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| rsys_logo |
| **LTE TOTALeNodeB Solution**  **(on Physical Abstraction Layer)**  **User Guide (for GA 4.0)**  **1222610 4.0** |
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# Preface

## Objective

This document provides the usage of LTE TOTALeNodeB FDD Solution on PAL platform designed by Radisys. This document describes the procedure to setup, configure, signaling and data calls.

## Audience

Radisys assumes that the readers of this document are:

* Product Development team,
* Product Line Management team,
* Sales team,
* Test/Validation team,
* Program Management team, and
* Existing and potential customers.

The readers must have an understanding of TeNB and its architecture.

## Document Organization

This document contains the following sections:

Table-1: Document Organization

|  |  |  |
| --- | --- | --- |
| **Ch. No.** | **Section** | **Description** |
|  | **Preface** | Provides the objective and release details. |
|  | **Introduction** | Provides an overview of the product, including the product description and features. |
|  | **Setup (End-to-End Solution)** | Describes the end-to-end setup information for this software. |
|  | **TeNB Directory Structure** | Illustrates the directory structure of the TeNB code base for PAL. |
|  | **Building Integrated Stacks** | Describes the procedure to build the integrated stack. |
|  | **Configuring Radisys CNE and TeNB** | Describes the procedure to configure TeNB and CNE. |
|  | **Execution of the Nodes** | Describes the execution process of this software. |
|  | **End-to-End Call Flow (Message Sequence Chart)** | Provides the call flow diagrams of the solution. |
|  | **Traffic Generators** | Describes the different performance testing options. |
|  | **Performance Management** | Describes the performance data recording environment. |
|  | **Troubleshooting** | Lists the troubleshooting information for this software. |
|  | **References** | Lists the reference documents. |

## Release History

The following table lists the history of changes in successive revisions to this document.

Table-2: Release History

|  |  |  |
| --- | --- | --- |
| **Version** | **Date** | **Description** |
| 4.0 | May 08, 2015 | LTE TeNB Solution GA 4.0 release on PAL. |
| 2.0 | July 14, 2014 | LTE TeNB Solution GA 3.0 release on PAL. |
| 1.0 | May 30, 2014 | LTE TeNB Solution Early Availability (EA) 3.0 release on PAL. |

# Introduction

## Product Description

Radisys TOTALeNodeB (TeNB) is a LTE eNodeB FDD Solution designed and productized for small cell deployments. Radisys TeNB is a comprehensive small solution available on leading SoC platforms optimized for performance. TeNB includes control and data plane protocol suites for L2 and L3 that are integrated with the L1 on the SoC, along with an application supporting a FSM and other key application components.

The key features of the TeNB solution are as follows:

* Attach and Detach
* Random Access procedure
* RRC Connection and Reconfiguration procedure
* E-RAB
  + E-RAB Setup
  + E-RAB Release
  + E-RAB Release initiated by eNB
  + E-RAB Modify
* S1AP
  + Reset (MME initiated)
  + Reset (eNB initiated)
  + S1 Setup (Successful Operation)
  + S1 Setup (Unsuccessful Operation)
  + MME Configuration Update (Successful Operation)
  + MME Configuration Update (Unsuccessful Operation)
  + eNB Configuration Update (Successful Operation)
  + eNB Configuration Update (Unsuccessful Operation)
* eNB Configuration Update (Retransmission)X2AP
  + X2AP Reset
  + X2AP: Reset (Retransmission)
  + X2AP: X2 Setup (Successful Operation)
  + X2AP: X2 Setup (Unsuccessful Operation)
  + X2AP: X2 Setup (Retransmission)
  + X2AP: eNB Configuration Update (Successful Operation)
  + X2AP: eNB Configuration Update (Unsuccessful Operation)
  + X2AP: eNB Configuration Update (Retransmission)
* Handover
  + Intra-frequency and Inter-frequency S1 Handover
  + Intra-frequency and Inter-frequency X2 Handover
  + Uplink & Downlink Data Forwarding
  + Inter-RAT Handover to WCDMA cell
* EPS Mobility Management
  + EMM Connection Management procedure
    - Paging
    - Service Request by UE
  + EMM specific procedures (UE initiated)
    - Tracking Area Update procedure for ECM Idle mode
    - Tracking Area Update procedure for ECM Connected mode
* Broadcast of MIBs and SIBs (SIB1, SIB2, SIB3, SIB4, SIB5, SIB6, SIB7, SIB8, SIB9, SIB10, SIB11, and SIB12)
* UL& DL HARQ
* 2x2 MIMO
* UE Context Release procedure initiated by eNB
* MME Selection and Load Balance
* eNodeB Overload Control
* Network Elements (MME, eNB) monitoring by using heartbeat messages
* Access Class Barring
* Emergency Calls
  + TeNB supports emergency calls for open mode of access by releasing existing calls when running at full capacity
* Periodic CQI Support
* Cell Broadcast Service / Public Warning System
  + Earthquake and Tsunami Warning System (ETWS)
  + Commercial Mobile Alert System (CMAS)
* Support for 5, 10 , 15 and 20 MHz Bandwidth
* 2 UE / TTI Scheduling
* 4 UE / TTI Scheduling
* SNOW3G Integrity and Ciphering Algorithms for AS Security
* UE Redirection feature when MAX\_ACTIVE\_USERS are reached
* Tested and integrated with Radisys OAM
* Automatic Neighbor Relation (ANR): Event (A3, A5) and Periodic based
* Improved Link Adaptation based on BLER (DL and UL)
* Binary and Text logging for RRC and eNB Application
* Watchdog
  + Software Watchdog to monitor registered applications
  + Hardware Watchdog to monitor Software Watchdog
* Radio Environment Monitoring (REM) / Networking Monitoring Module (NMM)
* Scheduling Algorithms
  + Proportional Fair Scheduler (PFS) for MAC scheduling
  + Semi Persistent Scheduling (SPS) for VoLTE
  + Round Robin (RR)
* Long and Short DRX
* Circuit Switched Fallback (CSFB)
  + UTRA FDD with or without UE measurements (with and without System Information)
  + CSFB to CDMA2000 1xRTT network with or without UE measurements
  + eCSFB to CDMA2000 1xRTT network with or without UE measurements
  + CSFB to GERAN without UE measurements (with or without System Information)
  + CSFB to GERAN with or without UE measurements (with or without NACC)
  + CSFB to TD-SCDMA with or without UE measurements (with or without System Information)
* Redirection to IRAT
  + Redirection to TD-SCDMA with SI based on B2 event
* Dynamic IP
* OAM statistical counters
  + Layer 3 Counters (RRC and S1AP)
  + Layer 2 Measurement Counters (RLC Downlink Throughput, RLC Uplink Throughput, PDCP SDU Discard Rate, MAC RACH Counters)
* Cell Access Mode
  + Open Access Mode
  + Closed Access Mode
* DSCP Marking support at eNodeB
* Release 11 ASN.1 Compliance for RRC, S1AP and X2AP
* Disabling DRX for QCI 1, 2, 3, 4
* SCTP Multi-homing
* S1-U Error Events
* Release-10 Compliance for S1AP and X2AP
* Dynamic Configuration Update through HeMS (only for LTE neighbor Frequency and neighbor Cell)
* Dynamic Control Format Indicator (DCFI)
* Downlink Frequency Selective Scheduling (DLFSS)
* UE History Information (UHI) and Handover Restriction List (HRL)
* RIM for UTRAN and GERAN SI.
* SON module supports the following features:
  + PRACH configuration parameter selection during cell bring up
  + DL-EARFCN selection during cell bring up
  + PCI selection during cell bring up
  + PCI collision prevention
  + PCI confusion detection and correction
* NTP
  + Static configuration of NTP server during TeNB boot up
  + Dynamic configuration of NTP server
  + Enable or disable NTP feature statically and dynamically
  + Reporting current time to OAM or HeMS after synchronizing with NTP server
  + Reporting NTP time status to OAM or HeMS
* TLS for secure TR-069 connection

The following end point applications are supported in end-to-end solution including UeSim, eNodeB, and CNE:

* 1. PING application
  2. Data transfer through iperf utility

## Definitions and Acronyms

The definitions, acronyms, and abbreviations used in this document are:

Table-3: Definitions and Acronyms

|  |  |
| --- | --- |
| **Acronym** | **Description** |
| 1xRTT | 1x (single-carrier) Radio Transmission Technology |
| ABS | Almost Blank Subframes |
| ANR | Automatic Neighbor Relations |
| App | Sample Application Layer |
| ARFCN | Absolute Radio Frequency Channel Number |
| BPSK | Binary Phase Shift Keying |
| BSP | Bicriterion Shortest Path |
| CLI | Command Line Interface |
| CMAS | Commercial Mobile Alert System |
| CN | Core Network |
| CNE | Core Network Emulators |
| CPRI | Common Public Radio Interface |
| CPU | Central Processing Unit |
| CQI | Channel Quality Indicator |
| CRE | Cell Range Expansion |
| C-RNTI | Cell Radio Network Temporary Identifier |
| CNM | Continuous Network Monitoring |
| CSFB | Circuit Switched FallBack |
| CDMA | Code Division Multiple Access |
| DCFI | Dynamic Control Format Indicator |
| DL | Downlink |
| DLFSS | Downlink Frequency Selective Scheduling |
| DLPC | Downlink Power Control |
| DRB | Data Radio Bearer |
| DRX | Discontinuous Reception |
| DTCH | Dedicated Traffic CHannel |
| EAID | Emergency Area ID |
| ECGI | E-UTRAN Cell Global Identifier |
| e-GTP | Evolved GTP |
| EARFCN | E-UTRA Absolute Radio Frequency Channel Number |
| eNB or eNodeB | E-UTRAN Node B |
| EPC | Evolved Packet Core |
| EPS | Evolved Packet System |
| E-RAB or ERAB | E-UTRAN Radio Access Bearer |
| ETWS | Earthquake and Tsunami Warning System |
| E-UTRAN | Evolved UTRAN |
| EVM | Error Vector Magnitude |
| EDGE | Enhanced Data rates for Global Evolution |
| FDD | Frequency Division Duplex |
| FDX | Full Duplex |
| FGI | Feature Group Indicator |
| GBR | Guaranteed Bit Rate |
| GTP | GPRS Tunneling Protocol |
| GERAN | GSM EDGE Radio Access Network |
| GPRS | General Packet Radio Service |
| HARQ | Hybrid ARQ |
| HeMS | Home eNodeB Management System |
| HRL | Handover Restriction List |
| HSS | Home Subscriber Server |
| IE | Information Element |
| IKEv2 | Internet Key Exchange v2 |
| IMSI | International Mobile Subscriber Identity |
| IP | Internet Protocol |
| IPsec | IP Security |
| LA | Link Adaptation |
| L-ARM or LARM | Lower ARM |
| LCG | Logical Channel Group |
| LTE | Long Term Evolution |
| MAC | Medium Access Control Protocol |
| MCC | Mobile Country Code |
| MIB | Master Information Block |
| MIMO | Multiple Input Multiple Output |
| MME | Mobile Management Entity |
| MNC | Mobile Network Code |
| MTU | Maximum Transmission Unit |
| NACC | Network-Assisted Cell Change |
| NAS | Non-Access Stratum |
| NMM | Network Monitor Mode |
| NR | Neighbor Relation |
| NRT | Neighbor Relation Table |
| NTP | Network Time Protocol |
| OAM | Operation And Maintenance |
| ODMA | Opportunity-Driven Multiple Access |
| OPC | Operations Controller |
| PAL | Physical Abstraction Layer |
| PCCH | Paging Control Channel |
| PCI | Physical Cell Identifier |
| PDCCH | Physical Downlink Control CHannel |
| PDCP | Packet Data Convergence Protocol |
| PDN | Packet Data Network |
| PDSCH | Physical Downlink Shared CHannel |
| PDU | Protocol Data Unit |
| PFS | Proportional Fair Scheduler |
| PRB | Physical Resource Block |
| PUSCH | Physical Uplink Shared CHannel |
| P-GW, PDN-GW or PGW | PDN Gateway |
| PLMN | Public Land Mobile Network |
| PWS | Public Warning System |
| QAM | Quadrature Amplitude Modulation |
| QPSK | Quadrature Phase Shift Keying |
| QXDM | Qualcomm Extensible Diagnostic Monitor |
| RAB | Radio Access Bearer |
| RAC | Radio Admission Control |
| RAN | Radio Access Network |
| RB | Radio Bearer |
| REM | Radio Environment Monitoring |
| RF | Radio Frequency |
| RLC | Radio Link Control Protocol |
| RIM | RAN Information Management |
| RNC | Radio Network Controller |
| RNTI | Radio Network Temporary Identifier |
| RRC | Radio Resource Control Protocol |
| RRM | Radio Resource Management |
| RV | Redundancy Version |
| Rx or RX | Receiver |
| S1AP | S1 Application Protocol |
| SCTP | Stream Control Transmission Protocol |
| SCTP RTO | SCTP Retransmission Time-Out |
| S-GW or SGW | Serving Gateway |
| SDU | Service Data Unit |
| SIB | System Information Block |
| SINR | Signal to Noise Ratio |
| SISO | Single Input Single Output |
| SI | System Information |
| SM | Stack Manager |
| SoC | System-on-a-Chip |
| SON | Self Organizing Network |
| SPS | Semi Persistent Scheduling |
| TCP | Transmission Control Protocol |
| TDD | Time Division Duplex |
| TeNB or TOTALeNB | TOTALeNodeB |
| TFTP | Trivial File Transfer Protocol |
| TLS | Transport Layer Security |
| TTI | Transmission Timing Interval |
| TUCL | TCP/UDP Convergence Layer |
| Tx or TX | Transmitter |
| U-ARM or UARM | Upper ARM |
| U-Boot | Universal Boot Loader |
| UDP | User Datagram Protocol |
| UE | User Equipment |
| UeSim, UESim or ueSim | Radisys UE Simulator |
| UHI | UE History Information |
| UL | Uplink |
| ULPC | Uplink Power Control |
| USB | Universal Serial Bus |
| UTRAN | Universal Terrestrial Radio Access Network |
| VC | Video Client |
| VS | Video Server |
| X2AP | X2 Application Protocol |

For a list of commonly used terms, refer to the engineering glossary at [www.radisys.com/resources/wireless-glossary/](http://www.radisys.com/resources/wireless-glossary/)

# Setup (End-to-End Solution)

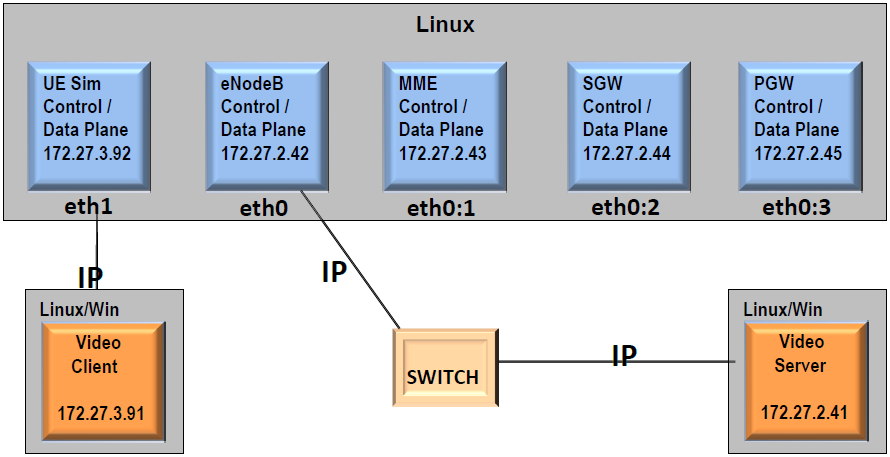
This section describes the hardware and software components and setup required to execute the CNEs (binaries) in end-to-end environment to demonstrate the functions and interactions of CNEs with rest of nodes like UeSim, eNodeB, external client and server. eNodeB and UeSim (Uu stack) is executed on Linux platform.

**Note:** MME, SGW, PGW together form core-network emulators (CNE). UeSim and CNE sample applications **must** be treated as reference applications with limited set of functionality**.**

## End-to-End Demo with Uu Stacks on Single Linux Machine

Figure-1 shows the setup of end-to-end demo executing LTE eNodeB with Uu stacks on single Linux machine.

**Figure-1: End-to-End Demo with Uu Stacks on Single Linux Machine**



For single PC setup, a system with two interfaces is required to configure with five different IPs as follows:

ifconfig eth0 172.27.2.42 up

ifconfig eth0:1 172.27.2.43 up

ifconfig eth0:2 172.27.2.44 up

ifconfig eth0:3 172.27.2.45 up

ifconfig eth1 172.27.3.92 up

There must be a route established between UE and Video Client (VC) using the following route command to ensure that VC is reachable only from UE.

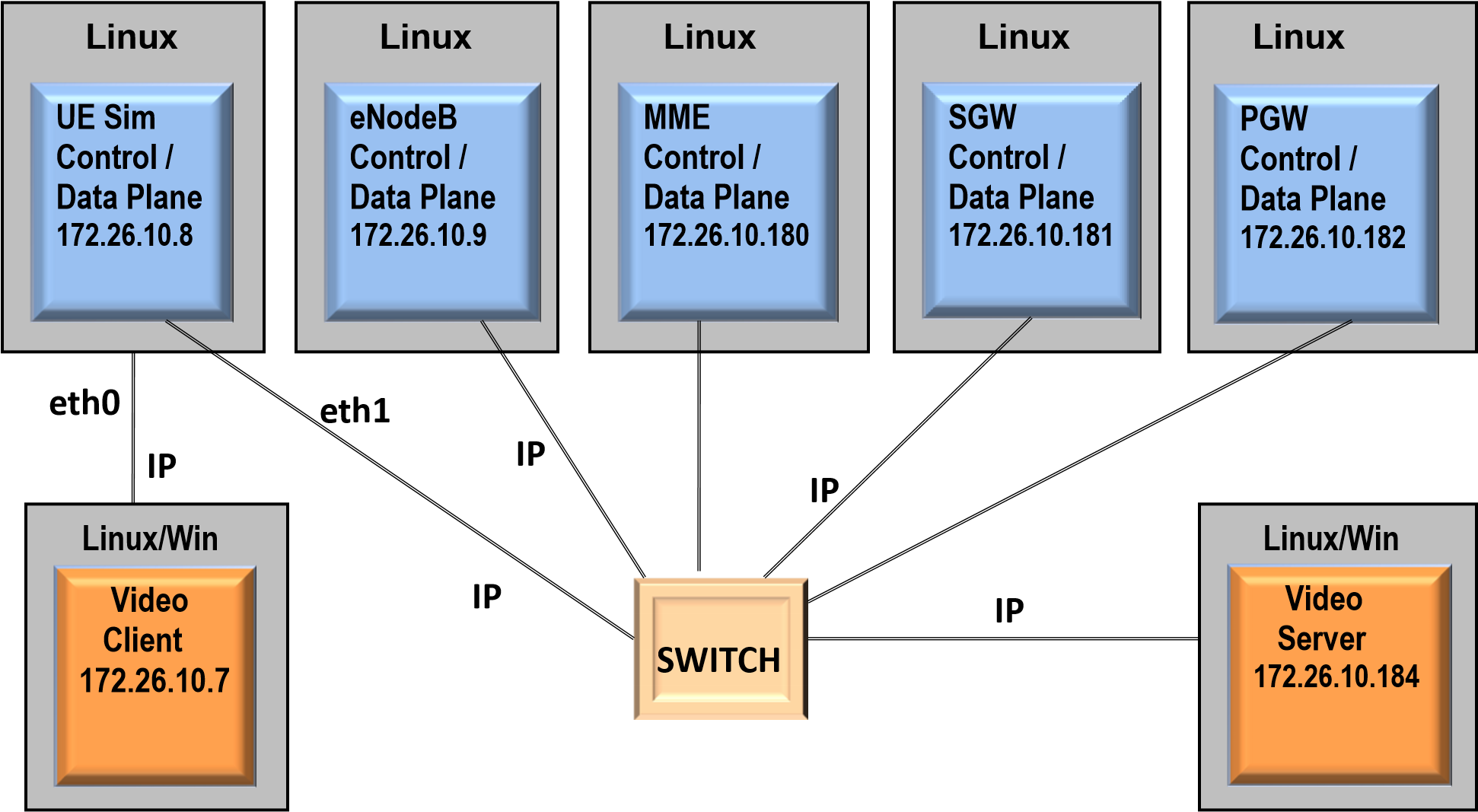
**route add –host <ue\_client\_ip\_addr> gw <ue\_sim\_ip\_addr\_connected\_to\_ue\_client> dev <device\_connected\_to\_ue\_client>**

For example: route add -host 172.27.3.91 gw 172.27.3.92 dev eth1, where 172.27.3.91 is used in the test setup for VC.

## End-to-End Demo with Uu Stacks on Multiple Linux Machines

Figure-2 shows the setup of end-to-end demo executing LTE eNodeB, CNEs, and UeSim with Uu Stacks on multiple Linux machines.

Figure-: End-to-End Demo with Uu Stacks on Multiple Linux Machines



## Hardware

The hardware requirements are as follows:

* One Linux machine (desktop/server) with an Ethernet card to run CNE.

With virtual IP configured on the same Linux machine (desktop/server) having an Ethernet card is used to execute MME, SGW, and PGW. However, based on hardware availability, the nodes are executed on different Linux machines.

* One Linux machine (desktop/server) with an Ethernet card to execute eNodeB.
* One Linux machine (desktop/server) with two Ethernet cards to execute UeSim.
* One machine (laptop/desktop) to execute the video client. This can be windows or Linux machine.

Connected directly to one of the interfaces of UE simulator and must not have any other connectivity other than the direct connection to UE simulator.

* One machine (laptop/desktop) to execute the video server. This can be windows or Linux machine.
* One 8 ports gig L2 switch and 5 to 6 Ethernet cables.

## Software

The software requirements are as follows:

* libpcap and libpcap-devel packages v0.9.1 or later required for PGW and UE simulator.
* Linux operating system with kernel version 2.6 to execute CNEs, eNodeB and UE simulator.

# TeNB Directory Structure

This section describes the directory structure for the TeNB code based on PAL.

Figure-3: TeNB Directory Structure

**PAL\_RSYS\_FDD**

cm

egtpu

lteclpal

ltemac

lterlc

ltepdcp

lterrc

mt

s1ap

x2ap

sctp

tucl

enbapp

lterrm

build

src

tenb\_commonplatform

(OAM Source)

**bin**

**src**

**docs**

rlog

lteremapp

watchdog rlog

**libs**

lteson

rlog

**Package information**:

In **PAL\_RSYS** directory, there are several folders.

1. **docs** folder contains documents released with the package.
2. **bin** folder contains:
   1. **rsys** folder containing precompiled OAM binaries, libraries, TeNB binaries and configuration files (**ys\_cfg.txt**, **wr\_cfg.txt**, **configFile**, and **start\_TeNB**).
3. **src** folder contains TeNB source code:
4. **tenb\_commonplatform** folder contains OAM source code and third party tools,
5. The other folders contain source code for LTE protocol stack layer corresponding to the name of the folder,
6. The **enbapp** folder contains **src** and **build** folders.
7. The **lteremapp** folder contains files for REM Application and REM convergence layer. REM convergence layer file is under the **lteremapp/remcl** folder.
8. **libs** folder contains RRM library, if RRM as a source code is not delivered.

# Building Integrated Stacks

The entities/nodes are bundled as an executable in a unique directory.

## Build Core Network Emulators (Radisys CNE)

The Radisys (RSYS) CNE binaries for MME, SGW, and PGW simulation can be built on any Linux machine.

### MME

#### Product Feature Flags

LTE MME Reference Application supports features that are conditionally compiled.

The compile-time flags that are enabled to invoke the corresponding features are as follows.

Table-4: MME Product Feature Flags

| **Flag** | **Description** |
| --- | --- |
| **VB** | MME main flag. |
| **VB\_DEBUG** | Debug flag to compile the code for debug printing in LTE MME Reference Application. |
| **LCLVB** | Loose coupling layer management flag. |
| **LCLVBMILVB** | Loose coupling from protocol stack towards stack manager. |
| **LCSMMILVB** | Loose coupling from stack manager towards protocol stack. |
| **VB\_USTA** | Alarm flag to compile the code for generating unsolicited status in LTE MME Reference Application. |
| **VB\_MME** | MME flag to compile MME support. |
| **LCSMVBMILVB** | Loose coupling from stack manager towards protocol stack. |
| **VB\_PERF\_MEAS** | Performance measurement flag to compile the code to measure performance in LTE MME Reference Application. |
| **VB\_MME\_AUTH** | Authentication flag to compile authentication support in LTE MME Reference Application. |
| **VB\_MME\_NW\_INIT\_DETACH** | Network initiated detach procedure. |
| **EG\_REL\_930** | Release-9 upgrade for eGTP. |
| **EG\_PHASE2** | Release-9 (phase 2) upgrade for eGTP. |
| **VB\_SB\_SCTP** | Trillium SCTP support. Enable this flag under product options for acceptance test build (**PRDACCOPTS**) in **ve.mak** file. |
| **HI\_LKSCTP**  **CM\_LKSCTP** | Kernel SCTP support.  **Note**: TUCL supports Kernel SCTP version 1.0.7 only and Linux Kernel version must be between 2.6.18 and 2.6.22. |
| **VB\_IMSI\_REATTACH** | To attach with the same IMSI, for which MME already has an UE context. |

#### Build MME

The makefile for building MME is **vb.mak**. Execute the following command to build the binary:

* **make –f vb.mak BLDENV=lnx\_acc acc**

The build command creates the sample stack manager and sample application of MME, and links with the required integrated stack libraries (TUCL, SCTP, S1AP, and eGTP). Creates the **vb\_acc** executable in the **/build** directory.

### SGW

#### Product Feature Flags

LTE SGW Reference Application supports features that are conditionally compiled.

The list of compile-time flags that are enabled to invoke the corresponding features are as follows.

**Table-5: SGW Product Feature Flags**

| **Flag** | **Description** |
| --- | --- |
| **QO** | SGW main flag. |
| **QO\_DEBUG** | Debug flag to compile the code for debug printing in LTE SGW Reference Application. |
| **LCLQO** | Loose coupling layer management flag. |
| **LCQOMILQO** | Loose coupling from protocol stack towards stack manager. |
| **LCSMMILQO** | Loose coupling from stack manager towards protocol stack. |
| **QO\_USTA** | Alarm flag to compile the code for generating unsolicited status in LTE SGW Reference Application. |
| **QO\_SGW** | SGW flag to compile SGW support. |
| **LCSMQOMILQO** | Loose coupling from stack manager towards protocol stack. |
| **EG\_REL\_930** | Release-9 upgrade for eGTP. |
| **EG\_PHASE2** | Release-9 (Phase-2) upgrade for eGTP. |

#### Build SGW

The makefile for building SGW is **qo.mak**. Execute the following command to build the binary:

* **make –f qo.mak BLDENV=lnx\_acc acc**

The build command creates the sample stack manager and sample application of SGW, and links with the required integrated stack libraries (TUCL and eGTP). Creates the **qo\_acc** executable in the **/build** directory.

### PGW

#### Product Feature Flags

LTE PGW Reference Application supports features that are conditionally compiled.

The list of compile-time flags that are enabled to invoke the corresponding features are as follows.

**Table-6: PGW Product Feature Flags**

| **Flag** | **Description** |
| --- | --- |
| **AV** | PGW main flag. |
| **LCLAV** | Loose coupling layer management flag. |
| **LCAVMILAV** | Loose coupling from protocol stack towards stack manager. |
| **LCSMAVMILAV** | Loose coupling from stack manager towards protocol stack. |
| **AV\_USTA** | Alarm flag to compile the code for generating unsolicited status in LTE PGW Reference Application. |
| **AV\_PERF** | Performance measurement flag to compile the code to measure performance in LTE PGW Reference Application. |
| **EG\_REL\_930** | Release-9 upgrade for eGTP. |
| **EG\_PHASE2** | Release-9 (Phase-2) upgrade for eGTP. |

#### Build PGW

The makefile for building PGW is **av.mak**. PGW makes use of the Libpcap APIs, for which the library (**libpcap.a**) must be present in the build directory. The relevant/associated header files of this library of PCAP must be present in the **/usr/include/** directory. Execute the following command to build the binary:

* **make –f av.mak BLDENV=lnx\_acc acc**

The build command creates the sample stack manager and sample application of PGW, and links with the required integrated stack libraries (TUCL and eGTP). Creates the **av\_acc** executable in the **/build** directory.

## Build TeNB

### Product Feature Flags

The list of mandatory flags enabled in TeNB integrated solution validations are as follows.

End-to-end validation of TeNB is performed only when all these flags are enabled. Validation of integrated solution when keeping a sub-set of these flags disabled is un-deterministic.

Table-: TeNB Product Feature Flags

| **Flag** | **Description** |
| --- | --- |
| **SI\_NEW** | SIBs for cell selection or reselection. |
| **RGR\_SI\_SCH** | Enabled along with SI\_NEW for SIBs cell selection or reselection. When the flags are enabled, the SIB3, SIB4, and SIB5 used for cell selection or reselection by the UE are sent. |
| **WR\_RELAY** | Relay of RRC to S1AP and S1AP to RRC. This flag needs to be enabled always. |
| **EU\_DAT\_APP** | Relay of PDCP to eGTP-u and eGTP-u to PDCP. This flag needs to be enabled always. |
| **EGTP\_U** | eGTP-u functionality. |
| **KW\_PDCP** | Conditionally compiles code to allow stack to support the LTE PDCP protocol. |
| **KW** | Conditionally compiles code to allow stack to support the LTE RLC protocol. |
| **LCEGUIEGT** | EGT interface. |
| **LCWRLICTF** | CTF interface. |
| **LCWRLINHU** | MAC interface. |
| **LCPJUIPJU** | PDCP interface. |
| **HI\_MULTI\_THREADED** | TUCL in multi-threaded mode. The S\_SINGLE\_THREADED flag must not be defined. |
| **SS\_M\_PROTO\_REGION** | Multi-region support from SSI. |
| **RGR\_RRM\_TICK** | TTI ticks to RRM (that is, TeNB application) by LTE MAC layer. |
| **LTE\_LNX\_AFFINITY** | Affinity [CPU/processor] set for different system threads on Linux. |
| **LTEMAC\_MIMO** | Multiple Input Multiple Output. |
| **LSZV1** | Release-9 upgrade for S1AP. |
| **SS\_TICKS\_SEC** | Tick resolution for timers.  If SS\_TICKS\_SEC=10 it means resolution is 100 milli seconds (ms).  If SS\_TICKS\_SEC=100 it means resolution is 10 ms (default configuration).  If SS\_TICKS\_SEC=1000 it means resolution is 1 ms.  (1/SS\_TICKS\_SEC) \* 1000 gives the resolution unit in terms of ms. |
| **LTE\_HO\_SUPPORT** | S1 handover and X2 handover support. |
| **WR\_SB\_SCTP** | Trillium SCTP support.  To avail this feature, need to enable this flag under product options for acceptance test build (PRDACCOPTS) in ve.mak file. |
| **LTEMAC\_DRX** | DRX functionality. UEs which support the long DRX are configured with the values set in the wr\_cfg.txt configuration file. The values are common for all the UEs. |
| **WR\_RSYS\_OAM** | OAM functionality. |
| **WR\_RSYS\_KPI** | KPI functionality. |
| **SS\_DIAG** | Logging support. |
| **RM\_INTF** | RRM functionality and must be enabled always. |
| **SS\_RBUF** | Ring Buffer optimization. |

The list of optional flags enabled in TeNB integrated solution validations are as follows.

| **Flag** | **Description** |
| --- | --- |
| **DEBUGP** | Debug prints on the screen. |
| **LTE\_ENB\_PAL** | Physical Abstraction Layer (that is, IP communication). |
| **TENB\_AS\_SECURITY** | Access Stratum Security. |

### Building TeNB Integrated Stack for Linux

The eNodeB integrated stack binary for Linux is built on any Linux machine.

**Build TeNB without OAM**

* Execute the following command to go to **eNodeB** compilation directory.
* **cd src/enbapp/build**
* Execute the following command to build without OAM.
* **make tenb**

The build command internally invokes **enodeb\_pal\_lnx.mak** makefile with   
‘**acc BLDENV=lnx\_split**’ build environment and creates the **enodeb** binary in **src/enbapp/build/obj** directory.

* Execute the following command to clean up the binary and object files of TeNB.
* **make clean**

**Build TeNB with OAM**

* Execute the following command to go to **eNodeB** compilation directory.
* **cd src/enbapp/build**
* Execute the following command to build with OAM.
* **make tenb\_oam**

The build command compiles and copies **enodeb** binary with OAM to the **/rsys** directory.

* Execute the following command to clean up the OAM libraries and OAM object files along with all other object files.
* **make clean**

# Configuring Radisys CNE and TeNB

The following sections explain the various configuration files and details to be considered before executing various binaries at different nodes.

## Configuration Settings for Core Network Emulators

### Configuration Settings for MME

1. Go to the executable directory of MME where the **vb\_acc** binary is present.
2. The **vbsm\_cfg.txt** and **vb\_hss\_ue.db** files must be present in the **/mme** directory of MME.
3. Edit the **vbsm\_cfg.txt** file and update the following IP addresses for demonstration purpose:
4. **VBSM\_ENB\_ADDR**: Provide IP address of server with eNodeB executable.
5. **VBSM\_MME\_IPADDR**: Provide IP address of server with MME executable.
6. **VBSM\_SGW\_IP\_ADDR**: Provide IP address of server with SGW executable.
7. **VBSM\_PGW\_IP\_ADDR**: Provide IP address of server with PGW executable.

**Table-8: vbsm\_cfg.txt Configuration File**

| **Parameters** | **Value** | **Description** |
| --- | --- | --- |
| VBSM\_EG\_DFLT\_PORT | 2123 | eGTP default port |
| VBSM\_EG\_NONDFLT\_PORT | 2124 | eGTP non default port |
| VBSM\_EG\_DFLT\_HOST\_NAME | egtp.rsys.com | eGTP host name |
| VBSM\_ENB\_ADDR | 172.26.2.4 | IP address of eNodeB |
| VBSM\_ENB\_PORT | 36412 | eNodeB port |
| VBSM\_MME\_IPADDR | 172.26.2.1 | MME IP address |
| VBSM\_MME\_SCTP\_PORT | 36412 | MME SCTP port |
| VBSM\_SGW\_IPADDR | 172.26.2.2 | SGW IP address |
| VBSM\_SGW\_PORT | 2123 | SGW port |
| VBSM\_PGW\_IPADDR | 172.26.2.3 | PGW IP address |
| VBSM\_PGW\_PORT | 2125 | PGW port |
| VBSM\_UE\_NUM | 35 | Number of UEs |
| VBSM\_SCTP\_UDP\_SERV\_TYPE | 0 | SCTP service type |
| VBSM\_VC\_IP | 172.27.2.26 | VC IP address |
| VBSM\_MME\_DBG\_MASK | 1111 | Debug mask to be set in the form:  |LVB\_DBGMASK\_INFO|LVB\_DBGMA SK\_ERROR|LVB\_DBGMASK\_TRC|LVB\_DBGMASK\_MEM |
| VBSM\_DBG\_MASK | 0000 | Debug mask to be set in the form:  |LVB\_DBGMASK\_INFO|LVB\_DBGMA SK\_ERROR|LVB\_DBGMASK\_TRC|LVB\_DBGMASK\_MEM |
| VBSM\_NW\_INIATED\_DETACH\_TIMER | 1000 | Timer configuration value for network initiated detach procedure. |
| VBSM\_MCC\_DIG0  VBSM\_MCC\_DIG1  VBSM\_MCC\_DIG2    VBSM\_MNC\_DIG0  VBSM\_MNC\_DIG1  VBSM\_MNC\_DIG2 | 0  2  1    2  1  f | Change MCC and MNC values according to the requirement. |
| VBSM\_MME\_GRP\_ID  VBSM\_MME\_REL\_CAP  VBSM\_MME\_CODE | 11  3  A | MME group ID  MME relative capability value  MME code (provide value in HEX). |

**Note**: Do NOT change the order of the parameters.

User must enter the UE details in **vb\_hss\_ue.db** file. Match with the required UE or UeSim under test for this setup, especially IMSI parameter.

### Configuration Settings for SGW

1. Go to the executable directory of SGW where the **qo\_acc** binary is present.
2. The **qosm\_cfg.txt** file must be present in the **/sgw** directory of SGW.
3. Edit the **qosm\_cfg.txt** file and update the following IP address for demonstration purpose:
4. **QOSM\_SGW\_IP\_ADDR**: Provide IP address of server with SGW executable.

**Table-9: qosm\_cfg.txt Configuration File**

|  |  |  |
| --- | --- | --- |
| **Parameters** | **Value** | **Description** |
| QOSM\_EG\_C\_DFLT\_PORT | 2123 | eGTP port |
| QOSM\_EG\_C\_S11\_PORT | 2124 | eGTP port |
| QOSM\_EG\_C\_S5S8\_PORT | 2125 | eGTP port |
| QOSM\_EG\_U\_DFLT\_PORT | 2152 | SGW port |
| QOSM\_EG\_DFLT\_HOST\_NAME | egtp1.rsys.com | eGTP host name |
| QOSM\_SGW\_IPADDR | 172.25.0.19 | SGW IP address |
| QOSM\_UE\_NUM | 35 | Number of UEs |
| QOSM\_SGW\_DBG\_MASK | 1111 | Debug mask to be set in the form:  |LQO\_DBGMASK\_INFO|LQO\_DBGMA SK\_ERROR|LQO\_DBGMASK\_TRC|LQO\_DBGMASK\_MEM |
| QOSM\_SM\_DBG\_MASK | 0000 | Debug mask to be set in the form:  |LQO\_DBGMASK\_INFO|LQO\_DBGMA SK\_ERROR|LQO\_DBGMASK\_TRC|LQO\_DBGMASK\_MEM |

**Note**: Do NOT change the order of the parameters.

### Configuration Settings for PGW

1. Go to the executable directory of PGW where the **av\_acc** binary is present.
2. The **avsm\_cfg.txt** file must be present in **/pgw** directory of PGW.
3. Edit the **avsm\_cfg.txt** file and update the following IP addresses for demonstration purpose:
4. **AVSM\_PGW\_DFLT\_ADDR**: Provide IP address of Server with PGW executable.
5. **AVSM\_PGW\_DFLT\_EXGW\_ADDR**: Provide IP address of external server [for example, Video Server (VS)] which intends to communicate with PGW.
6. **AVSM\_PGW\_UE\_START\_ADDR**: Provide IP address of server where UE client [for example: Video Client (VC)] is present. This is the IP address assigned by PGW for the first UE. PGW uses this IP address as a reference for new assignment to a new UE.
7. **AVSM\_PGW\_IP\_NUM**: Number of IP addresses configured for UE clients.

Ensure the source port number of Video server is configured with a port less than **AV\_PGW\_MAX\_WELL\_KNOWN\_IP\_PORT** specified in the **av.h** file.

**Table-10: avsm\_cfg.txt Configuration File**

| **Parameters** | **Value** | **Description** |
| --- | --- | --- |
| AVSM\_EG\_C\_DFLT\_PORT | 2123 | eGTP port |
| AVSM\_EG\_C\_NONDFLT\_PORT | 2124 | eGTP port |
| AVSM\_EG\_U\_DFLT\_PORT | 2152 | eGTP port |
| AVSM\_EG\_DFLT\_HOST\_NAME | egtp2.rsys.com | eGTP host name |
| AVSM\_PGW\_DFLT\_ADDR | 172.27.2.94 | PGW IP address |
| AVSM\_PGW\_DFLT\_EXGW\_ADDR | 172.27.2.50 | External gateway address |
| AVSM\_PGW\_UE\_START\_ADDR | 172.27.2.96 | Starting address of UE |
| AVSM\_PGW\_UE\_NUM | 35 | Number of UEs supported |
| AVSM\_PGW\_IP\_NUM | 35 | Number of PGW IP addresses |
| AVSM\_SGW\_IPADDR | 172.27.2.93 | SGW IP address |
| AVSM\_SGW\_PORT | 2152 | SGW port |
| AVSM\_PGW\_DBG\_MASK | 0000 | Debug mask to be in the form:  |LAV\_DBGMASK\_INFO|LAV\_DBGMASK\_ ERROR|LAV\_DBGMASK\_TRC|LAV\_DBGMASK\_MEM |
| AVSM\_DBG\_MASK | 0000 | Debug mask to be in the form:  |LAV\_DBGMASK\_INFO|LAV\_DBGMASK\_ERROR|LAV\_DBGMASK\_TRC|LAV\_DBGMASK\_MEM |
| AVSM\_INACTIVE\_TMR\_VAL | 10000 | Inactive timer value |
| AVSM\_EXPIRY\_CNT | 500 | Expiry count |
| AVSM\_PGW\_DNS\_ADDR | 172.27.2.26 | DNS IP address. |

**Note**: Do NOT change the order of the parameters.

## Configuration Settings for eNodeB

1. Edit the **wr\_cfg.txt** configuration file with the following entries:
2. Update the following IP addresses for demonstration purpose:
3. **WR\_TAG\_ENB\_IP\_ADDR**: Provide IP address of the server intended to run eNodeB.
4. **WR\_TAG\_MME\_INFO**: Provide IP address of the server intended to run MME.
5. **WR\_TAG\_SCTP\_IP\_ADDR**: Provide IP address of the server intended to run eNodeB.
6. **WR\_TAG\_INACTIVITY\_TIMER\_VAL**: Specifies the time in milliseconds (ms) after which the inactivity timer in the eNodeB expires.
7. **WR\_TAG\_MAX\_EXPIRY**: Specifies the number of expiries after which the inactivity of the UE is detected.
8. **WR\_TAG\_SCTP\_SRVC\_TYPE**: Specifies **0** for SCTP over RAW IP and **1** for SCTP over UDP.
9. Long DRX Configuration parameters: The below values are common for all UEs
10. **WR\_TAG\_DRX\_ON\_DURATION\_TMR**: Enumerator used to configure the DRX On-Duration timer. Recommended value is 8.
11. **WR\_TAG\_DRX\_INACTIVITY\_TMR**: Enumerator used to configure the DRX Inactivity timer. Recommended value is 4.
12. **WR\_TAG\_DRX\_RETX\_TMR**: Enumerator used to configure the DRX Retransmission timer. Recommended value is 1.
13. **WR\_TAG\_DRX\_LONG\_CYCLE**: Enumerator used to configure the DRX Long Cycle value. Recommended value is 3 (40 ms).

It is also recommended that the DRX Long Cycle is in multiples of 10 ms, in alignment with the CQI reporting periodicity 10, 20, 40, 80, and so on. The values 32, 64, 128, and so on, are not recommended. The maximum recommended value for DRX Long Cycle is 3 (40 ms).

For example: if long duration is 20 ms, the number of unique DRX, CQI/RI offsets possible is 20/2 = 10. Implies that only 10 UEs get unique offsets. For the eleventh UE, the offset must be reused resulting in CQI/RI decoding failure.

Recommended not to use the DRX Long Cycle values 10, 20 in this release.

**Table-11: wr\_cfg.txt Configuration File**

|  |  |  |
| --- | --- | --- |
| Parameters | Value | Description |
| WR\_TAG\_CELL\_ID | 1 | Cell ID |
| WR\_TAG\_OP\_MODE | 4 | Not applicable to PAL |
| WR\_TAG\_PERIOD | 2 | Not applicable to PAL |
| WR\_TAG\_MOD\_TYPE | 0 | Modulation type: BPSK / QPSK /16QAM / 64QAM |
| WR\_TAG\_TDD\_ULDL\_CFG\_MODE | 2 | TDD Uplink Downlink Configuration Mode |
| WR\_TAG\_TDD\_SPCL\_SF\_CONFIG | 7 | SF configuration |
| WR\_TAG\_DUP\_MODE | 1 | Duplexing mode: TDD/FDD |
| WR\_TAG\_MAX\_UE\_SUPPORT | 20 | Maximum number of UEs that can be supported |
| WR\_TAG\_MCC\_0 | 3 | MCC0 |
| WR\_TAG\_MCC\_1 | 1 | MCC1 |
| WR\_TAG\_MCC\_2 | 1 | MCC2 |
| WR\_TAG\_MNC\_0 | 4 | MNC0 |
| WR\_TAG\_MNC\_1 | 8 | MNC1 |
| WR\_TAG\_MNC\_2 | 1 | MNC2 |
| WR\_TAG\_TA\_CODE | 1 | Tracking Area Code |
| WR\_TAG\_FREQ\_BAND\_IND | 7 | Frequency Band Indicator |
| WR\_TAG\_DL\_EARFCN | 3100 | DL EARFCN value for Band-7 |
| WR\_TAG\_UL\_EARFCN | 0 | UL EARFCN value for Band-7 |
| WR\_TAG\_ENB\_IP\_ADDR | 172.26.10.22 | Provide IP address of server intended to run eNodeB. |
| WR\_TAG\_PCI\_SELECT\_TYPE | 1 | Enable or disable PCI selection type from SON. |
| WR\_TAG\_PRACH\_SELECT\_TYPE | 1 | Enable or disable PRACH selection type from SON. |
| WR\_TAG\_EARFCN\_SELECT\_TYPE | 1 | Enable or disable EARFCN selection type from SON. |
| WR\_TAG\_PCI\_LIST | {{1,2,3,4}} | List of PCIs from which SON select the serving PCI. |
| WR\_TAG\_DL\_EARFCN\_LIST | {{3100}} | DL-EARFCN list from which SON selects the serving DL-EARFCN. |
| WR\_TAG\_UL\_EARFCN\_LIST | {{21100}} | UL-EARFCN list from which SON selects the serving UL-EARFCN. |
| WR\_TAG\_ROOTSEQ\_IDX\_LIST | {{823,10,18}} | Root Sequence Index list from which SON selects the RootSeqIndex value. |
| WR\_TAG\_PRACHCFG\_IDX\_LIST | {{1,2,48}} | PRACH Configuration Index list from which SON selects the PrachCfgIndex value. |
| WR\_TAG\_ZERO\_CORR\_ZONE\_CFG\_LIST | {{8,10,14}} | Zero Correlation Zone Configuration list from which SON selects the ZeroCorrZoneCfg value. |
| WR\_TAG\_PRACH\_FREQ\_OFFSET\_LIST | {{1,5}} | PRACH Frequency Offset list from which SON selects the PrachFreqOffset value. |
| WR\_TAG\_ROOTSEQ\_IDX | 823 | Configured RootSeqIndex value. |
| WR\_TAG\_PRACHCFG\_IDX | 1 | Configured PrachCfgIndex value. |
| WR\_TAG\_ZERO\_CORR\_ZONE\_CFG | 10 | Configured ZeroCorrZoneCfg value. |
| WR\_TAG\_PRACH\_FREQ\_OFFSET | 1 | Configured PrachFreqOffset value. |
| WR\_TAG\_NO\_OF\_MME\_INFO | 1 | Number of MMEs |
| WR\_TAG\_MME\_INFO | {{1,1, 172.26.10.154}} | Provide IP address of server intended to run MME. |
| WR\_TAG\_SCTP\_IP\_ADDR | 172.26.10.22 | Provide IP address of server intended to run eNodeB. |
| WR\_TAG\_HI\_DBG | 0 | TUCL debug prints. |
| WR\_TAG\_SB\_DBG | 0 | SCTP debug prints. |
| WR\_TAG\_SZ\_DBG | 0 | S1AP debug prints. |
| WR\_TAG\_EG\_DBG | 0 | eGTP debug prints. |
| WR\_TAG\_WR\_DBG | 1 | eNBApp debug prints. |
| WR\_TAG\_NH\_DBG | 0 | RRC debug prints. |
| WR\_TAG\_KW\_DBG | 0 | PDCP debug prints. |
| WR\_TAG\_RG\_DBG | 0 | MAC debug prints. |
| WR\_TAG\_CZ\_DBG | 0 | X2AP debug prints. |
| WR\_TAG\_YS\_DBG | 0 | Convergence Layer debug prints. |
| WR\_TAG\_SM\_DBG | 1 | Layer Manger debug prints. |
| WR\_TAG\_INACTIVITY\_TIMER\_VAL | 20000 | Specifies the time in milliseconds after which inactivity timer in the eNodeB expires. |
| WR\_TAG\_END\_MARKER\_TIMER\_VAL | 10 | Specifies the time in milliseconds for end marker packet value. |
| WR\_TAG\_MAX\_EXPIRY | 30 | Specifies the number of expiries after which the inactivity of the UE is detected. |
| WR\_TAG\_X2\_PREP\_TMR | 1000000 | The time to wait for reception of the HandoverCommand message after sending the HandoverRequired from the eNB to the MME. |
| WR\_TAG\_X2\_OVRALL\_TMR | 1000000 | The time to wait for the UEContextRelease message from the Target eNB after receiving the HandoverRequestAcknowledge message from the Target eNB and handover is complete. |
| WR\_TAG\_NO\_OF\_BRDCST\_PLMN | 1 | Number of broadcast PLMN IDs. |
| WR\_TAG\_PLMN\_ID\_LST | {311481} | List of PLMN IDs. |
| WR\_TAG\_CELL\_FDD\_CFG | {0, 1, 2, 3} | FDD-specific cell configuration. |
| WR\_TAG\_CELL\_TDD\_CFG | {0, 1, 2, 3, 4, 5} | TDD-specific cell configuration. |
| WR\_TAG\_NO\_OF\_NGH\_INFO | INVLD | Number of neighbors’ information. |
| WR\_TAG\_NGH\_INFO\_CFG | INVLD | Configuration of neighbor information. |
| WR\_TAG\_NO\_OF\_GU\_GRP | 1 | Number of MME groups. |
| WR\_TAG\_GU\_GRP\_ID\_CFG | {{0, 1}} | List of MME group IDs to be connected to the eNB. |
| WR\_TAG\_S1\_PREP\_TMR | 100000 | The time to wait for reception of the HandoverCommand message after sending the HandoverRequired from the eNB to the MME. |
| WR\_TAG\_S1\_OVRALL\_TMR | 100000 | The time to wait for the UEContextReleaseCommand message from the MME after the HandoverCommand message from the eNB is received by the MME and handover is complete. |
| WR\_TAG\_MEAS\_CFG\_ENB | 1 | Measurement configuration. |
| WR\_TAG\_RRM\_RNTI\_STRT | 205 | Start RNTI for RRM. |
| WR\_TAG\_MAX\_RRM\_RNTIS | 20 | Maximum RNTIs managed by RRM. |
| WR\_TAG\_MAC\_RNTI\_STRT | 61 | Start RNTI for MAC. |
| WR\_TAG\_MAX\_MAC\_RNTIS | 35 | Maximum RNTIs managed by MAC. |
| WR\_TAG\_RRM\_NO\_OF\_DED\_PREMBL | 10 | Dedicated preambles for RRM. |
| WR\_TAG\_RRM\_DED\_PREMBL\_STRT | 41 | Initial random access preamble ID for RRM. |
| WR\_TAG\_MAC\_NO\_OF\_PREMBL | 6 | Number of non-dedicated preambles. |
| WR\_TAG\_A1\_RSRP\_THRSHLD\_VAL | 90 | Threshold value for the event A1. |
| WR\_TAG\_A2\_RSRP\_THRSHLD\_VAL | 6 | Threshold value for the event A2. |
| WR\_TAG\_INTRA\_A5\_RSRP\_THRSHLD1\_VAL | 65 | Threshold-1 value for event A5 (Intra-frequency). |
| WR\_TAG\_INTRA\_A5\_RSRP\_THRSHLD2\_VAL | 70 | Threshold-2 value for event A5 (Intra-frequency). |
| WR\_TAG\_INTER\_A5\_RSRP\_THRSHLD1\_VAL | 65 | Threshold-1 value for the event A5 (Inter-frequency). |
| WR\_TAG\_INTER\_A5\_RSRP\_THRSHLD2\_VAL | 70 | Threshold-2 value for the event A5 (Inter-frequency). |
| WR\_TAG\_INTRA\_HO\_A3\_OFFSET | 10 | Event A3 offset for HO. Offset value is 10. |
| WR\_TAG\_INTRA\_ANR\_A3\_OFFSET | 5 | Event A3 offset for ANR. Offset value is 5. |
| WR\_TAG\_INTER\_ANR\_A5\_RSRP\_THRSD1\_VAL | 75 | Threshold-1 value for ANR event A5 (Inter-frequency). |
| WR\_TAG\_INTER\_ANR\_A5\_RSRP\_THRSD2\_VAL | 50 | Threshold-2 value for ANR event A5 (Inter-frequency). |
| WR\_TAG\_ANR\_REPORT\_CFG\_VAL | 3 | ANR report configuration.  Valid values are:  0 = No ANR,  1 = Intra-frequency ANR event,  3 = Periodical ANR (default),  4 = Intra- and Inter-frequency ANR event. |
| WR\_TAG\_HO\_REPORT\_CFG\_VAL | 1 | Handover report configuration.  Valid values are:  1 = Event A3,  2 = Event A5. |
| WR\_TAG\_ANR\_EPOC\_TMR\_VAL\_IN\_SECS | 1000 | EPOCH timer values. |
| WR\_TAG\_ANR\_TRICE\_INTV\_COUNT | 10 | TRICE timer value = EPOCH timer value / TRICE interval count. |
| WR\_TAG\_S\_MEASURE\_VAL | 0 | S-Measure value for measurement configuration. |
| WR\_TAG\_INTRA\_TTT\_VAL | 7 | Time to trigger value for event measurement configuration. |
| WR\_TAG\_INTRA\_HYTERISIS | 1 | Hysteresis value for event measurement configuration. |
| WR\_TAG\_NO\_OF\_NGH\_ENB\_CFG | INVLD | Number of neighbor eNodeBs configured. |
| WR\_TAG\_NGH\_ENB\_CFG | INVLD | Neighbor eNodeB configuration. |
| WR\_TAG\_PCI\_VAL | 1 | Physical Cell ID. |
| WR\_TAG\_DL\_NUM\_UE\_PER\_TTI | 1 | Configuring number of UEs per TTI for DL.  Valid values are:  1 = Minimum value (default),  4 = Maximum value. |
| WR\_TAG\_UL\_NUM\_UE\_PER\_TTI | 1 | Configuring number of UEs per TTI for UL.  Valid values are:  1 = Minimum value (default),  4 = Maximum value. |
| WR\_TAG\_MAX\_DL\_NUM\_UE\_PER\_TTI | 1 | Configuring maximum number of UEs per TTI for DL.  Valid values are:  1 = Minimum value (default),  4 = Maximum value. |
| WR\_TAG\_MAX\_UL\_NUM\_UE\_PER\_TTI | 1 | Configuring maximum number of UEs per TTI for UL.  Valid values are:  1 = Minimum value (default),  4 = Maximum value. |
| WR\_TAG\_DL\_SCHD\_TYPE | 2 | Configuring DL Scheduler type:  Valid values are:  1 = PFS,  2 = RR (default). |
| WR\_TAG\_UL\_SCHD\_TYPE | 2 | Configuring UL Scheduler type.  Valid values are:  1 = PFS,  2 = RR (default). |
| WR\_TAG\_DLFS\_SCHD\_TYPE | 1 | Enable/disable DLFSS feature.  Valid values are:  0 = Disable DLFSS,  1 = Enable DLFSS. |
| WR\_TAG\_MAX\_X2\_PEERS | 5 | Maximum number of X2AP peers. |
| WR\_TAG\_X2\_TIME\_TO\_WAIT | 200000 | The Time-to-Wait value included in the X2SetupFailure message sent by the eNB that receives an X2SetupRequest message. |
| WR\_TAG\_SCTP\_SRVC\_TYPE | 0 | SCTP service type.  Valid values are:  0 = SCTP over RAW IP,  1 = SCTP over UDP. |
| WR\_TAG\_DIAG\_TUCL | {{0, 10}} | Enable/disable and log level configuration for TUCL.  Valid values are:  0 = Disable the log,  1 = Enable the log,  10 = Number of levels that must be enabled. |
| WR\_TAG\_DIAG\_S1AP | {{0, 10}} | Enable/disable and log level configuration for S1AP.  Valid values are:  0 = Disable the log,  1 = Enable the log,  10 = Number of levels that must be enabled. |
| WR\_TAG\_DIAG\_EGTP | {{0, 10}} | Enable/disable and log level configuration for eGTP-c.  Valid values are:  0 = Disable the log,  1 = Enable the log,  10 = Number of levels that must be enabled. |
| WR\_TAG\_DIAG\_LTERLC | {{0, 10}} | Enable/disable and log level configuration for LTE RLC.  Valid values are:  0 = Disable the log,  1 = Enable the log,  10 = Number of levels that must be enabled. |
| WR\_TAG\_DIAG\_LTEPDCP | {{0, 10}} | Enable/disable and log level configuration for LTE PDCP.  Valid values are:  0 = Disable the log,  1 = Enable the log,  10 = Number of levels that must be enabled. |
| WR\_TAG\_DIAG\_LTECL | {{0, 10}} | Enable/disable and log level configuration for LTE CL.  Valid values are:  0 = Disable the log,  1 = Enable the log,  10 = Number of levels that must be enabled. |
| WR\_TAG\_DIAG\_LTEMAC | {{0, 10}} | Enable/disable and log level configuration for LTE MAC.  Valid values are:  0 = Disable the log,  1 = Enable the log,  10 = Number of levels that must be enabled. |
| WR\_TAG\_DIAG\_LTEX2AP | {{0, 10}} | Enable/disable and log level configuration for LTE X2AP.  Valid values are:  0 = Disable the log,  1 = Enable the log,  10 = Number of levels that must be enabled. |
| WR\_TAG\_DIAG\_SCTP | {{0, 10}} | Enable/disable and log level configuration for SCTP.  Valid values are:  0 = Disable the log,  1 = Enable the log,  10 = Number of levels that must be enabled. |
| WR\_TAG\_SCTP\_RTO\_MIN | 100 | SCTP RTO minimum value (100). |
| WR\_TAG\_SCTP\_RTO\_MAX | 1000 | SCTP RTO maximum value (1000). |
| WR\_TAG\_SCTP\_RTO\_INITIAL | 200 | SCTP RTO initial value (200). |
| WR\_TAG\_SCTP\_HRTBEAT\_INTERVAL | 5000 | SCTP heartbeat interval value (5000). |
| WR\_TAG\_UL\_ENABLE\_TIME | 1 | PHY logging interval in seconds. This parameter is used to enable logging period for PHY. |
| WR\_TAG\_NUM\_EUTRA\_FREQ | 3 | Number of E-UTRA frequencies. |
| WR\_TAG\_EUTRA\_FREQ\_CFG | {{5230, 23230}, {2600, 20600}, {3100, 21100}} | List of E-UTRA frequency configurations. |
| WR\_TAG\_NUM\_UTRA\_FREQ | 2 | Number of UTRA frequencies. |
| WR\_TAG\_UTRA\_FREQ\_CFG | {{10713, 23230}, {10714, 23231}} | List of UTRA frequency configurations.  Parameter contains list of DL ARFCN, UL ARFCN values. For example:  10713 = DL ARFCN,  23230 = UL ARFCN. |
| WR\_TAG\_NO\_OF\_NGH\_CFG | 2 | Number of target base stations for multi-target preparation during handover. Maximum of four eNBs can be prepared. If the value entered is 1, the multi-target preparation is not executed. |
| WR\_TAG\_NGH\_CELL\_CFG | {{1, 172.27.3.95, 141, 1, 1, 8, 3100, 21100, 0, 1, 0}, {0, 172.27.2.101, 142, 1, 67, 45006, 2600, 20600, 0, 1, 0}} | List of neighbor cell configurations.  The parameter values are:  1 = Home eNB (eNodeB type) or 0 = Macro,  172.27.3.95 = IP address,  141 = Physical Cell Identity,  1 = TAC,  1 = Cell ID,  21901 = PLMN ID,  3100 = DL ARFCN,  1100 = UL ARFCN,  0 = Disabled (is X2 required) or 1 = Enabled,  0 = Start RB,  24 = End RB. |
| WR\_TAG\_NO\_OF\_UTRA\_NGH\_CFG | 2 | Number of UTRA neighbor configurations. |
| WR\_TAG\_NGH\_UTRA\_CELL\_CFG | {{10,70,10713,23230,6,1,21901,145,45},{20,71,10714,23231,10,1,21901,150,50.0}} | List of UTRA cell configurations.  The parameter values are:  10 = RNC ID,  70 = Cell ID,  172.27.2.100 = eNB IP address,  10713 = DL ARFCN,  23230 = UL ARFCN.  0 = RIM support flag, disabled by default, change it to 1 to enable it. |
| WR\_TAG\_NUM\_CDMA\_1XRTT\_BAND\_CLS | 1 | Number of CDMA 1xRTT band classes. |
| WR\_TAG\_CDMA\_1XRTT\_BAND\_CLS | {{1,1,1,1}} | CDMA 1xRTT band class.  The parameter values are: Parameter 1 = Band class,  Parameter 2 = Cell reselector,  Parameter 3 = Maximum threshold value,  Parameter 4 = Minimum threshold value. |
| WR\_TAG\_NUM\_CDMA\_1XRTT\_NEIGH\_FREQ | 1 | Number of neighbor CDMA 1xRTT frequency configurations. |
| WR\_TAG\_CDMA\_1XRTT\_NEIGH\_FREQ | {{1,1000,1}} | Neighbor CDMA 1xRTT frequency configuration.  The parameter values are: Parameter 1 = Band class,  Parameter 2 = ARFCN,  Parameter 3 = Frequency priority. |
| WR\_TAG\_NUM\_CDMA\_1XRTT\_NEIGH\_CELL | 1 | Number of CDMA 1xRTT neighbor cells. |
| WR\_TAG\_CDMA\_1XRTT\_NEIGH\_CELL | {{1,1000,1,1,1}} | Neighbor CDMA 1xRTT cell configuration.  The parameter values are: Parameter 1 = Band class,  Parameter 2 = ARFCN,  Parameter 3 = PN offset,  Parameter 4 = Current rank,  Parameter 5 = Neighbor cell flag. |
| WR\_TAG\_CSFB\_UTRA\_CFG\_VAL | 0 | CSFB to UTRA configuration.  Valid values are:  0 = CSFB to UTRA without Measurement,  1 = CSFB to UTRA with Measurement. |
| WR\_TAG\_CSFB\_CDMA\_CFG\_VAL | 0 | CSFB to CDMA configuration.  Valid values are:  0 = CSFB to 1xRTT without Measurement,  1 = CSFB to 1xRTT with Measurement. |
| WR\_TAG\_ECSFB\_CFG\_VAL | 0 | eCSFB configuration.  Valid values are:  0 = eCSFB not supported,  1 = eCSFB without Measurement,  2 = eCSFB with Measurement. |
| WR\_TAG\_DUAL\_RX\_SUPPORTED | 1 | Enable/disable Dual Rx. |
| WR\_TAG\_AS\_PRI\_INTG\_ALGO\_LST | {1} | Enable/disable Integrity protection on AS Security.  Valid values are:  0 = EIA0,  1 = 128-EIA1 (SNOW3G),  2 = 128-EIA2 (AES). |
| WR\_TAG\_AS\_PRI\_CIPH\_ALGO\_LST | {0} | Enable/disable Ciphering on AS Security.  Valid values are:  0 = EEA0,  1 = 128-EEA1 (SNOW3G),  2 = 128-EEA2 (AES). |
| WR\_TAG\_A3\_OFFSET | -6 | Event A3 offset for eNB.  Valid values are:  -30 = Minimum value,  30 = Maximum value. |
| WR\_TAG\_PICO\_OFFSET | 20 | Cell-specific offset for neighbor eNB  (Q-Offset Range).  Valid values are:  -24db = Minimum value,  24db = Maximum value. |
| WR\_TAG\_ABS\_PATTERN\_TYPE | 2 | ABS subframes pattern type to transmit or mute.  Valid values are:  RGR\_ABS\_TRANSMIT for a pico eNB,  RGR\_ABS\_MUTE for a macro eNB. |
| WR\_TAG\_ABS\_PATTERN | 0101010101010101010101010101010101010101 | ABS pattern type to mute or transmit over 4 subframes. |
| WR\_TAG\_ABS\_LOAD\_PERIODICITY | 0 | Periodicity of ABS pattern negotiation with peer eNodeBs. Value “0” is for OAM mode ABS pattern configuration. |
| WR\_TAG\_SFR\_START\_RB | 25 | Starting PRB of Cell edge bandwidth.  Range: 0 to 99, default is 25. |
| WR\_TAG\_SFR\_END\_RB | 49 | Ending PRB of Cell edge bandwidth.  Range: 0 to 99, default is 49. |
| WR\_TAG\_SFR\_POWER\_LOW | 4 | Power level for cell center UE.  Valid values are:  0 = dB-6,  1 = dB-4dot77,  2 = dB-3,  3 = dB-1dot77,  4 = dB0 (default),  5 = dB1,  6 = dB2,  7 = dB3. |
| WR\_TAG\_SFR\_POWER\_HIGH | 5 | Power level for cell edge UE.  Valid values are:  0 = dB-6,  1 = dB-4dot77,  2 = dB-3,  3 = dB-1dot77,  4 = dB0,  5 = dB1 (default),  6 = dB2,  7 = dB3. |
| WR\_TAG\_DRX\_ENABLED | 1 | Enable/disable DRX feature.  Valid values are:  0 = Disable DRX feature (default),  1 = Enable DRX feature. |
| WR\_TAG\_DRX\_ON\_DURATION\_TMR | 0 – 15 | DRX on duration timer value. psf value is in number of PDCCH sub-frames. Value of psf1 corresponds to 1 PDCCH subframe.  Valid values are:  0 = psf1,  1 = psf2,  2 = psf3,  3 = psf4,  4 = psf5,  5 = psf6,  6 = psf8,  7 = psf10 (default),  8 = psf20,  9 = psf30,  10 = psf40,  11 = psf50,  12 = psf60,  13 = psf80,  14 = psf100,  15 = psf200. |
| WR\_TAG\_DRX\_INACTIVITY\_TMR | 0 – 21 | DRX inactivity timer value. psf value is in number of PDCCH sub-frames. Value of psf1 corresponds to 1 PDCCH subframe.  Valid values are:  0 = psf1,  1 = psf2,  2 = psf3,  3 = psf4,  4 = psf5,  5 = psf6,  6 = psf8,  7 = psf10,  8 = psf20(default),  9 = psf30,  10 = psf40,  11 = psf50,  12 = psf60,  13 = psf80,  14 = psf100,  15 = psf200,  16 = psf300,  17 = psf500,  18 = psf750,  19 = psf1280,  20 = psf1920,  21 = psf2560. |
| WR\_TAG\_DRX\_RETX\_TMR | 0 – 7 | DRX retransmission timer value. psf value is in number of PDCCH sub-frames. Value of psf1 corresponds to 1 PDCCH subframe.  Valid values are:  0 = psf1,  1 = psf2 (default),  2 = psf4,  3 = psf6,  4 = psf8,  5 = psf16,  6 = psf24,  7 = psf33. |
| WR\_TAG\_DRX\_LONG\_CYCLE\_GBR | 5 | DRX long cycle to be configured for an UE with GBR bearers. |
| WR\_TAG\_DRX\_LONG\_CYCLE\_NON\_GBR | 1 | DRX long cycle to be configured for an UE with non-GBR bearers. |
| WR\_TAG\_DRX\_LONG\_CYCLE | 0 – 15 | DRX long cycle value. sf value is in number of subframes. Value of sf10 corresponds to 10 subframes.  Valid values are:  0 = sf10,  1 = sf20,  2 = sf32,  3 = sf40 (default),  4 = sf64,  5 = sf80,  6 = sf128,  7 = sf160,  8 = sf256,  9 = sf320,  10 = sf512  11 = s1f640,  12 = sf1024,  13 = sf1280,  14 = sf2048,  15 = sf2560. |
| WR\_TAG\_ANR\_DRX\_LONG\_CYCLE | 0 – 15 | ANR specific DRX long cycle value (default value is 11, which corresponds to sf640).  Valid values are:  0 = sf10,  1 = sf20,  2 = sf32,  3 = sf40,  4 = sf64,  5 = sf80,  6 = sf128,  7 = sf160,  8 = sf256,  9 = sf320,  10 = sf512,  11 = sf640 (default),  12 = sf1024,  13 = sf1280,  14 = sf2048,  15 = sf2560. |
| WR\_TAG\_DEFAULT\_PAGING\_CYCLE | 0 | Default paging cycle value with range from 0 to 3. |
| WR\_TAG\_DEFAULT\_PCCH\_CFG\_NB | 7 | Default NB value for paging configuration (PCCH\_CFG\_NB) with range from 0 to 7. |
| WR\_TAG\_BANDWIDTH | 10 | LTE bandwidth of 5 MHz, 10 MHz or 20 MHz respectively. |
| WR\_TAG\_BOOT\_MODE | 0 | Boot mode value set to zero for E-UTRAN Test Module (ETM) testing. |
| WR\_TAG\_PRIMETWS\_NO\_BROADCAST | 5 | Primary ETWS broadcasted value in hours. |
| WR\_TAG\_PRIMETWS\_REPETITION\_PERIOD | 10 | Primary ETWS repetition period. |
| WR\_TAG\_WATCHDOG\_SOFT\_LIMIT | 5 | Time period in seconds for the watchdog task to report a problem, if the context is not responding at least this often. |
| WR\_TAG\_WATCHDOG\_HARD\_LIMIT | 15 | Time period in seconds for the watchdog task to stop responding to the hardware watchdog, if the context is not responding at least this often eventually causing the system to reset. |
| WR\_TAG\_LOG\_PATH | /var/log | Path of the log files to be stored. |
| WR\_TAG\_LOG\_FILE | dbglog / stdout | Log file name. If file name is given as “stdout”, log framework prints the logs on console. |
| WR\_TAG\_LOG\_MAX\_FILES | 5 (Maximum) | Maximum number of log files that can be created for storing. |
| WR\_TAG\_LOG\_FILESIZE\_LIMIT | 3 | Maximum file size limit in multiples of MB for each log file. When log file size exceeds the limit, new log file is created. |
| WR\_TAG\_LOG\_LEVEL | 2 | There are 6 log levels. If log level is defined as 3, all logs with log level 1, 2 and 3 are logged in the log file. If log level is 1, the log with level 1 only is logged in the log file. |
| WR\_TAG\_LOG\_MASK | [0]  or  [4,32,16] | Logging for particular module can be enabled by specifying its module name in module mask. Logging for multiple modules can be enabled by giving comma separated module numbers. |
| WR\_TAG\_LOG\_PORT | 9999 | Remote application (post processor) port to connect to the eNB, collect live binary logs and display on console or re-direct to any file. |
| WR\_TAG\_LOG\_REMOTE\_LOGGING | 0,1 | Enable/disable remote logging.  Valid values are:  0 = Disable remote logging,  1 = Enable remote logging. |
| WR\_TAG\_LOG\_CIRBUF\_SIZE | 1024 | Maximum size of circular buffer in multiples of 1 Kb or 1024 bytes. |
| WR\_TAG\_LOG\_COREDUMP\_FLAG | 0,1 | Generate core file or not.  Valid values are:  0 = Generate core file,  1 = Do not generate core file. |
| WR\_TAG\_INT\_FREQ\_MEAS\_GAP | 1 | Inter-frequency measurement gap value. |
| WR\_TAG\_ANR\_MEAS\_GAP\_CONFIG | 1 | ANR measurement gap value. |
| WR\_TAG\_NO\_OF\_EAID\_INFO | 1 | Number of EAIDs. |
| WR\_TAG\_EAID\_LIST\_INFO | {1} | List of EAIDs to be transmitted. |
| WR\_TAG\_RRM\_SR\_PRDCTY | 3 | Index to the SR periodicity to be configured for the SR. Range is 0 to 6. |
| WR\_TAG\_RRM\_CQI\_PRDCTY | 4 | Index to the CQI periodicity to be configured for the CQI. Range is 0 to 9. |
| WR\_TAG\_RRM\_NUM\_SR\_PER\_TTI | 2 | Number of SR resources that can be scheduled per TTI. Range is 0 to 2047. |
| WR\_TAG\_RRM\_NUM\_CQI\_PER\_TTI | 2 | Number of CQI resources that can be scheduled per TTI. Range is 0 to 1176. |
| WR\_TAG\_RRM\_N1\_PUCCH | 6 | Number of resources reserved for N1 PUCCH. Range is 1 to 8. |
| WR\_TAG\_DRX\_QCI\_SUPPORT\_ENABLED | 0 | Enable/Disable Configure DRX QCI.  Valid values are:  0 = Disable DRX QCI (default),  1 = Enable DRX QCI.  If this feature is disabled, DRX is enabled for QCI 1,2,3,4 and vice versa. |
| WR\_TAG\_PWS\_ETWS\_CMAS\_CNTRL | 0,1,2 | PWS control for CMAS and ETWS.  Valid values are:  0 = Disable PWS,  1 = Enable PWS with ETWS,  2 = Enabled PWS with CMAS. |
| WR\_TAG\_SPS\_ENABLE\_FLAG | 0,1 | Enable/Disable SPS feature.  Valid values are:  0 = Disable SPS (default),  1 = Enable SPS.  **Note**: For value other than 1, the SPS feature is disabled. |
| WR\_TAG\_DL\_NUM\_SPS\_UE\_PER\_TTI | 1, WR\_TAG\_DL\_NUM\_UE\_PER\_TTI | Maximum number of downlink SPS UE scheduling (for transmission or retransmission) per TTI.  Valid values are:  Minimum value = 1 (default),  Maximum value = WR\_TAG\_DL\_NUM\_UE\_PER\_TTI.  **Note**: This parameter is considered only if SPS feature is enabled. For invalid value, the value “1” is configured. |
| WR\_TAG\_UL\_NUM\_SPS\_UE\_PER\_TTI | 1, WR\_TAG\_UL\_NUM\_UE\_PER\_TTI | Maximum number of uplink SPS UE scheduling (for transmission or retransmission) per TTI.  Minimum value = 1 (default),  Maximum value = WR\_TAG\_UL\_NUM\_UE\_PER\_TTI.  **Note**: This parameter is considered only if SPS feature is enabled. For invalid value, the value “1” is configured. |
| WR\_TAG\_MAX\_SPS\_RB | 1 to 100 | Maximum resource blocks allocated for SPS.  Default value = 10  **Note**: If invalid value is provided, the value is configured as 50% of the cell resource blocks derived from the cell bandwidth (WR\_TAG\_BANDWIDTH). |
| WR\_TAG\_DSCP\_ENABLE | 0,1 | Enable or disable DSCP feature.  Valid values are:  0 = Disable DSCP (default),  1 = Enable DSCP. |
| WR\_TAG\_QCI\_DSCP\_MAP | {152,120,104,72,180,44,12,4,4} | QCI and DSCP values are mapped as follows:  (QCI,DSCP) = {(1,152),(2,120),(3,104),(4,72),(5,180),(6,44),(7,12),(8,4),(9,4)}  where:  QCI value ranges from 1 to 9 as per 3GPP TS 23.203.  For DSCP, the default values are arrived for using the purpose of each QCI.  **Note**: Each DSCP value is a combination of 8 bits as follows:  Bits 7 to 5 = IP precedence  Bit 4 = Delay  Bit 3 = High / low throughput  Bit 2 = High / normal reliability  Bit 1,0 = Unused  Refer to specifications: IETF RFC 2460, 2474, 2475 and 3GPP TS 23.203. |
| WR\_TAG\_CSG\_CSG\_ID | 1234567 | CSG ID of the cell. The CSG ID of a cell can be 27 bits starting from value 0. |
| WR\_TAG\_CSG\_ACCESS\_MODE | 1,2,3 | Operational mode for the cell.  Valid values are:  1 = Open access mode (default),  2 = Closed access mode,  3 = Hybrid access mode (not supported). |
| WR\_TAG\_CSG\_CSG\_PCI\_START | 1 | Start of closed access mode PCI range. The values can be 0 to 503. The configured serving cell PCI must be within this range for closed access mode. |
| WR\_TAG\_CSG\_CSG\_PCI\_RANGE | 5 | Number of consecutive physical cell identities (including Start PCI) is an enumeration starting from value 0 to 13.  As per 3GPP TS 36.331,  PhysCellIdRange = ENUMERATED {n4, n8, n12, n16, n24, n32, n48, n64, n84, n96, n128, n168, n252, n504, spare2, spare1}.  For example: The PCI range 5 translates to n32 which indicates the number of physical cell identities (32 in this case) in the range (including Start PCI). |
| WR\_TAG\_CSG\_SMCELL\_PCI\_START | 1 | Start PCI value of small cell PCI range. Small cell start PCI value must be configured based on the configured serving cell PCI and CSG PCI start.  **Note**: The CSG PCI range can be a completely distinct set from small cell PCI range or a sub-set of small cell PCI range. But small cell PCI range cannot and must not be configured as a subset of CSG PCI range. |
| WR\_TAG\_CSG\_SMCELL\_PCI\_RANGE | 5 | Range of the consecutive PCI values starting from WR\_TAG\_CSG\_SMCELL\_PCI\_START. Values can range between from 0 to 503.  **Note**: Default value of the parameter is 5 and small cell PCI range is from 1 to 6. |
| WR\_TAG\_CSG\_HENB\_NAME | “RADISYS” | Indicates the HeNB name. |
| WR\_TAG\_CNM\_ENABLE | 0 | Enable or disable Continuous Network Mode **Note**: For PAL, CNM must always be disabled. |
| WR\_TAG\_DCFI\_ENABLE | 0 | Enable or disable the Dynamic CFI feature. |
| WR\_TAG\_CFI | 1 | Default CFI value configured. |
| WR\_TAG\_RIM\_CFG | {86400000, 5000, 5000, 5000, 2} | RIM configuration feature.  Valid values are:  86400000 = RIM overall timer value,  5000 = RIR retransmission timer value,  5000 = RI retransmission timer Value,  5000 = RIAE retransmission timer value,  2 = Maximum retransmission count. |
| WR\_TAG\_NUM\_GERAN\_NEIGH\_FREQ | 4 | Number of GERAN frequencies. |
| WR\_TAG\_GERAN\_NEIGH\_FREQ | {{1,92,2,255}, {2,512,6,255}, {2,800,7,255}, {0,130,3,255}} | Idle mode GERAN neighbor cell information in the order of:  1, 2, 2, 0 = BandIndicator,  92, 512, 800, 130 = BCCHARFCN,  2, 6, 7, 3 = CellReselectionPriority,  255, 255, 255, 255 = ncc-Permitted. |
| WR\_TAG\_GERAN\_NEIGH\_CELL | {{32020,3,4,63,972,1,92,255,0,0}, {32020,3,2,62,971,2,512,255,0,0}, {32020,3,3,61,973,2,800,255,0,0}, {32020,3,5,60,974,0,130,255,0,0}} | Connected mode neighbor cell information in the order of:  32020, 32020, 32020, 32020 = PLMNID,  3, 3, 3, 3 = LAC,  4, 2, 3, 5 = RAC,  63, 62, 61, 60 = BSIC,  972, 971, 973, 974 = CI,  1, 2, 2, 0 = BandIndicator,  92, 512, 800, 130 = BCCHARFCN,  255, 255, 255, 255 = ncc-PermittedMeas,  0, 0, 0, 0 = isDTMCapbility,  0, 0, 0, 0 = isRIMSupported. |
| WR\_TAG\_GERAN\_MEAS\_CFG | {2,1,1,1000, 2500,480} | GERAN measurement related parameters.  Valid values are:  2 = ReportInterval,  1 = isGERANMeasAllowedForCCO,  1 = isCCOAllowed,  1000 = GERANMeasWaitTmr,  2500 = T304expWaitTmrVal,  480 = rrcDatCfmWaitTmr. |
| WR\_TAG\_CELL\_SIZE\_TYPE | 0 | Default value of CellSizeType corresponding to very small for UE History Information. |
| WR\_TAG\_ARP\_EMER\_SERV | 1 | Default value of ARP Emergency Bearer configured for HRL. |
| CFGEND | 1 | End of the configuration file. |

**Note**: For more information about logging tags, refer *TeNB\_Logging\_Framework\_User\_Guide\_1222469.pdf* document.

1. For PAL, edit the **ys\_cfg.txt** file in the **/build** directory.
2. Update only the following IP addresses for demonstration purpose:
   * 1. **YS\_IP\_ADDR\_ENB**: Provide IP address of the server intended to run the eNodeB.
     2. **YS\_IP\_ADDR\_UE**: Provide IP address of the machine intended to run the UeSim.
     3. **YS\_TTI\_TMR\_VAL\_CFG**: Configure the TTI value.

Table-: ys\_cfg.txt Configuration File

|  |  |  |
| --- | --- | --- |
| **Parameters** | **Value** | **Descriptions** |
| YS\_PORT\_ENB | 6789 | eNodeB port |
| YS\_PORT\_UE | 9876 | UE port |
| YS\_IP\_ADDR\_ENB | 127.0.0.1 | eNodeB IP address |
| YS\_IP\_ADDR\_UE | 127.0.0.1 | UeSim IP address towards eNodeB |
| YS\_TTI\_TMR\_VAL\_CFG | 1000000 | TTI value: 1000000 --> 1 ms TTI,  10000000 --> 10 ms TTI |
| WIRESHARK\_SRVR\_IP\_ADDR | 172.27.2.30 | IP address of the machine where Wireshark is intended to run |
| YS\_CELL\_ID | 1 | eNodeB Cell ID |

## Configuration Setting of Video Client

The laptop running video client is assigned a static IP address and have the IP address of UE simulator as its default gateway. Check route information and verify route is created. Use the following command, for example:

* **route add –host <IP address of VC client machine> gw <IP address of UeSim machine> dev eth0**

## Configuration Settings in CNE for Multi-UE Scenario

The configuration settings in CNE required for multi-UE scenario are as follows:

* **AVSM\_PGW\_UE\_NUM** and **AVSM\_PGW\_IP\_NUM** in **avsm\_cfg.txt** file

Change the values to the number of UEs to be supported.

* **VB\_HSS\_MAX\_PDN\_SUB\_CTXT** in **vb\_hss.h** file

Change the value to the number of UEs to be supported.

* **HSS DB UE Entries** in **vb\_hss\_ue.db** file

Add of HSS DB entry for all the UEs with unique IMSI value.

* **VBSM\_UE\_NUM** in **vbsm\_cfg.txt** file

Change the value to number of UEs to be supported.

* **UE\_NUM\_PER\_CELL** in **lteue/ue.h** file

Set value of UE\_NUM\_PER\_CELL same as WR\_MAX\_MAC\_RNTI of **wr\_cfg.txt** file

* **WR\_TAG\_MAX\_UE\_SUPPORT** in **wr\_cfg.txt** file

Set the WR\_TAG\_MAX\_UE\_SUPPORT value more than WR\_MAX\_UE value.

* **QOSM\_MAX\_UE** in **sgw/qosm\_cfg.txt** file

Change the value to maximum number of UEs.

# Execution of the Nodes

This section describes the execution of nodes.

## Radisys CNE

Start the RSYS CNE as follows and run the corresponding binary:

1. MME Emulator (Refer Section 6.1.1 to configure RSYS MME) and run **vb\_acc** binary.
2. SGW Emulator (Refer Section 6.1.2 to configure RSYS SGW) and run **qo\_acc** binary.
3. PGW Emulator (Refer Section 6.1.3 to configure RSYS PGW) and run **av\_acc** binary.

## TeNB

This section describes the execution of the Radisys TeNB software on PAL along with RSYS CNE simulators.

## TeNB without OAM

Execute the following steps to start the demonstration:

1. **On Linux Machine 1, start the Core Network Emulators**:
2. MME Emulator (Refer Section 6.1.1 to configure RSYS MME) and run **vb\_acc** binary.
3. SGW Emulator (Refer Section 6.1.2 to configure RSYS SGW) and run **qo\_acc** binary.
4. PGW Emulator (Refer Section 6.1.3 to configure RSYS PGW) and run **av\_acc** binary.

**Note**: For third party CNEs, start the CNE as per respective command.

1. **TeNB on PAL:**

Copy the packages (**enodeb**, **wr\_cfg.txt** and **ys\_cfg.txt**) to the **/root/** directory in the Linux machine.

* 1. Execute the following command in **/root/** directory and convert the binaries to executable mode:
     + - **chmod +x enodeb**
  2. Execute the following command to boot the eNodeB:
     + - **./enodeb**

eNodeB console prints **TTI indication** on successful **enodeb** binary execution.

**Note**: The order to follow is: start the CNEs, run eNodeB, and attach UE to bring up the setup.

### TeNB with OAM

Execute the following steps to start the demonstration:

1. **On Linux Machine 1, start the Core Network Emulators**:
2. MME Emulator (Refer Section 6.1.1 to configure RSYS MME) and run **vb\_acc** binary.
3. SGW Emulator (Refer Section 6.1.2 to configure RSYS SGW) and run **qo\_acc** binary.
4. PGW Emulator (Refer Section 6.1.3 to configure RSYS PGW) and run **av\_acc** binary.

**Note**: For third party CNEs, start the CNE as per respective command.

1. **TeNB on Linux machine:**

The startup script (**start\_TeNB)** executes OAM components and eNodeB. Before starting the script, appropriate configuration must be provided in the **configFile** (refer Table 13) placed at the following path.

* **<path>/rsys/configFile**

Go to the following path and execute the **start\_TeNB** script:

* **cd <path>/rsys/**
* **. ./start\_TeNB**

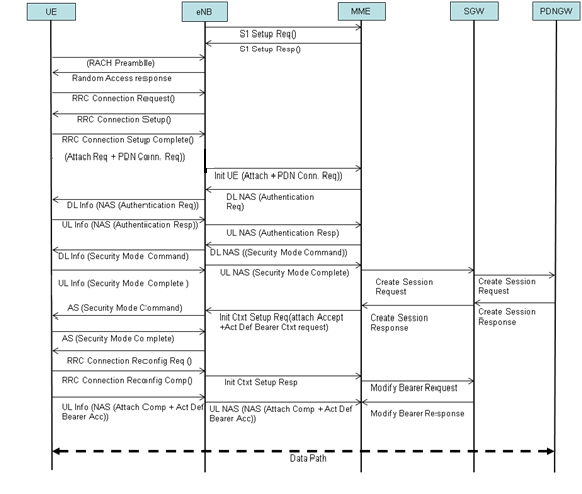
Table : configFile Configuration File

|  |  |  |
| --- | --- | --- |
| **Parameters** | **Value** | **Descriptions** |
| OAM\_CONFIG\_FILES\_DIR | ../setup | Path of TeNB setup |
| OAM\_LOGGING\_DIR | /root/OAM/setup/trace | Path of logging directory |
| OAM\_ETHERNET\_INTERFACE | eth0 | OAM interface |
| STRONGSWAN\_INSTALL\_DIR | /tmp/strongswan | Path for Strongswan installed directory and related libraries |
| STRONGSWAN\_LEFTCERT\_FILENAME | carolcert.pem | Strongswan Certificate file name |
| STRONGSWAN\_LEFT\_ID | radisys.smallcell-forum.org | Strongswan leftid configuration |
| MANAGEMENT\_PASSWORD | Cpe | HeMS User Password |
| MANAGEMENT\_SERVER | <http://172.27.4.244:80/cpe.php> | HeMS URL |
| MANAGEMENT\_USERNAME | Cpe | HeMS User Name |
| LTE\_SIGLINK\_SERVER\_LIST | "172.27.2.52" | IP address of server intended to run MME |
| LTE\_DUPLEX\_MODE | TDDMode | Duplex mode: TDDMode or FDDMode |
| LTE\_BANDS\_SUPPORTED | 40 | Supported bands |
| LTE\_FREQ\_BAND\_INDICATOR | 40 | Serving band indicator |
| LTE\_DL\_EARFCN | 39150 | DL-EARFCN value |
| LTE\_UL\_EARFCN | 39150 | UL-EARFCN value |
| LTE\_RRM\_SR\_PRDCTY | 4 | Index to the SR periodicity to be configured for the SR.  Range is 0 to 6. |
| LTE\_RRM\_CQI\_PRDCTY | 5 | Index to the CQI periodicity to be configured for the CQI.  Range is 0 to 9. |
| LTE\_RRM\_NUM\_SR\_PER\_TTI | 8 | Number of SR resources that can be scheduled per TTI.  Range is 0 to 2047 |
| LTE\_RRM\_NUM\_CQI\_PER\_TTI | 8 | Number of CQI resources that can be scheduled per TTI.  Range is 0 to 1176. |
| tr69.addobject | Device.Services.FAPService.1.CellConfig.LTE.EPC.PLMNList | Command to add object from OAM CLI |
| LTE\_EPC\_PLMN\_ENABLE | 1 FAP.0.LTE\_CELL\_PLMN\_LIST.0 | PLMN configured for this index 0 |
| LTE\_OAM\_PRIMARY\_PLMN | 1 FAP.0.LTE\_CELL\_PLMN\_LIST.0 | PLMN Primary on this index 0 |
| LTE\_OAM\_PLMNID | 22020 FAP.0.LTE\_CELL\_PLMN\_LIST.0 | Serving PLMN set as “22020”. |
| LTE\_SON\_EARFCNUL\_LIST | 39150 | List of EARFCNs from which SON selects the serving UL-EARFCN. To set multiple EARFCN, assign values as “39150”,”38000”,”39250” |
| LTE\_SON\_EARFCNDL\_LIST | 39150 | List of EARFCNs from which SON selects the serving DL-EARFCN. To set multiple EARFCNs, assign values as “39150”,”38000”,”39250” |
| LTE\_FAP\_ADMIN\_STATE | 0 | Admin State |

# End-to-End Call Flow (Message Sequence Chart)

**The call flow for S1 setup and valid UE Attach with default bearer establishment is illustrated in Figure-4.**

**Figure-4: LTE Control and Data Call Flow**



**Figure-5: Message Sequence Flow between UE and CNE through eNodeB**



Figure-6: LTE Control and Data Call Flow using Dedicated Bearer

**S1 Setup and Valid UE Attach with Default and Dedicated Bearer Establishment**

UE

eNB

MME

SGW

PDNGW

RACH Procedure

RRC Connection Request ()

RRC Connection Setup ()

RRC Connection Setup Comp. (NAS PDU: Attach Req + PDN Conn. Req)

Init UE (NAS PDU)

DL NAS (Authentication Req)

DL Info (NAS: Authentication Req)

UL Info (NAS: Authentication Rsp)

UL NAS (Authentication Rsp)

DL NAS (Security Mode Command)

DL Info (NAS: Security Mode Command)

UL Info (NAS: Security Mode

Complete)

UL NAS (Security Mode Complete)

Init Ctxt Setup Req (NAS: Attach Acc + Activate Def. Bearer Context)

AS (Security Mode Command)

AS (Security Mode Complete)

RRC Connection Reconfig Req + NAS PDU (Attach Acc + Act Def Bearer Ctxt)

RRC Connection Reconfig Comp()

UL Info (NAS: Attach Comp + Act Def Bearer Acc)

Init Ctxt Setup Rsp()

UL NAS (Attach Comp + Act Def Bearer Acc.)

Create Session Req.

Create Session Rsp.

Create Session Rsp

Modify Bearer Req.

Modify Bearer Rsp.

Create Bearer Rsp

Create Bearer Rsp

UL Info (NAS: Bearer

Resource Alloc Req)

Create Session Req.

UL NAS (NAS: Bearer Resource

Alloc Req)

Bearer Resource Command

Bearer Resource Command

Create Bearer Req

Create Bearer Req

UL Info (NAS:   
Act Ded bearer Acc)

UL NAS: Activate Ded Bearer Acc

E-RAB Setup Req (NAS: Activate Ded Bearer Req)

E-RAB Setup Response

RRC Connection Reconfig Req

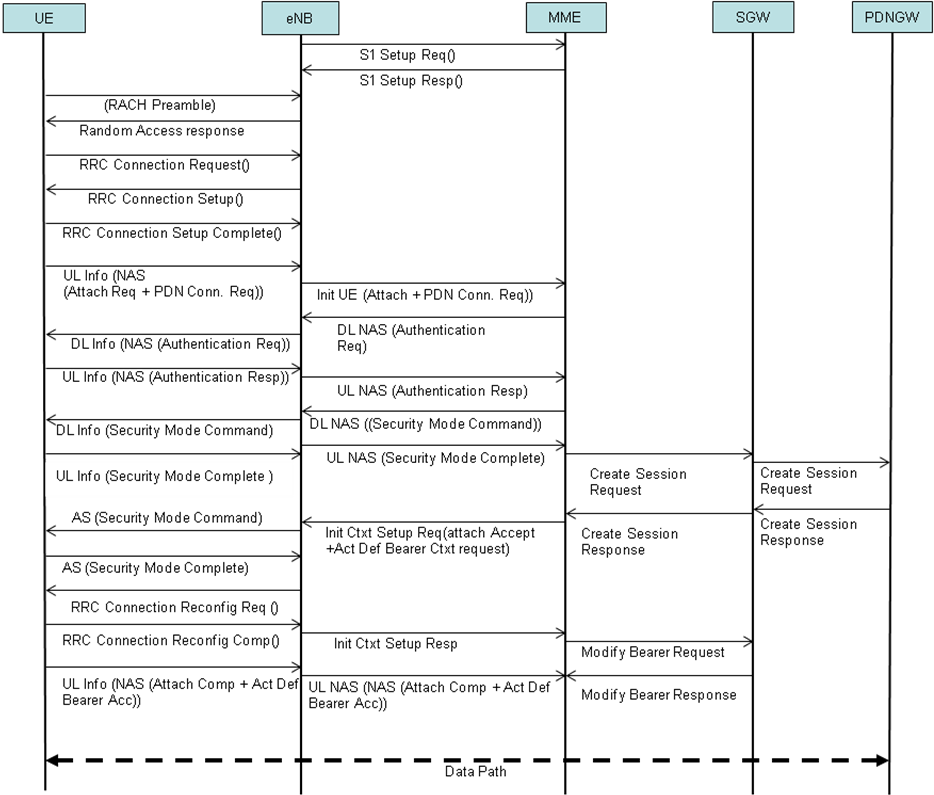
(Act Ded. Bearer Ctxt)

RRC Connection Reconfig Comp()

S1 SetupReq ()

S1 Setup Rsp ()

Figure-7: Mobile Terminating Call Sequence - Flow 1



**Figure-8: Mobile Terminating Call Sequence - Flow 2**

**UE**

**eNB**

**MME**

**SGW**

**PDNGW**

Inactivity Timer Expiry

S1 UE Context Release Request

Modify Bearer Request (Release of eNB S1-U resources)

Modify Bearer Response

S1 UE Context Release Command

RRC Connection Release

S1 UE Context Release Complete

ECM\_IDLE

Downlink Data

Downlink Data Notification

Paging

Paging

RACH and RRC

Connection Est

Buffer Data

Downlink Data

Notification Ack

**Figure-9: Mobile Terminating Call Sequence - Flow 3**

**UE**

**eNB**

**MME**

**SGW**

**PDNGW**

RRC Conn Est Setup complete

+ NAS Service Request

NAS Common Procedures

Modify Bearer Request

Modify Bearer Response

RRC Conn ReCfg

ECM\_CONNECTED

**DATA TRANSFER**

S1 Initial UE Msg

(NAS Service Request)

Initial Context Setup

Request (SGW S1 IP/TEID)

Initial Context Setup

Response (eNB S1 IP/TEID)

# Traffic Generators

The performance testing for different scenarios is done using special commands as follows.

## UDP Performance Testing

Execute the following commands to collect the UDP performance data.

### Uplink Data

External Server side:

**iperf -s -u -i 1 -p 5000 –B <External Server IP address>**

For example: iperf -s -u -i 1 -p 5000 –B 172.26.10.211

UE Client side:

**iperf -c <External Server IP address> -B <UE Client IP address> -u -i 1 -t 1000 -p 5000 -b 19m**

For example: iperf -c 172.26.10.211 -B 172.26.10.xxx -u -i 1 -t 1000 -p 5000 -b 19m

### Downlink Data

UE Client side:

**iperf -s -u -i 1 -p 9999 -B <UE Client IP address>**

For example: iperf -s -u -i 1 -p 9999 -B 172.26.10.xxx

External Server side:

**iperf -c <UE Client IP address> -B <External Server IP address> -u -i 1 -t 1000 -p 9999 -b 23m**

For example: iperf -c 172.26.10.xxx -B 172.26.10.211 -u -i 1 -t 1000 -p 9999 -b 23m

## TCP Performance Testing

To collect the TCP performance data, execute the following commands.

### 9.2.1 Uplink Data

External Server side:

**iperf -s –w 128K -i 1 -p 5000 –B <External Server IP address>**

For example: iperf -s –w 128K -i 1 -p 5000 –B 172.26.10.211

UE Client side:

**iperf -c <External Server IP address> -B <UE Client IP address> -i 1 -t 1000 -p 5000 –w 128K**

For example: iperf -c 172.26.10.211 -B 172.26.10.xxx -i 1 -t 1000 -p 5000 –w 128K

### Downlink Data

UE Client side:

**iperf -s –w 512K -i 1 -p 9999 -B <UE Client IP address>**

For example: iperf -s –w 512K -i 1 -p 9999 -B 172.26.10.xxx

External Server side:

**iperf -c <UE Client IP address> -B <External Server IP address> -i 1 -t 1000 -p 9999 –w 512K**

For example: iperf -c 172.26.10.xxx -B 172.26.10.211 -i 1 -t 1000 -p 9999 –w 512K

# Performance Management

Any evaluation of HeNB system behavior requires performance data collected and recorded for inspection. TeNB collects and records performance data according to a schedule established by the HeMS. This aspect of the management environment is termed as Performance Management (PM).

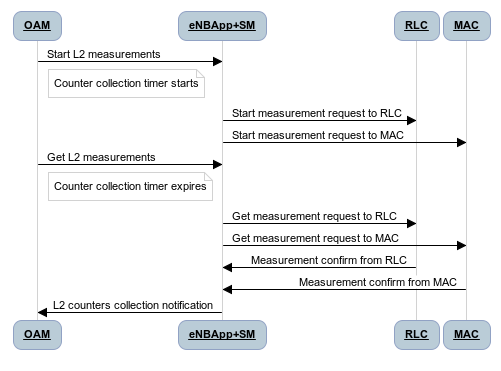
## L2 Layer Measurement Counters

The L2 counters are defined in the 3GPP TS 36314-910 and TS 32425-990. Currently, four measurement counters are implemented.

* RLC Downlink Throughput
* RLC Uplink Throughput
* PDCP SDU Discard Rate
* MAC RACH Counters

The DL throughput and UL throughput is reported per UE per QCI while the Discard rate is reported per QCI by the L2 layers. Each L2 layer (currently RLC and MAC) has its own interface APIs to Start, Report (Get) and Stop L2 Measurement.

**Figure-10: L2 Layer Measurement Counters**



1. The OAM sends the Start L2 Measurement to the eNBApp+SM, which contains the counters that are required from the L2 layers.
2. The SM configures the related layers with the measurements, namely, DL/UL throughput; discard rate is configured at RLC, and MACH RACH counters are configured at MAC.
3. These measurements are periodically fetched from the respective layers by sending Get/Send L2 measurement.
4. In response, each layer sends the measurement confirm with the calculated measurements. After sending the measurements, each layer resets all the measurement related counters and starts them again.
5. A L2 counters collection notification is sent to OAM.

# Troubleshooting

This section describes the solution for the common problems that are seen while executing the demo:

1. Messages exchange between CNE or eNodeB fails:
   1. MME and eNodeB must run from root mode, since SCTP uses RAW sockets. If root access is not available then run SCTP over UDP sockets. For information on how to configure UDP sockets, contact [trillium-support@radisys.com](mailto:trillium-support@radisys.com)
   2. PGW must run with root privilege, since it uses PCAP library to communicate with external network [Video Server].
   3. Verify that the right IP addresses are provided in **wr\_cfg.txt** and **vbsm\_cfg.txt** files.
   4. Verify correct IP address is provided in **configFile** if used with OAM.
   5. Verify platform and server running CNEs are reachable on Ethernet interface. Try PING command from both the sides to receive reply.
2. Failed to bring up binaries:
   1. Verify **vbsm\_cfg.txt** configuration file and **vb\_hss\_ue.db** database file is present with MME binary.
   2. Verify **qosm\_cfg.txt** configuration file is present with SGW binary.
   3. Verify **avsm\_cfg.txt** configuration file is present with PGW binary.
   4. Verify **wr\_cfg.txt** and **ys\_cfg.txt** configuration are files present with eNodeB binary.
   5. Verify **configFile** configurations if used with OAM.
3. Check-points for End-to-End PAL setup:
   1. Verify that **ys\_cfg.txt** file of both UeSim and eNodeB have loopback address on a single PC setup as shown in Section 6.3.1.
   2. When UeSim and eNodeB are running on different machines, verify that UeSim IP address mentioned in **ys\_cfg.txt** is of the interface which is connected to switch and not the one which is communicating with the VC.
   3. Verify VC is reachable from UeSim, if not add route for the same as mentioned in Section 6.3.
   4. SCTP UDP service type must be same at eNodeB and MME configuration file. The parameters to verify are: VBSM\_SCTP\_UDP\_SERV\_TYPE (for eNodeB) and WR\_TAG\_SCTP\_SRVC\_TYPE (for MME).
   5. SB\_CHECKSUM and SB\_CHECKSUM\_CRC flags must be defined or undefined, both at eNodeB and MME side.
   6. All the nodes must be in the same network.

# References

Refer to the following documents for additional information.

1. TeNB\_PAL\_FDD\_Release\_Notes\_1225610.pdf
2. TeNB\_Solution\_Functional\_Specification\_1091606.pdf
3. TeNB\_Logging\_Framework\_User\_Guide\_1222469.pdf.
4. TeNB\_OAM\_User\_Guide\_1222464.pdf
5. TeNB\_OAM\_Integration\_Guide\_1555464.pdf



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