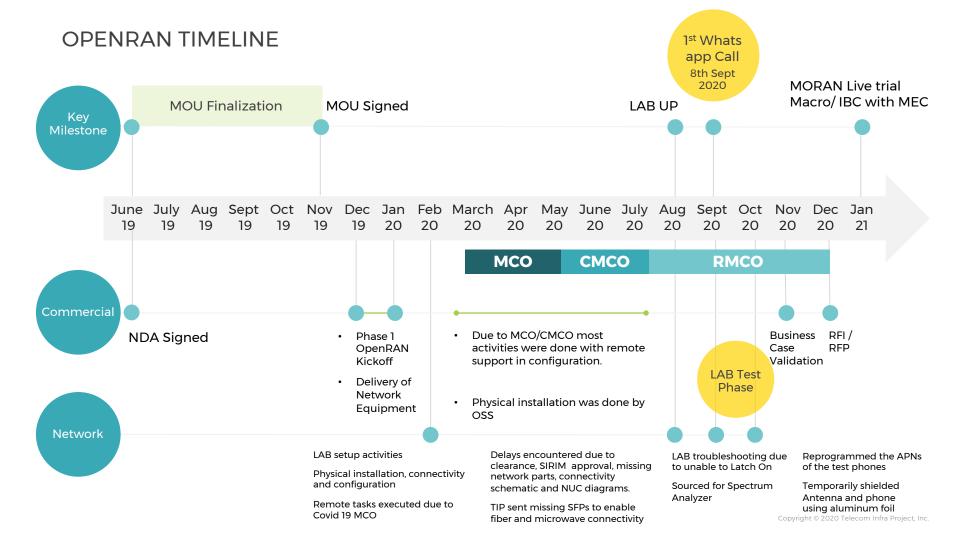
Mavenir, as an approved vendor to TIP, supplies the virtualized network solutions in cooperation with various radio hardware manufacturers.

SUNWAVE

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.



SYSTEM UP AND WORKING - SEPT 8TH 2020

Gayan Koralage • 1st Director - Group Strategy, edotco Group [Speaker | Analyst | Writer] 4d • Edited • 🔞

Proud to see Asia's third successful lab trial for **#OpenRan** (Virtual-RAN") here in **#Malaysia**. Delivering data speed of 30mbps, the latency of 30ms, **#4G** for a single mobile operator. The telecom industry is heading towards the disaggregated, plugand-play, open-sourced, low-cost, network designs that will bring down the cost per G8.

#openRAN #telecom #mobile #5G #rollout #TIP #facebook #telecominfrastructure #telecominfrastructureproject #malaysia #digitaleconoy #lowcostnetworks #disruptions





Live Streaming of 4K & HD video

Ultra HD

Full HF

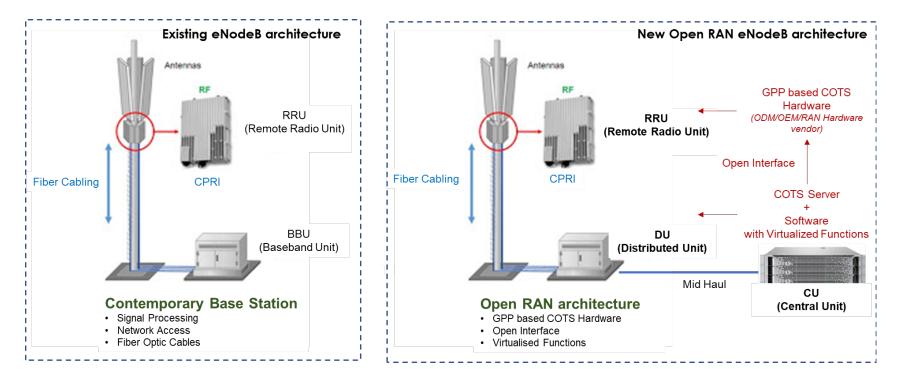
What is **OpenRAN**?





WHAT IS OPENRAN?

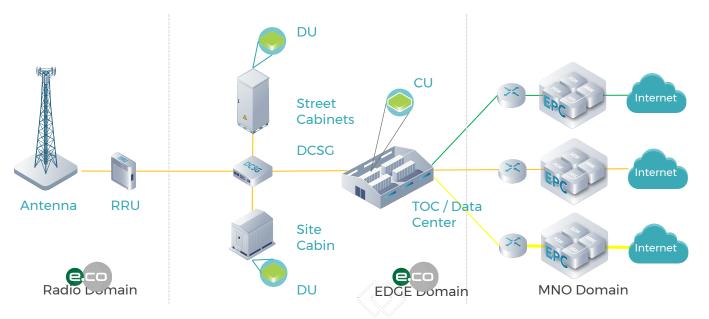
OpenRAN is a vendor-neutral disaggregation of RAN at both the hardware and software levels on general purpose processor-based platforms.



Traditional Architecture

OpenRAN Architecture

E2E Openran network configuration



1. CU: logical node that consist of a part of protocol stack that are as provides hardware acceleration for certain L1 and L2 blocks. 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





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, Edoco embarked on sourcing for a Multi Operator Neutral Hosted RAN Solution.

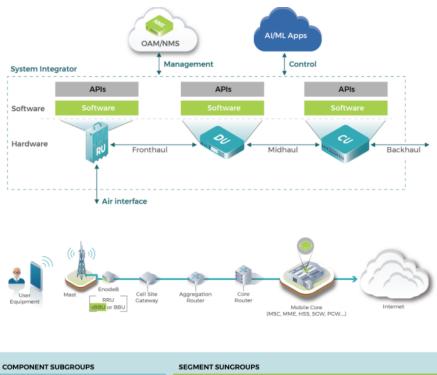
As such Edotco needed to find a solution that was Open, Software Defined, Able to be deployed on COTS, Agile, Scalable and most importantly Cost Effective

Edotco embarked on the trials by proposing 2 staged approach:

- Stage 1 LAB Trials
- Stage 2 Live Trials

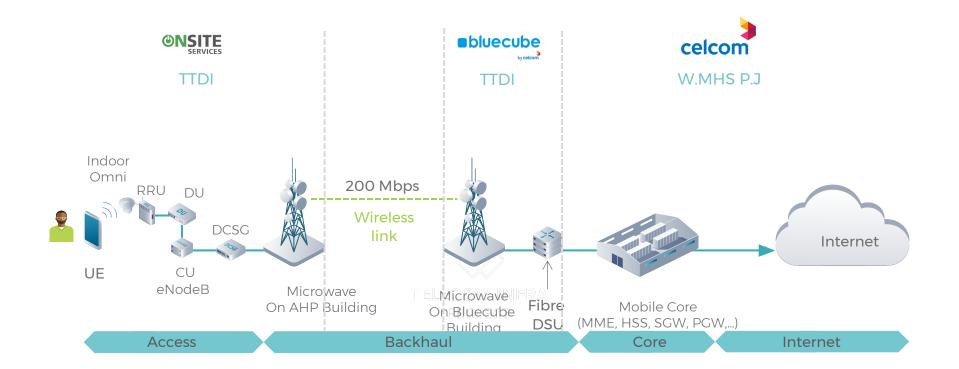
Stage 1 - LAB Trial is to validate the following:

- 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



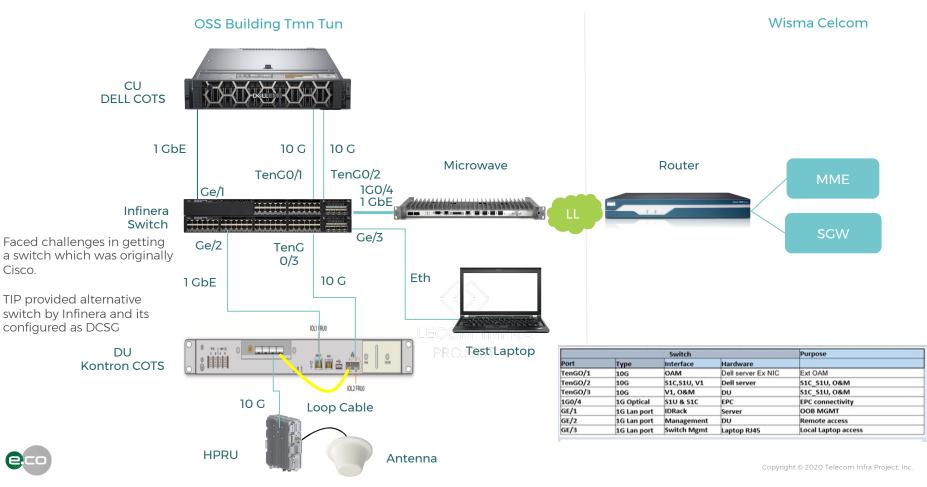


OPENRAN TEST BED NETWORK CONNECTIVITY

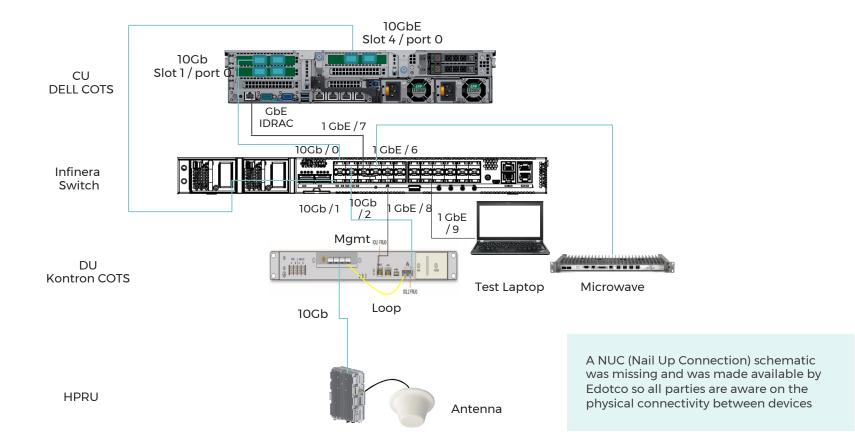




Phase 1 - Lab POC Architecture

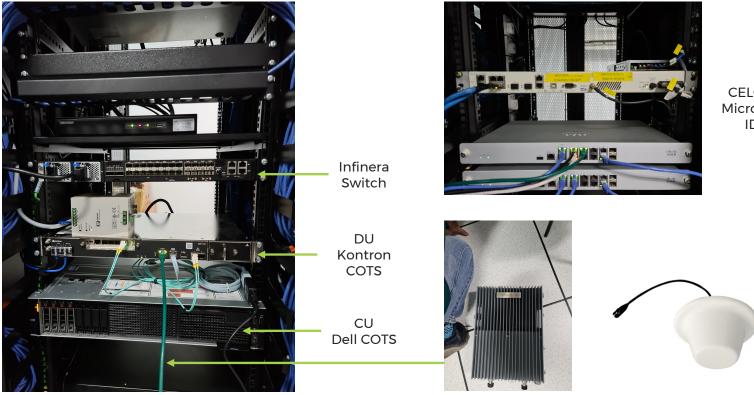


Phase 1 - Lab connectivity schematic





Phase 1 - LAB INSTALL PHOTOS AS OF 30TH JUNE 2020



RRH

CELCOM Microwave IDU



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

SI AP - SI 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

si. r-	Test Case Objective	Priority 🖕	Test Case Category	Test Case Sub-Category	Remarks
1	Verify successful 'S1 Setup' procedure	P1	Functional	S1AP Procedure	Done
2	between CU and MME 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	Р1	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	Р3	Stability	Cell Throughput	Pending
31	Verify long run two UE UL alone peak throughput	Р3	Stability	Cell Throughput	Pending
32	Verify long run two UE bi directional peak throughput	Р3	Stability	Cell Throughput	Pending

BASIC LAB SETUP TEST CASES

SI. No.	Test Case Objective	Priorit y	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	Р3	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

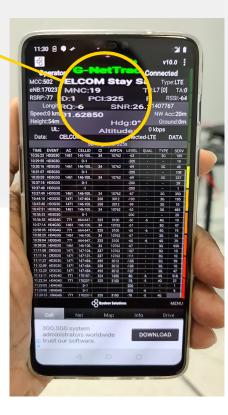
On successful latch Cell ID 325 should be seen on G-Net Track

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



	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	SIAP	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	
ireshark - Pa	cket 1751 - enbcu_	020_09_10-14_35_45.pcap				
```	<ul> <li>S1SetupRequi</li> </ul>	est				
	✓ protocol1	Es: 4 items				
	∨ Item 0	: id-Global-ENB-ID				
	✓ Pro	tocolIE-Field				
	:	id: id-Global-ENB-ID (	59)			
		riticality: reject (@	)			
	~	alue				
		arue				
		✓ Global-ENB-ID				
			f291			
		<ul> <li>Global-ENB-ID</li> <li>pLMNidentity: 05</li> </ul>	f291 ode (MCC): Malaysia	(502)		
		<ul> <li>Global-ENB-ID</li> <li>pLMWidentity: 05</li> <li>Mobile Country C</li> </ul>			(19)	
		<ul> <li>Global-ENB-ID</li> <li>pLMWidentity: 05</li> <li>Mobile Country C</li> </ul>	<mark>ode (MCC): Malaysia</mark> ode (MNC): Celcom (M		(19)	
		<ul> <li>Global-ENB-ID</li> <li>pLMWidentity: 05</li> <li>Mobile Country C</li> <li>Mobile Network C</li> <li>v eNB-ID: macroENB</li> </ul>	ode (MCC): Malaysia ode (MNC): Celcom (M -ID (0)	alaysia) Berhad	(19) 5, 0010 1001 1000 1111 1101 decimal value 170237]	
		<ul> <li>Global-ENB-ID</li> <li>pLMWidentity: 05</li> <li>Mobile Country C</li> <li>Mobile Network C</li> <li>v eNB-ID: macroENB</li> </ul>	ode (MCC): Malaysia ode (MNC): Celcom (M -ID (0)	alaysia) Berhad		
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	✓ Item 1 ✓ Pro	<ul> <li>Global-ENB-ID</li> <li>pLMWidentity: 05</li> <li>Mobile Country C</li> <li>Mobile Network C</li> <li>eNB-ID: macroENB</li> <li>macroENB-ID: ;</li> <li>id-eNBname</li> </ul>	ode (MCC): Malaysia ode (MNC): Celcom (M -ID (0)	alaysia) Berhad		

# 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

	Time	Source	Destination	Protocol	Length	Into
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
		[:] ulOutcome dureCode: id-S1 cality: reject				
	proce criti ✓ value ✓ <mark>S1</mark>	dureCode: id-S1 cality: reject SetupResponse protocolIEs: 2 ~ Item 0: id-S ~ ProtocolI	(0) items GervedGUMMEIS E-Field	(105.)		
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	proce criti ✓ value ✓ <mark>S1</mark>	dureCode: id-S1 cality: reject SetupResponse protocolIEs: 2 ~ Item 0: id-S ~ ProtocolI id: id.	(0) items GervedGUMMEIS E-Field			
	proce criti ✓ value ✓ <mark>S1</mark>	dureCode: id-S1 cality: reject SetupResponse protocolIEs: 2 > Item 0: id-S > ProtocolI id: id critica > value	(θ) items ervedGUMMEIs E-Field -ServedGUMMEIs	<b>)</b> )		
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	proce criti ✓ value ✓ <mark>S1</mark>	dureCode: id-S1 cality: reject SetupResponse protocolIEs: 2 > Item 0: id-S > ProtocolI id: id critic: > value > Serv > I	(0) items ervedGUMMEIS E-Field -ServedGUMMEIS ( ality: reject ( vedGUMMEIs: 1 it	em		

	Time	Source	Destination	Protocol	Length	Info
32	2 20.507153	10.156.152.18	192.168.110.9	SCTP	64	SACK
33	3 20.508255	localhost	localhost	LTE RRC BCCH_BCH	51	MasterInformationBlock (SFN=0)
34	4 20.508298	localhost	localhost	LTE RRC DL_SCH	65	SystemInformationBlockType1
35	5 20.508365	localhost	localhost	LTE RRC DL_SCH	74	SystemInformation [ SIB2 ]
36	5 20.508409	localhost	localhost	LTE RRC DL_SCH	59	SystemInformation [ SIB3 ]
37	7 20.508533	10.156.152.18	192.168.110.9	LTE RRC BCCH_BCH	96	MasterInformationBlock (SFN=0)
38	3 20.510603	192.168.110.9	10.156.152.18	DU -> CU	104	SACK EVT_SCH_SI_CFG_RESP
39	9 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 '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

	Time	Source	Destination	Protocol	Length	Info
33	20.508255	127.0.0.1	127.0.0.1	LTE RRC BCCH_BCH		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 RCK Release Number Major.minor = 14.3.0 Rado _ Belo ID = 0. Physical Cell ID = 325 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 ::=
<pre>temporture for the second second</pre>
cellReservedForOperatorUse notReserved Activate Mindows

	Time ^	Source	Destination	Protocol	Length Info
		localhost	localhost	LTE RRC DL_SCH	65 SystemInformationBlockType1
		localhost	localhost	LTE RRC DL_SCH	74 SystemInformation [ SIB2 ]
		localhost	localhost	LTE RRC DL_SCH	59 SystemInformation [ SIB3 ]
				LTE RRC BCCH_BCH	
			10.156.152.18		104 SACK EVT_SCH_SI_CFG_RESP
39	20.510518	10.155.152.18	192.168.110.9	CUDU HEADER	464 SACK , SystemInformationBlockType1, SystemInformation [ SIB2 ], SystemInformation [ SIB3 ] 104 CACK FUE CCU CL CCC PECP.
Viresha	rk · Packet 35 ·	enbcu_2020_09_10-1	14_35_45.pcap		- [
	∨ message	e: c1 (0)			
		systemInformati			
		ystemInformatio			
	~			formation-r8 (0)	
		✓ systemInfor			
			AndInfo: 1 item		
		∨ Item			
			b-TypeAndInfo it sib2	cem: S1D2 (0)	
			v radioResourc	·Confragonan	
			✓ rach-Conf		
			v preambl		
				erOfRA-Preambles:	n52 (12)
				mblesGroupAConfig	
				izeOfRA-Preambles	roupA: n28 (6)
			m	essageSizeGroupA:	b56 (0)
			m	essagePowerOffset(	roupB: dB10 (4)
			·		
Subs Pkt RRC Rad: Frec Sys] PDU	script: Versic Relea: Lo Bean g = 310 FrameNu Numben	ion ID = on = 20 se Number rer ID = 00 um = 512.	1 .Major.mi 0. Physic SubFrame DL_SCH Me	inor = 14.3 cal Cell II eNum = 0	LTE RRC OTA Packet BCCH_DL_SCH / SystemInformation 1.0 9 = 325 Msg Length = 26
Inte	erprete	ed PDU:			
	ie BCCH	H-DL-SCH-	Message	: :=	
{ 	essage {	cl : sys	temInform	nation :	
	, ci	riticalEx {	tensions	systemInfo	ormation-r8 :
		sib-Ty	peAndInfo	0	
		sib2			
			{	ourceConfig onfigCommon	
			{	nnigCommon nbleInfo	
			{ nur pre		eambles n52, upAConfig
			{		

# { sizeOfRA-PreamblesGroupA n28, messageSizeGroupA b56, messagePowerOffsetGroupB dB10 } powerRampingParameters

Activate W

# 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

).	Time	Source	Destination	Protocol	Length	Info
3	4 20.508298	localhost	localhost	LTE RRC DL_SCH	65	SystemInformationBlockType1
3	5 20.508365	localhost	localhost	LTE RRC DL_SCH		SystemInformation [ SIB2 ]
3	6 20.508409	localhost	localhost	LTE RRC DL_SCH	59	SystemInformation [ SIB3 ]
-	7 20.508533	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 Freg = 3100SvsFrameNum = 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, of High dD 4

#### 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
Freg = 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-CarrierFreg 1580.
 a-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 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

#### 📔 Packet Text

#### Hex Dump

#### 2020 Sep 11 12:51:48.069 [DE] 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 = 1, SubFrameNum = 0 PDU Number = BCCH_DL_SCH Message, Msg Length = 15 SIB Mask in SI = 0x40

```
Interpreted PDU:
```

value BCCH-DL-SCH-Message ::=

```
message c1 : systemInformation :
```

```
criticalExtensions systemInformation-r8 :
```

```
sib-TypeAndInfo
```

```
sib6 :
{
 carrierFreqListUTRA-FDD
 {
 carrierFreqListUTRA-FDD
 {
 carrierFreq_10/211
```

```
carrierFreq 10711,
cellReselectionPriority 1,
threshX-High 31,
q-RxLevMin -60,
p-MaxUTRA 1,
q-QualMin -16,
threshX-Q-r9
{
threshX-HighQ-r9 0,
threshX-LowQ-r9 0
```

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)
msq_type = 65 (0x41) (Attach request)
lte_emm_msq
 emm_attach_request
 tsc = 0 (0x0) (cached sec context)
 nas kev 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_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 = 3230497472 (0xc08d7ac0)
 ue netwk cap
 EEA0 = 1 (0x1)
 EEA1_{128} = 1 (0x1)
 2020 Sep 11 06:07:34.076 [22] 0xB0ED LTE NAS EMM Plain OTA Outgoing Message -- Attach complete Msg
 EEA2_{128} = 1 (0x1)
 EEA3_{128} = 1 (0x1)
 Subscription ID = 1
 EEA4 = 0 (0x0)
 EEA5 = 0 (0x0)
 pkt_version = 1 (0x1)
 EEA6 = 0 (0x0)
 EEA7 = 0 (0x0)
 rel number = 9 (0x9)
 EIA0 = 0 (0x0)
 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 msa
 emm attach complete
 esm_msq_container
 eps_bearer_id_or_skip_id = 5 (0x5)
 prot_disc = 2 (0x2) (EPS session management messages)
 trans id = 0 (0x0)
 msq_type = 194 (0xc2) (Activate default EPS bearer context accept)
 lte esm msq
 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_msq 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)

Ping Test Tool		:
8.8.8.8	START	HISTORY
NG 8.8.8.8 (8.8.8.8) 56(84) by		
4 bytes from 8.8.8.8: icmp_se		
4 bytes from 8.8.8.8: icmp_se		
4 bytes from 8.8.8.8: icmp_se		
4 bytes from 8.8.8.8: icmp_se		
4 bytes from 8.8.8.8: icmp_se		
4 bytes from 8.8.8.8: icmp_se		
4 bytes from 8.8.8.8: icmp_se		
4 bytes from 8.8.8.8: icmp_se		
4 bytes from 8.8.8.8: icmp_se		
4 bytes from 8.8.8.8; icmp_se 4 bytes from 8.8.8.8; icmp_se		
4 bytes from 8.8.8.8. icmp_se		
4 bytes from 8.8.8.8: icmp_se		
4 bytes from 8.8.8.8: icmp_se		
4 bytes from 8.8.8.8: icmp_se		
4 bytes from 8.8.8.8: icmp_se		
4 bytes from 8.8.8.8; icmp_se		
4 bytes from 8.8.8.8; icmp_se		
4 bytes from 8.8.8.8; icmp_se		
4 bytes from 8.8.8.8: icmp_se		
1 bytes from 8.8.8.8; icmp_se		
bytes from 8.8.8.8: icmp_se		
bytes from 8.8.8.8: icmp_see	q=23 ttl=114 ti	me=36.9 ms
4 bytes from 8.8.8.8: icmp_set		
4 bytes from 8.8.8.8: icmp_set		
4 bytes from 8.8.8.8: icmp_se		
4 bytes from 8.8.8.8: icmp_se		
4 bytes from 8.8.8.8: icmp_se		
4 bytes from 8.8.8.8; icmp_se		
4 bytes from 8.8.8.8; icmp_see		
bytes from 8.8.8.8: icmp_se		
4 bytes from 8.8.8.8: icmp_se		
4 bytes from 8.8.8.8; icmp_se		
4 bytes from 8.8.8.8; icmp_se	q=34 ttl=114 ti	me=38.9 ms

ONEPLUS	A0003 I	• n ? •	•
7:39 🖽 ± Р			2
Ping			
0 The Shebbak	Meleysia Ask Question	n T Open	
PING	MY IP	SPEED TE	ST
Host 8.8.8.8		8	-
	Start		
time=31.5 ms 64 bytes from 8.8 time=32.6 ms 64 bytes from 8.8 time=32.8 ms 64 bytes from 8.8 time=48.9 ms	1.8.8: icmp_s	eq=1 ttl=114	i.

ime=48.9 ms 54 bytes from 8.8.8.8: icmp_seq=1 ttl=114 ime=96.6 ms

64 bytes from 8.8.8.8: icmp_seq=1 ttl=114 time=41.0 ms

64 bytes from 8.8.8.8: icmp_seq=1 ttl=114 time=30.4 ms

54 bytes from 8.8.8.8: icmp_seq=1 ttl=114 ime=32.2 ms

54 bytes from 8.8.8.8: icmp_seq=1 ttl=114 time=51.5 ms

54 bytes from 8.8.8.8: icmp_seq=1 ttl=114 time=30.2 ms

64 bytes from 8.8.8.8: icmp_seq=1 ttl=114 time=35.3 ms

64 bytes from 8.8.8.8: icmp_seq=1 ttl=114 time=45.0 ms

OPENSIGNAL Latency Experience 0 in ms The lower the figure the better the latency Games Experience 43.4 Voice App Experience Cleicom Download Speed Experience 44.0 Upload Speed Experience 52.9 Latency Experience 53.1 4G Availability 48.5 U)Unifi 4G Coverage Experience Mobile Network Experience Report | April 2020 | © Opensignal Limited 13.75 41.25 The brackets -- represent confidence intervals. Download Image 4 Read why confidence intervals are important.

# 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

Open Signal report April 2020

# 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 msa 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)

Time	Source	Destination	Protocol	Length	Info	
214 9.767894	10.156.152.11	10.223.174.128	S1AP/NAS-EPS	136	UplinkNASTransport, Ciphered message	
6703 322.1730	45 127.0.0.1	127.0.0.1	LTE RRC UL_DCCH/N	161	RRCConnectionSetupComplete, Tracking area upda	te request
6704 322.1732	28 10.156.152.11	10.223.174.128	S1AP/NAS-EPS	236	InitialUEMessage, Tracking area update request	
ireshark - Packet	5703 · enbcu_2020_09_16-05_	19_12.pcap				
	✓ registere	dmme				
	•	05b5 [bit length 16,			al value 1461]	
		2b [bit length 8, 001				
	✓ dedicated	InfoNAS: 17bfd6affdb0	0748120bf605f29105b5	2bc1014	231821969	
	✓ Non-Ac	cess-Stratum (NAS)PDU				
	000	l = Security hea	der type: Integrity p	rotecte	ed (1)	
		0111 = Protocol dis	criminator: EPS mobil	ity mar	nagement messages (0x7)	
	Mess	age authentication c	ode: 0xbfd6affd			
	Sequ	uence number: 176				
	0000	= Security head	der type: Plain NAS m	iessage,	, not security protected (0)	
		0111 = Protocol dis	criminator: EPS mobil	ity mar	nagement messages (0x7)	
	NAS	EPS Mobility Managem	ent Message Type: Tra	icking a	area update request (0x48)	
	0	= Type of secu	rity context flag (TS	C): Nat	tive security context (for KSIasme)	
	.001	L = NAS key set :	identifier: (1) ASME			
		0 = Active flag:	No bearer establish	nent rea	quested	
		.010 = EPS update t	ype value: Combined 1	A/LA up	odating with IMSI attach (2)	
	✓ EPS	mobile identity - Ole	d GUTI			
	L	ength: 11				
		0 = Odd/even i	indication: Even numb	er of i	dentity digits	
		110 = Type of id	dentity: GUTI (6)			Activate Window
	M	lobile Country Code (M	MCC): Malaysia (502)			
	M	obile Network Code (M	NC): Celcom (Malaysi	a) Berh	ad (19)	Go to Settings to activ
		ME Group ID: 1461	,,			

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

# 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]				
Wire	shark - Packet 60	1922 - enhcu 2020 0	9_11-12_12_30.pcap							
	mant Factor of		olini ucluclooibeab							
		✓ Item 3: id-E	UTRAN-CGI							
		✓ ProtocolI	E-Field							
	id: id-EUTRAN-CGI (100)									
		critica	ality: ignore (1	L)						
		∨ value								
		✓ EUTF	RAN-CGI							
		P	LMNidentity: 05	f291						
		м	Nobile Country C	ode (MCC): Malays	ia (50	2)				
		м	Nobile Network C	ode (MNC): Celcom	(Mala	/sia) Berhad (19)				
		c	ell-ID: 0x0298f	d01						
		✓ Item 4: id-R	RC-Establishmen	t-Cause						
		✓ ProtocolI	E-Field							
		id: id	-RRC-Establishme	ent-Cause (134)						
		critica	ality: ignore (1	L)						
		∨ value								
	RRC-Establishment-Cause: mo-Data (4)									

No.	Time	Source	Destination	Protocol	Length Info
-	188 06:30:31,47844		127.0.0.1	LTE RRC UL DCCH	52 MeasurementReport
	189 06:30:31.47848		127.0.0.1	LTE RRC UL DCCH	52 MeasurementReport
	190 06:30:31.47850		127.0.0.1	LTE RRC UL DCCH	52 MeasurementReport
	193 06:30:31.67835		127.0.0.1	LTE RRC UL DCCH	52 MeasurementReport
	198 06:30:32.07936		127.0.0.1	LTE RRC UL DCCH	52 MeasurementReport
	201 06:30:32.28033		127.0.0.1	LTE RRC UL DCCH	52 MeasurementReport
	204 06:30:32,48036		127.0.0.1	LTE RRC UL DCCH	52 MeasurementReport
	209 06:30:32.88133		127.0.0.1	LTE RRC UL DCCH	52 MeasurementReport
	274 06:30:39,09649		127.0.0.1	LTE RRC UL CCCH	54 RRCConnectionReestablishmentRequest
	281 06:30:39.30055	3 127.0.0.1	127.0.0.1	LTE RRC DL CCCH	85 RRCConnectionReestablishment
	293 06:30:39.54649	5 127.0.0.1	127.0.0.1	LTE RRC UL DCCH	50 RRCConnectionReestablishmentComplete
	294 06:30:39.54664	7 127.0.0.1	127.0.0.1	LTE RRC DL DCCH	67 RRCConnectionReconfiguration
	304 06:30:39,97954	\$ 127.0.0.1	127.0.0.1	LTE RRC UL DCCH	50 RRCConnectionReconfigurationComplete
	321 06:30:41.58337	2 127.0.0.1	127.0.0.1	LTE RRC UL CCCH	54 RRCConnectionReguest
	326 06:30:41.58739	1 127.0.0.1	127.0.0.1	LTE RRC DL CCCH	82 RRCConnectionSetup
	334 06:30:41.62949	1 127.0.0.1	127.0.0.1	LTE RRC UL DCCH/NA	180 RRCConnectionSetupComplete, Attach request, PDN connectivity request
	335 06:30:41.62959	9 192.168.0.9	192.168.0.10	S1AP/NAS-EPS	252 InitialUEMessage, Attach request, PDN connectivity request
	336 06:30:41.63134		192.168.0.9		116 DownlinkWASTransport, ESN information request
		2 192.168.0.10	197.168.0.9	S1AP/NAS-FPS	116 DownlinkWASTransport, ESM information request
	550 WR: 58:41.05154	2 192.168.0.10	192.168.0.9	STAP/NAS-EPS	116 DownlinkWASTransport, ESM information request
		2 192.168.0.10 21, Src Port: 64659, D		STAP/NAS-FPS	116 Down IntellaStransport, ESM Internation request           A)           0000         00 00 60 00 00 00 00 00 00 00 00 00 00 0
Us	er Datagram Protoco		st Port: 9999	STAD/NAS-EPS	▲ 0000 00 00 03 04 00 05 00 00 00 00 00 00 00 00 00 00 00
Us	er Datagram Protoco venir LTE Radio Res	)], Src Port: 64659, D	st Port: 9999	STAP/NAS-EPS	A 0000 00 00 01 00 00 00 00 00 00 00 00 0
Us	er Datagram Protoco venir LTE Radio Res	ol, Src Port: 64659, D cource Control (RRC) p	st Port: 9999	\$140/N45-FP5	▲ 0000 00 00 03 04 00 05 00 00 00 00 00 00 00 00 00 00 00
Us	er Datagram Protoco venir LTE Radio Res 0000 0010 = Messag	ol, Src Port: 64659, D cource Control (RRC) p	st Port: 9999	\$140/N45-FD5	A 0000 00 00 01 00 00 00 00 00 00 00 00 0
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# Verify RRC Connection Reestablishment 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

## 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 :

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# 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

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Note: Industry best practise is 20% of Downlink Speed

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Note: Industry best practise is 20% of Downlink Speed

## 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	RSRQ - 12
DL throughput - 31208 Kbps	RSSI - 63
Attenuation – 30db	SNR - 18.6
RSRP - 57	

# UE 1

Ist UE UL throughput - 7286 Kbps Ist UE DL throughput - 19704 Kbps Attenuation - 30db RSRP - 55 RSRQ - 11 RSSI - 63 SNR - 20.6

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Verify Single Cell, 2 UE TCP bi-directional throughput

# 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	Changed the RACH parameter value in DU phycfg.xml from 280 to 150
			not seen on DU cli	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**





# 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:

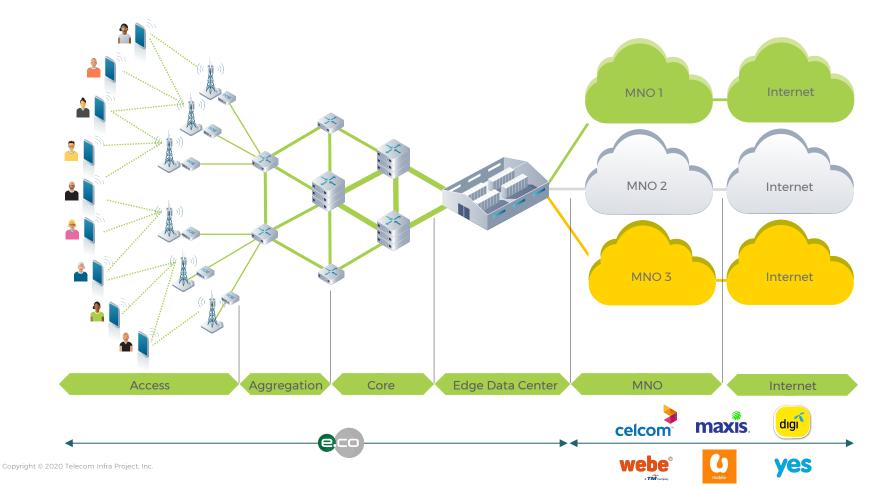
- Integration to 3rd party L2/L3 SD switch was possible
- Integration to Huawei LTE Core was successful
- Integration to SUNWAVE RRU was successful
- · Ease of Deployment (with initial Hiccups)
- Validate Open RAN Architecture works
- Stability of the solution seems fine throughout the trial
- Acceptable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

# Next Steps

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



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





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