

ATTACHMENT E.

- USER MANUAL -

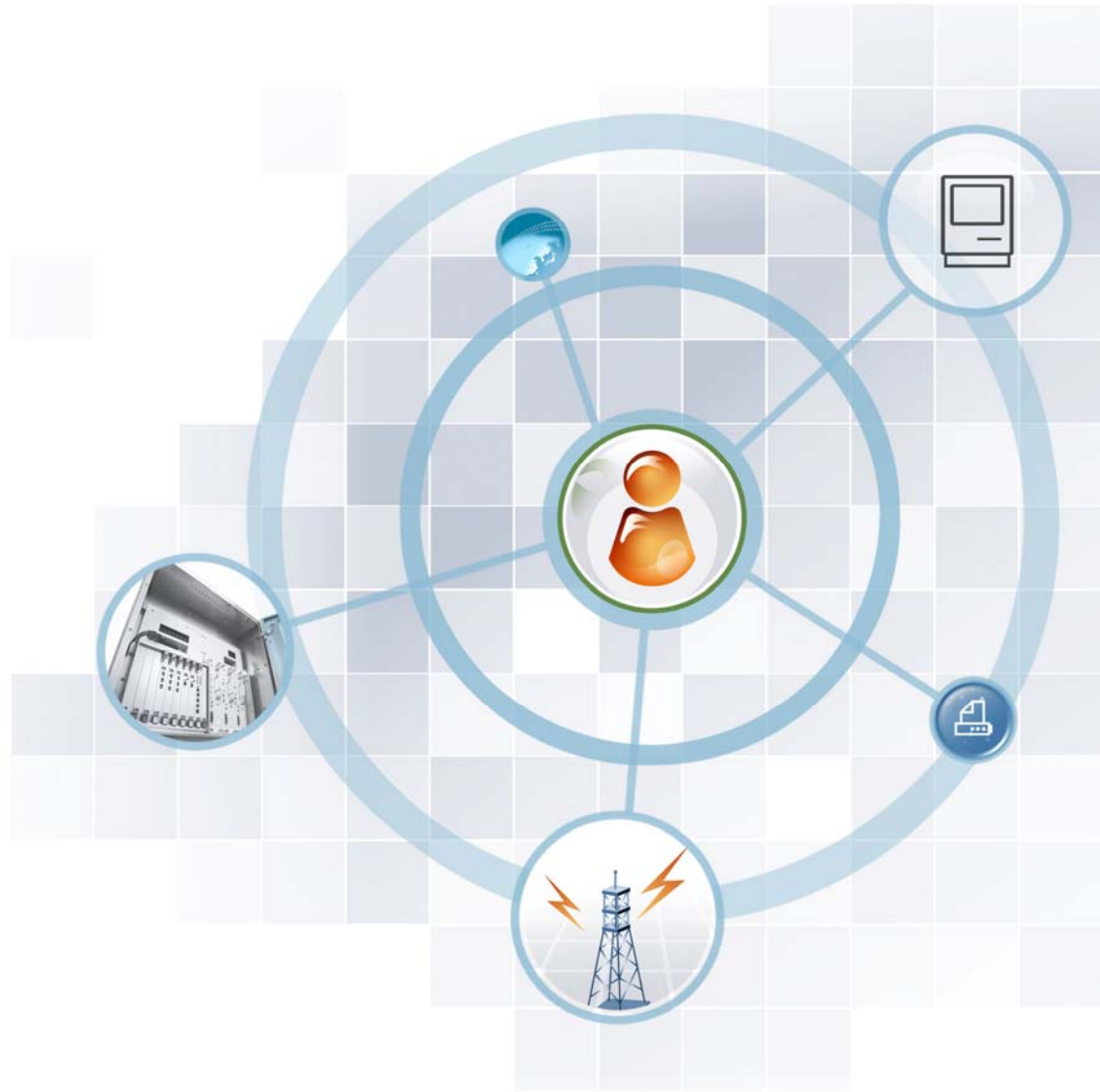
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Ed. 00

MetroPCS

User Manual



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INTRODUCTION

Purpose

This document introduces evolved NodeB (eNB) system of the Samsung Electronics and describes its architecture and functions.

Document Content and Organization

This document consists of five Chapters, Abbreviation.

CHAPTER 1. Overview of LTE Network

- Introduction to LTE Network
- Interface between Systems

CHAPTER 2. Overview of LTE eNB

- Introduction to LTE eNB
- Main Functions
- Specifications

CHAPTER 3. System Architecture

- Hardware Structure
- Software Structure

CHAPTER 4. Message Flow

- Attach Procedure
- Service Request Procedure
- Detach Procedure
- Intra E-UTRAN Handover Procedure
- Network Synchronization Signal Flow

- Alarm and Reset Signal Flow
- Loading Flow
- Operation and Maintenance Signal Flow

CHAPTER 5. Additional Functions and Tools

Command Line Interface (CLI)

ABBREVIATION

Describes the acronyms used in this description.

Revision History

EDITION	DATE OF ISSUE	REMARKS
00	03. 2010.	First Edition

TABLE OF CONTENTS

INTRODUCTION	I
Purpose	I
Document Content and Organization.....	I
Revision History.....	II
CHAPTER 1. Overview of LTE Network	1-1
1.1 Introduction to LTE network	1-1
1.2 Interface between Systems	1-5
1.2.1 LTE Network Interface	1-5
1.2.2 Interface protocol	1-6
CHAPTER 2. Overview of LTE eNB	2-1
2.1 Introduction to LTE eNB	2-1
2.2 Main Functions	2-2
2.3 Specifications	2-4
CHAPTER 3. System Architecture	3-1
3.1 Hardware Structure	3-1
3.1.1 Digital Unit (L9DU).....	3-2
3.1.2 Radio Unit	3-5
3.1.3 Cooling Architecture.....	3-8
3.1.4 Environment Sensors	3-9
3.2 Software Structure	3-10
3.2.1 Operating System (OS)	3-10
3.2.2 Network Processing Software (NP SW).....	3-10
3.2.3 Device Driver (DD).....	3-11
3.2.4 Middleware (MW).....	3-11
3.2.5 IP Routing Subsystem (IPRS)	3-11
3.2.6 Call Processing Software (CPS)	3-11
3.2.7 Operation and Maintenance (OAM)	3-13

CHAPTER 4. Message Flow	4-1
4.1 Attach Procedure.....	4-1
4.2 Service Request Procedure.....	4-5
4.3 Detach Procedure.....	4-9
4.4 Intra E-UTRAN Handover Procedure	4-12
4.5 Network Synchronization Signal Flow.....	4-18
4.6 Alarm and Reset Signal Flow	4-19
4.7 Loading Flow	4-20
4.8 Operation and Maintenance Signal Flow.....	4-21
CHAPTER 5. Additional Functions and Tools	5-1

ABBREVIATION	I
3	I
A ~ E	I
F ~ L	II
M ~ S	III
T ~ W	IV

LIST OF FIGURES

Figure 1.1	LTE Network Configuration	1-1
Figure 1.2	LTE Network Interface.....	1-5
Figure 1.3	User plane protocol stack between eNB and UE.....	1-6
Figure 1.4	Control plane protocol stack between eNB and UE.....	1-7
Figure 1.5	User plane protocol stack between eNB and S-GW.....	1-7
Figure 1.6	Control plane protocol stack between eNB and MME	1-8
Figure 1.7	User plane protocol stack between eNBs.....	1-8
Figure 1.8	Control plane protocol stack between eNBs.....	1-9
Figure 1.9	Protocol stack between eNB and LSM	1-9
Figure 1.10	Protocol stack between eNB and LSS.....	1-10
Figure 3.1	Rack Configuration of Macro Outdoor Cabinet.....	3-1
Figure 3.2	Internal Configuration of Macro Outdoor Cabinet	3-2
Figure 3.3	RF Configuration for Antenna Sharing.....	3-7
Figure 3.4	Configuration of FANs	3-8
Figure 3.5	Configuration of Environment Sensors.....	3-9
Figure 3.6	Software Structure.....	3-10
Figure 3.7	OAM Block	3-13
Figure 4.1	Attach procedure	4-2
Figure 4.2	UE triggered Service Request procedure.....	4-6
Figure 4.3	Network triggered Service Request procedure.....	4-8
Figure 4.4	UE initiated Detach procedure.....	4-9
Figure 4.5	MME initiated Detach procedure	4-11
Figure 4.6	X2 based handover procedure	4-12
Figure 4.7	S1 based handover procedure	4-15
Figure 4.8	DU Synchronization Signal Flow	4-18
Figure 4.9	RU Synchronization Signal Flow	4-18
Figure 4.10	Alarm and Reset Signal Flow	4-19
Figure 4.11	Loading Flow	4-20
Figure 4.12	Operation/Maintenance Signal Flow.....	4-21
Figure 5.1	Connecting to the CLI.....	5-1



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CHAPTER 1. Overview of LTE Network

1.1 Introduction to LTE network

3GPP Long Term Evolution (LTE) network is composed of E-UTRAN NodeB (eNB), LTE System Manager (LSM) and Evolved Packet Core (EPC). LTE network is the subnet of Packet Data Network (PDN) and enables User Equipments (UE) to interwork with IP network.

The following diagram shows the composition of 3GPP LTE network.

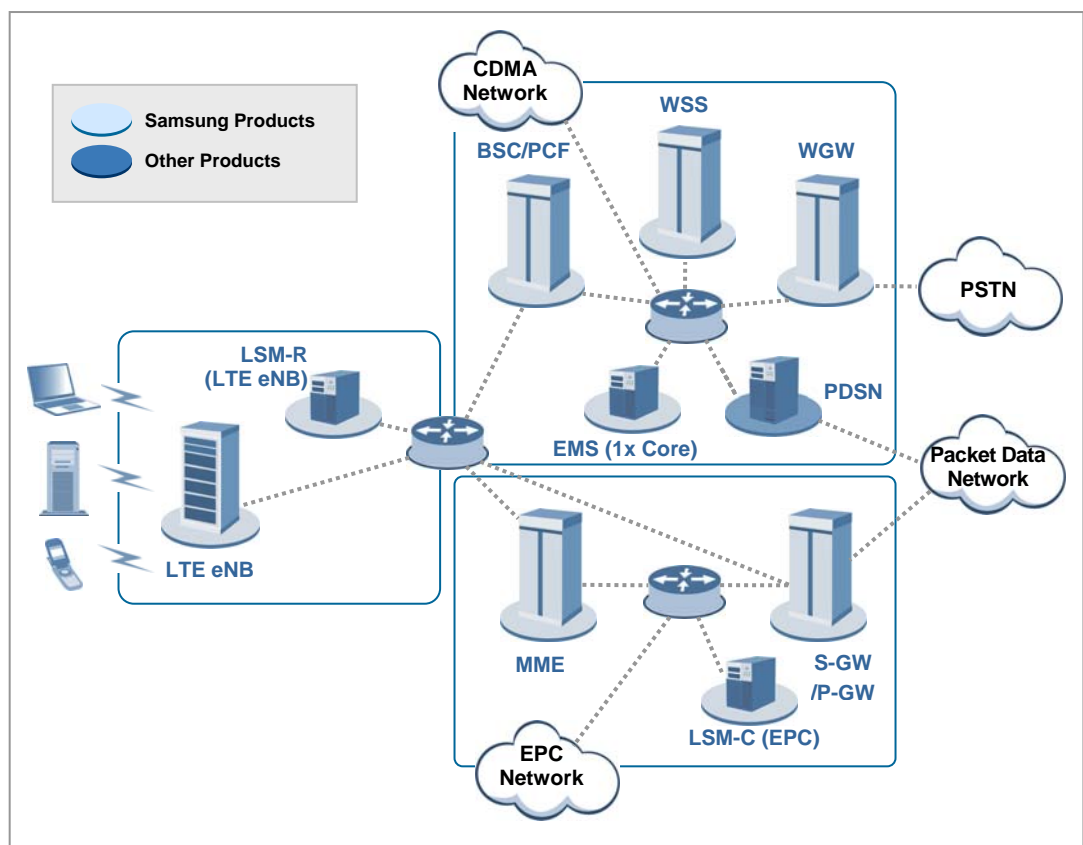


Figure 1.1 LTE Network Configuration

Evolved UTRAN Node-B (eNB)

The eNB is located between the UE and EPC. It processes packet calls by connecting to the UE wirelessly according to the LTE Air standard. The eNB performs functionalities such as transmission and receipt of wireless signals, modulation and demodulation of packet traffic signals, packet scheduling for efficient utilization of wireless resources, Hybrid Automatic Repeat Request (HARQ)/ARQ processing, Packet Data Convergence Protocol (PDCP) for packet header compression, and wireless resources control. Moreover, it performs handover interoperating with the EPC.

Evolved Packet Core (EPC)

The EPC succeeds to the 3GPP Release 7 packet-switched core network and consists of Mobility Management Entity (MME), Serving GW (S-GW), and PDN GW (P-GW). The MME performs MS mobility management and session management, Mobile Station (MS) authentication, and HO control. The MME also processes the control plane through interoperation between eNB and MME, UE and MME, Serving General Packet Radio Service (GPRS) Support Node (SGSN) and MME, MME and MME, MME and SGW, MME, Home Subscriber Server (HSS) and Equipment Identity Register (EIR). The S-GW/P-GW processes the user plane.

It processes routing and forwarding the user data between the UE and the PDN network. The P-GW performs the gateway function to the PDN network, interoperation with non-3GPP network, and address allocation for the UE.

Mobility Management Entity (MME)

The MME processes the control functions for the control plane, such as call connection control and mobility management, tracking area list management, bearer and session management by processing NAS signaling with the MS and S1 Application Protocol (S1-AP) signaling with the eNB.

The control functions for the control plane that the MME processes are given below.

- Non Access Stratum (NAS) signaling
- NAS signaling security
- Inter Core Network (CN) node signaling for mobility between 3GPP access networks
- UE Reachability in ECM-IDLE state (including control and execution of paging retransmission)
- Tracking Area list management
- PDN GW and Serving GW selection
- MME selection for handovers with MME change
- SGSN selection for handovers to 2G or 3G/3GPP access networks
- Roaming (S6a towards home HSS)
- Authentication
- Bearer management functions including dedicated bearer establishment
- Lawful Interception

Serving Gateway (S-GW)

The S-GW performs the mobility anchor function within the LTE system and between LTE and 3GPP access system, and processes transmission of downlink/uplink packet data. The S-GW supports GPRS Tunneling Protocol (GTP) and Proxy Mobile IP (PMIP) protocols for signaling processing with MME, P-GW, and SGSN.

PDN Gateway (P-GW)

The P-GW allocates an IP address to UE and, for mobility between the LTE system and non-3GPP access system, provides the anchor function and the packet filtering function for each subscriber. In addition, it handles accounting and bearer policy in accordance with the policy interoperating with the Policy Charging & Rule Function (PCRF), and provides the accounting function, the transmission rate management and change functions that depend on the service level.

LTE System Manager (LSM)

The LSM provides the interface for the operator, and the software management, configuration management, performance management, and error management functions so that s/he can operate and maintain eNB/EPC. The LTE System Manager-Core (LSM-C) performs the operating management function for EPC (MME, S-GW, P-GW). The LTE System Manager-Radio (LSM-R) performs the operating management function for eNB, and also the SON server (LTE SON server, LSS) function.

Home Subscriber Server (HSS)

The HSS is a database management system that stores and manages the parameters and location information for all registered mobile subscribers. The HSS manages key data such as the mobile subscriber's access capability, basic services and supplementary services, and provides a routing function to the subscribed receivers.

Policy Charging & Rule Function (PCRF)

The PCRF creates policy rules to dynamically apply the QoS and accounting policies differentiated by service flow, or creates the policy rules that can be applied commonly to multiple service flows. Since the IP edge contains the Policy and Charging Enforcement Function (PCEF), it can apply the policy rules transmitted from PCRF to each service flow.

Authorization, Authentication and Accounting (AAA)

The AAA is a system providing authentication and authorization functions to the packet data service subscribers. The AAA server also provides a billing function based on service usage.

Charging Gateway Functionality (CGF)

The accounting data generated from the PCEF is stored in the CGF and is provided for each subscriber.

Online Charging System (OCS)

When a subscriber for whom online information is required makes a call, the PCEF sends and receives his accounting information in interoperation with the OCS.

Domain Name Service (DNS)

The DNS manages mapping between domain names and IP addresses. When an MS requests, it notifies the IP address of the requested domain.

Dynamic Host Configuration Protocol (DHCP)

The DHCP server is an auxiliary device for providing packet services. It manages and assigns IP addresses.

1.2 Interface between Systems

1.2.1 LTE Network Interface

The figure below shows LTE network interface.

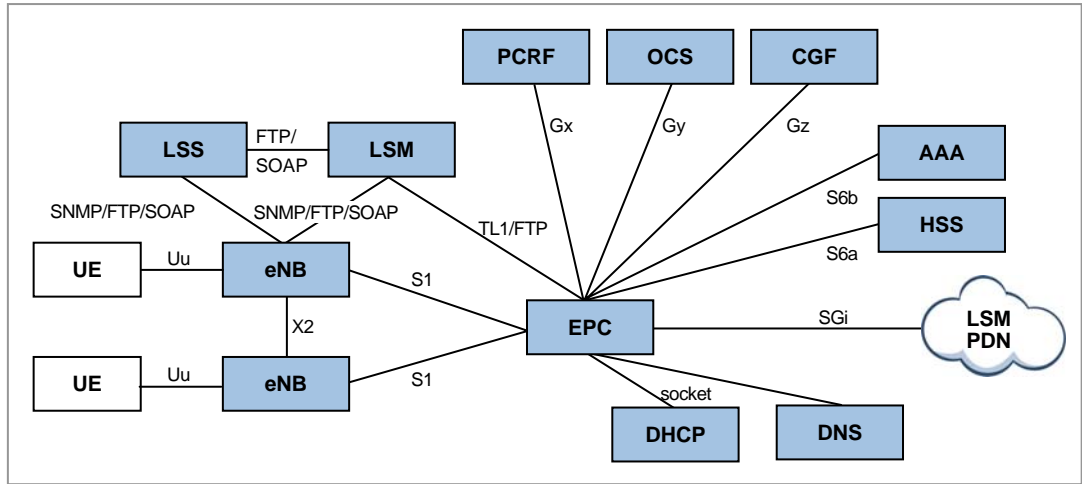


Figure 1.2 LTE Network Interface

AAA: Authentication, Authorization and Accounting	CGF: Charging Gateway Function
DHCP: Dynamic Host Configuration Protocol	DNS: Domain Name System
eNB: E-UTRAN NodeB	LSM: LTE System Manager
EPC: Evolved Packet Core	HSS: Home Subscriber Server
OCS: Online Charging System	PCRF: Policy and Charging Rule Function
PDN: Packet Data Network	UE: User Equipment
FTP: File Transfer Protocol	SOAP: Simple Object Access Protocol
SNMP: Simple Network Management Protocol	TL1: Transaction Language 1

The interfaces between LTE system components are depicted below.

Interfaces	Interface Specifications
UE/eNB	- Physical Interface: LTE PHY OFDMA/SC-FDMA - Interface protocol: LTE Uu Interface
eNB/EPC	- Physical Interface: FE/GE - Interface protocol: LTE S1 Interface (S1-MME, S1-U)
eNB/eNB	- Physical Interface: FE/GE - Interface protocol: LTE X2 Interface
eNB/LSM	- Physical Interface: FE/GE - Interface protocol: SNMP/FTP/SOAP

(Continued)

Interfaces	Interface Specifications
EPC/LSM	- Physical Interface: FE/GE - Interface protocol: TL1/FTP
eNB/LSS	- Physical Interface: FE/GE - Interface protocol: SNMP/FTP
LSS/LSM	- Physical Interface: FE/GE - Interface protocol: RMI/SOAP
EPC/PCRF	- Physical Interface: FE/GE - Interface protocol: Gx Interface
EPC/DHCP Server	- Physical Interface: FE/GE - Interface protocol: socket communication

1.2.2 Interface protocol

These are interface protocols between components.

Interface between eNB and UE

This shows the user plane protocol stack for interface between eNB and UE.

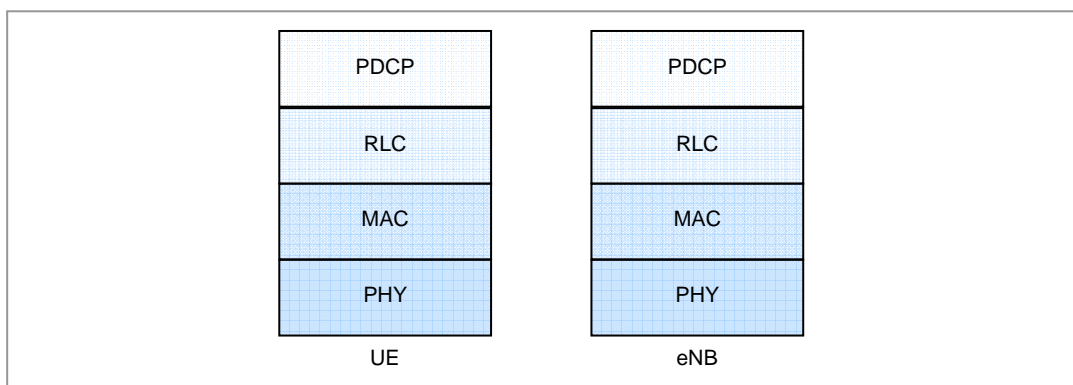


Figure 1.3 User plane protocol stack between eNB and UE

The user plane protocol stack between eNB and UE is used for transmission of the IP packet, consisted of packet data convergence protocol (PDCP) sublayer, Radio Link Control (RLC) sublayer, Medium Access Control (MAC) sublayer and physical layer.

This shows the control plane protocol stack for interface between eNB and UE.

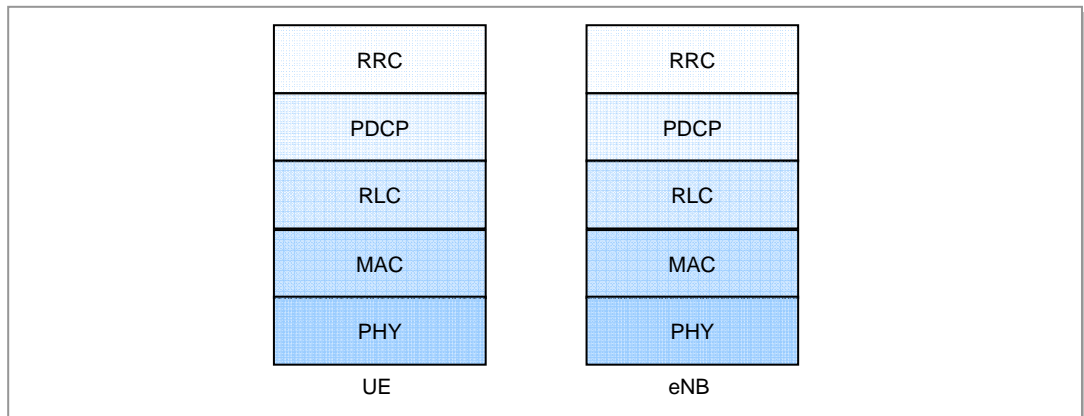


Figure 1.4 Control plane protocol stack between eNB and UE

The control plane protocol stack between eNB and UE is used for transmission the control signal, consisted of Radio Resource Control (RRC), PDCP sublayer, RLC sublayer, MAC sublayer and physical layer.

Interface between eNB and S-GW

This shows the user plane protocol stack for interface between eNB and Serving Gateway (S-GW).

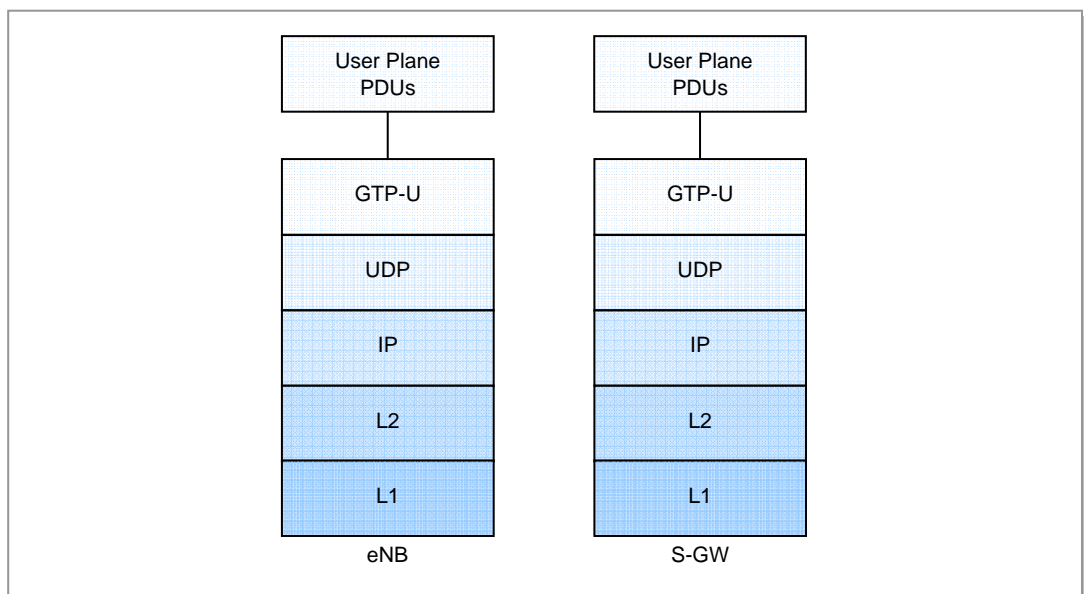


Figure 1.5 User plane protocol stack between eNB and S-GW

The user plane protocol stack between eNB and S-GW is used for transmission of Protocol Data Unit (PDU)s of user plane, consisted of GPRS Tunneling Protocol - User (GTP-U), User Datagram Protocol (UDP), IP, L2 data link layer and L1 physical layer.

Interface between eNB and MME

This shows the control plane protocol stack for interface between eNB Mobility Management Entity (MME).

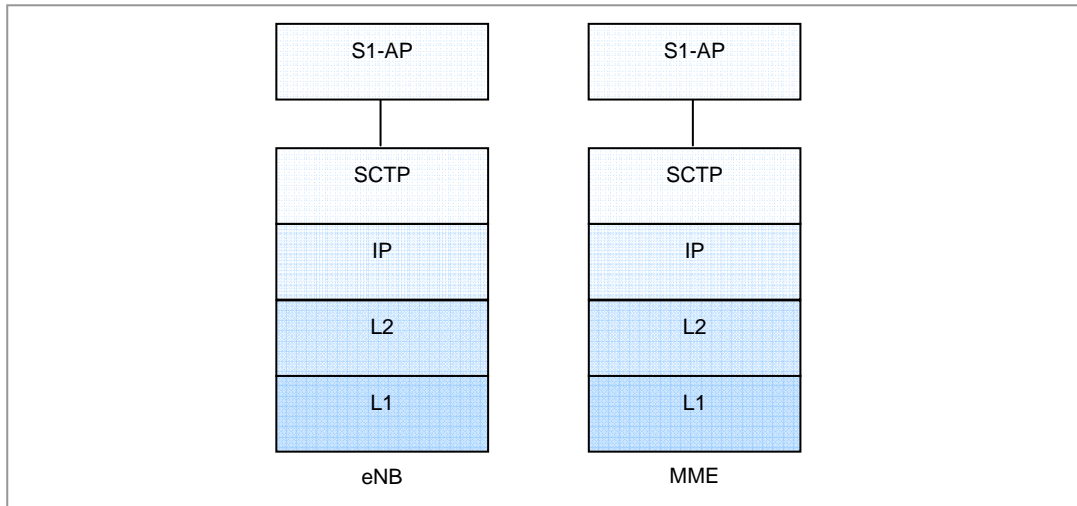


Figure 1.6 Control plane protocol stack between eNB and MME

The control plane protocol stack between eNB and MME is used for the signaling transmission for S1 interface, consisted of Stream Control Transmission Protocol (SCTP), IP, L2 data link layer and L1 physical layer.

Interface between eNB and eNB

This shows the user plane protocol stack for interface between eNBs.

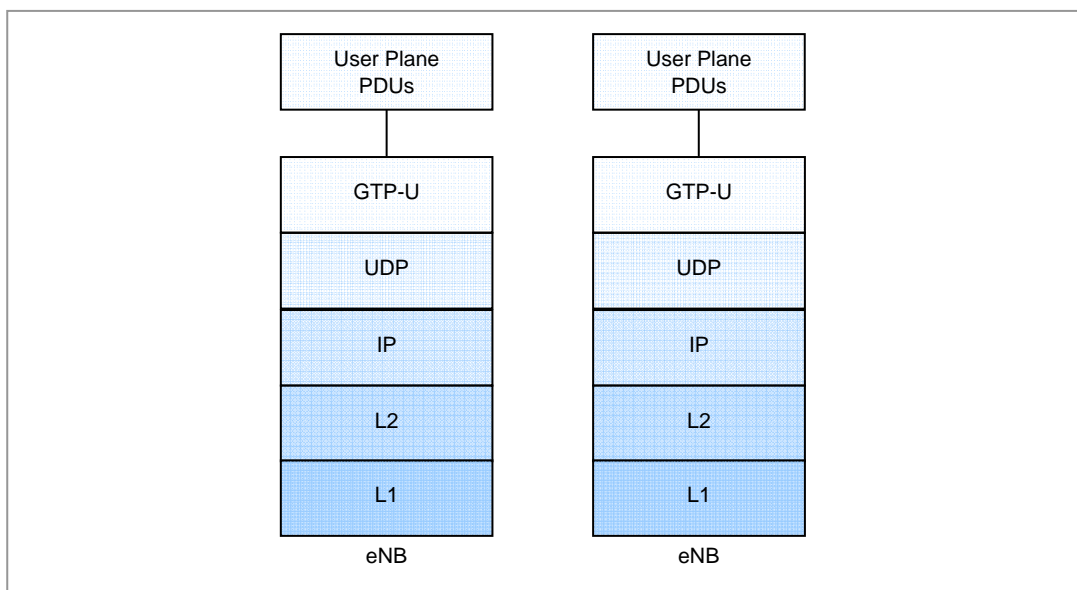


Figure 1.7 User plane protocol stack between eNBs

The user plane protocol stack between eNBs is used to transmit the user plane PDUs between eNBs, consisted of GTP-U, UDP, IP, L2 data link layer and L1 physical layer.

This shows the control plane protocol stack for interface between eNBs.

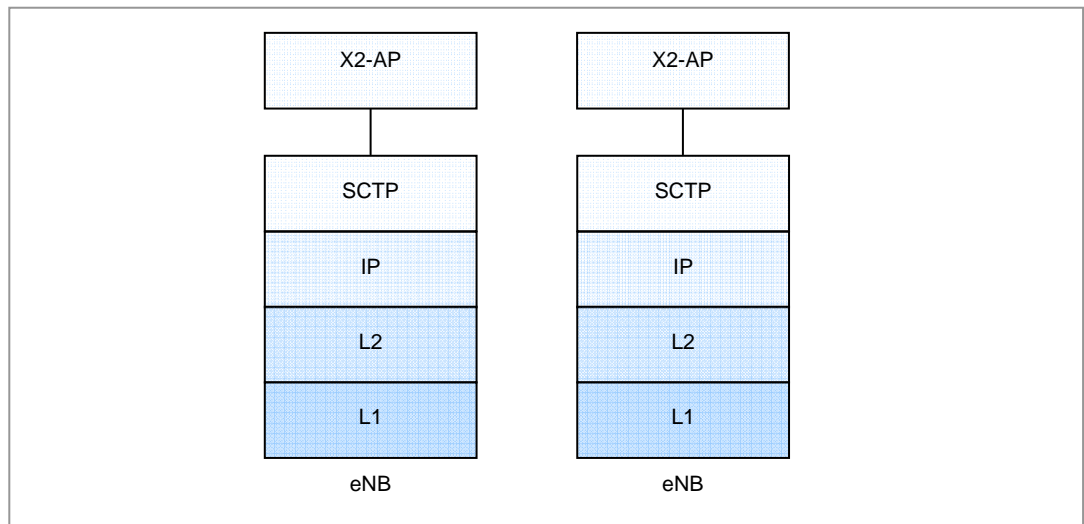


Figure 1.8 Control plane protocol stack between eNBs

The control plane protocol stack between eNBs is used for transmission of control signal between eNBs, consisted of SCTP, IP, L2 data link layer and L1 physical layer.

Interface between eNB and LSM

This shows the protocol stack for interface between eNB and LSM.

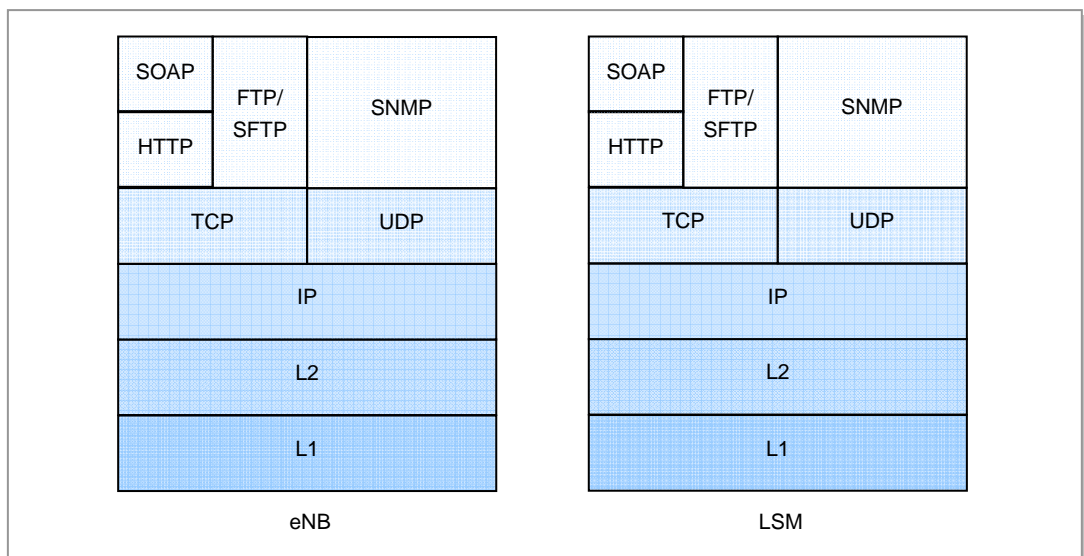


Figure 1.9 Protocol stack between eNB and LSM

The protocol stack between eNB and LTE System Manager (LSM) is used for transmission of Simple Object Access Protocol (SOAP), File Transfer Protocol (FTP), Secure FTP (SFTP) and Simple Network Management Protocol (SNMP) using Hypertext Transfer Protocol (HTTP), consisted of TCP/UDP, IP, L2 data link layer and L1 physical layer.

Interface between eNB and LSS

This shows the protocol stack for interface between eNB and LSS (LTE SON Server).

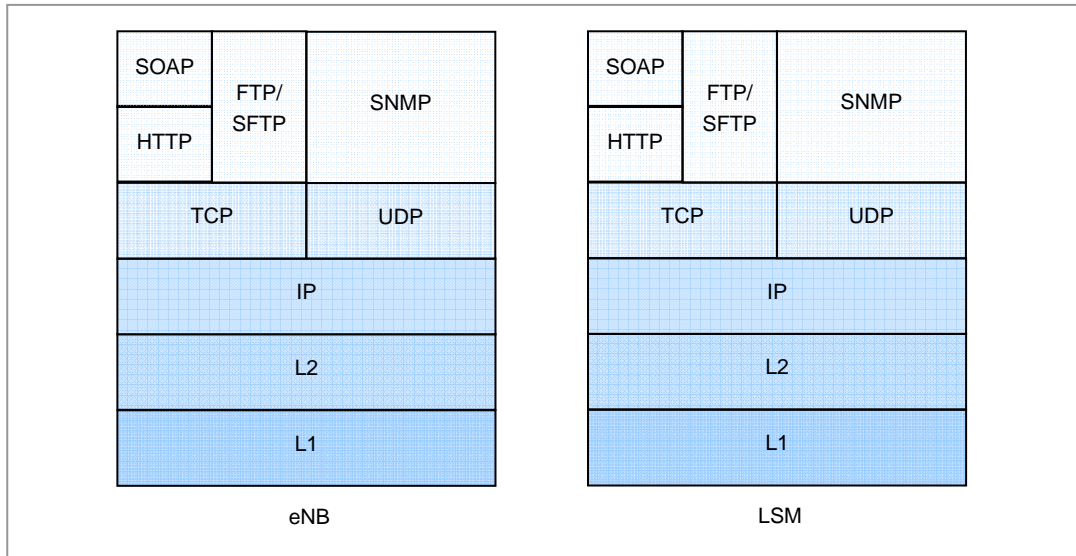


Figure 1.10 Protocol stack between eNB and LSS

The protocol stack between eNB and LSS is used for transmission of SOAP, FTP, secure FTP and SNMP using HTTP, consisted of TCP/UDP, IP, L2 data link layer and L1 physical layer.

CHAPTER 2. Overview of LTE eNB

2.1 Introduction to LTE eNB

The 3GPP LTE represents a major advance in cellular technology. LTE is designed to meet needs for high-speed data and media transport as well as high-capacity voice support.

The LTE encompasses high-speed data, multimedia unicast and multimedia broadcast services. The LTE PHY is a highly efficient means of conveying both data and control information between an enhanced eNB and mobile UE.

LTE has been set aggressive performance requirements that rely on physical layer technologies. These include Orthogonal Frequency Division Multiplexing (OFDM) and Multiple Input Multiple Output (MIMO) data transmission. In addition, the LTE PHY uses Orthogonal Frequency Division Multiple Access (OFDMA) on the downlink and Single Carrier - Frequency Division Multiple Access (SC-FDMA) on the uplink.

LTE eNB is controlled by EPC and connects LTE calls to UE.

The LTE eNB interfaces with UE via a wireless channel observing the 3GPP LTE standard and provides high-speed data service and multimedia service in wireless broadband.

The LTE eNB provides the following functions: modulation/demodulation of packet traffic signal, scheduling and radio bandwidth allocation to manage air resources efficiently and ensure Quality of Service (QoS), connection control and set/hold/disconnect the packet call connection, handover control and EPC interface and system operation management function.

2.2 Main Functions

The major characteristics of the LTE system are listed below.

OFDMA Downlink Transmission

OFDMA is employed as the multiplexing scheme in the LTE downlink.

OFDMA is used to transmit data to several users simultaneously by using the sub-carrier allocated to each user and transmit data by allocating one or more sub-carriers to a specific subscriber according to the channel status and the transmission rate requested by a user.

In addition, since it can select the sub-carriers with excellent features for each subscriber and allocate them to the subscribers when some subscribers divide and use the whole sub-carrier, it can raise the data throughput by distributing the resources efficiently.

SC-FDMA Uplink Transmission

In the uplink, SC-FDMA is selected to efficiently meet Evolved Universal Terrestrial Radio Access (E-UTRA) performance requirements. SC-FDMA has a low power amplifier de-rating (Cubic Metric/PAPR) requirement, thereby conserving battery life or extending range.

Downlink MIMO

For the LTE downlink, a 2×2 configuration for MIMO is assumed as baseline configuration, i.e., 2 transmit antennas at the base station and 2 receive antennas at the terminal side. Configurations with 4 antennas are also considered.

It has to be differentiated between spatial multiplexing and transmit diversity, and it depends on the channel condition which scheme to select. Spatial multiplexing allows transmitting different streams of data simultaneously on the same downlink resource block (s). These data stream can belong to one single user (single user MIMO/SU-MIMO) or to different users (multi user MIMO/MU-MIMO). While SU-MIMO increases the data rate of one user, MU-MIMO allows increasing the overall capacity.

Uplink MIMO

Uplink MIMO schemes for LTE will differ from downlink MIMO schemes to take into account UE complexity issues. For the uplink, MU-MIMO can be used. Multiple UEs may transmit simultaneously on the same resource block.

This is also referred to as Spatial Domain Multiple Access (SDMA).

The scheme requires only one transmit antenna at UE side which is a big advantage.

Power Control

The LTE carries out the power control function for the uplink signal received from multiple UEs and then set the power intensity of the uplink signal to a specific level.

The LTE transmits the power correction command to each UE and then makes the UE power intensity be the level required when the UE transmits the modulated uplink signal in a specific Quadrature Amplitude Modulation (QAM) modulation method.

LTE eNB is mainly composed of digital unit and radio unit to perform the advance technologies.

The main functions of digital unit are as follows.

- Subscriber data traffic processing
- Call processing, resource allocation and OAM
- GTP, PDCP, OAM, RRC, RRM processing
- Reception of the GPS signal and creation and supply of the clock
- Fault diagnosis and alarm collection and control
- Fast Ethernet/Gigabit Ethernet interface to backhaul
- RLC, MAC/PHY processing
- OFDMA/SC-FDMA channel processing

The main functions of radio unit are as follows.

- Upconversion/downconversion of frequency
- High-power amplification of RF transmission signal
- Suppression of out-of-band spurious wave emitted from RF Rx/Tx signal
- Gain control of RF Rx/Tx signal
- Rx/Tx RF signal from/to an antenna
- Low noise amplification of band-pass filtered RF Rx signal

2.3 Specifications

The table below shows detailed specifications.
Macro Outdoor Cabinet Specifications are as follows.

Items	Specification
System Type	Macro Outdoor
Frequency	2,135MHz – 2,140MHz
Sector	3
Channel BW (MHz)	5
Weight (lbs)	Max. 860
Output power (top of cabinet)	Max. (60 + 60 W)/RU
Network Interface	Gigabit Ethernet (Optic or copper)
Physical Dimensions (H x W x D)	70.8 in x 29.5 in x 37.0 in
Power Supply	220 VAC
DU-RU Interface	CPRI 4.0 specification (Copper)
Power Consumption	5 MHz BW, 3Sector, (60 W+60 W)/Sector MIMO

a) AWS stands for Advanced Wireless Services.

Power (Rectifier)

The electric properties of the rectifier in the outdoor eNB-8910 are as follows.

Items	Specification
Input Voltage	176~250 VAC
Input voltage permissible range	85~300 VAC
Input Frequency	45~65 Hz
Rated output voltage	27 VDC
Output voltage variable range	21.00~28.50 VDC
Rated output capacity	1000 W x 7 @25°C
Weight(Rectifier)	12 kg

Environmental Condition

The table below lists the environmental conditions and related standards such as operational temperature and humidity.

Items	Specification	Applied Standard
Temperature Condition ^{a)}	-5~50°C	GR-487-CORE Sec. 3.26
Humidity Condition ^{a)}	5~95% However, the vapor content for air of 1 kg should not exceed 0.024 kg.	GR-487-CORE Sec.3.34.2
Altitude	-60~1,800 m (-197~6,000 ft)	GR-63-CORE Sec.4.1.3
Earthquake	Zone 4	GR-63-CORE Sec.4.4.1
Vibration	Commercial Transportation Curve 2	GR-63-CORE Sec.4.4.4
Noise (sound pressure level)	Under 65 dBA in height of 1.0 m (3 ft) and distance of 1.5 m (5 ft)	GR-487-CORE Sec.3.29
Electromagnetic Wave (EMI)	Standard satisfied	FCC Title47 Part 15 Class B GR-1089-CORE Sec. 3.2
US Federal Regulation	Standard satisfied	FCC Title47 Part27

- a) The standards of temperature/humidity conditions are based on the value on the position where is 400 mm (15.8 in.) away from the front of the system and in the height of 1.5 m (59 in.) on the bottom.

Environmental alarm

The table below lists the environmental alarm provided in the outdoor eNB-8910 in default.

Items	Specification
ECM Status	ECM Fail report
Temperature Alarm	High Temperature
Fan Fail	System Fan Fail
Others	Flood, Fire, Door open, etc.



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CHAPTER 3. System Architecture

3.1 Hardware Structure

Macro Outdoor Cabinet for 5 MHz and 3sectors is shown in following figure.

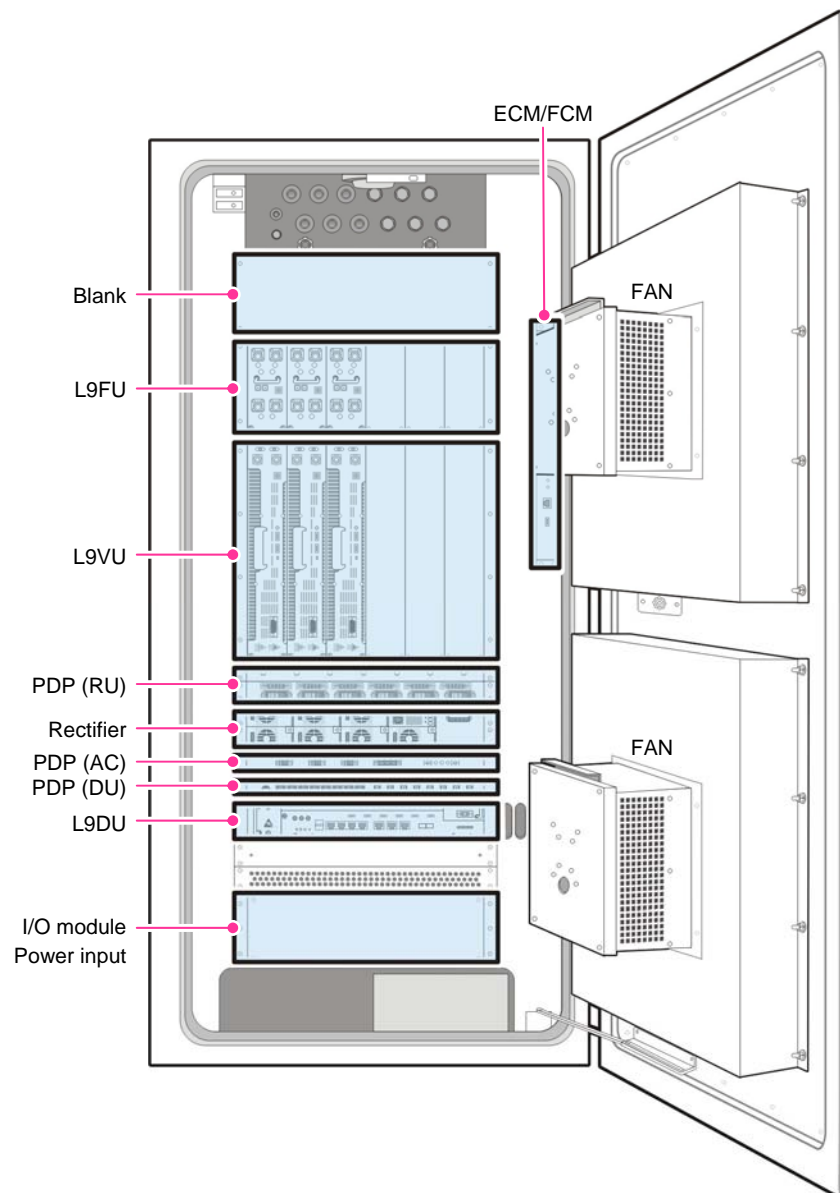


Figure 3.1 Rack Configuration of Macro Outdoor Cabinet

LTE eNB is mainly composed of digital unit and radio unit to perform the advance technologies as shown in following figure.

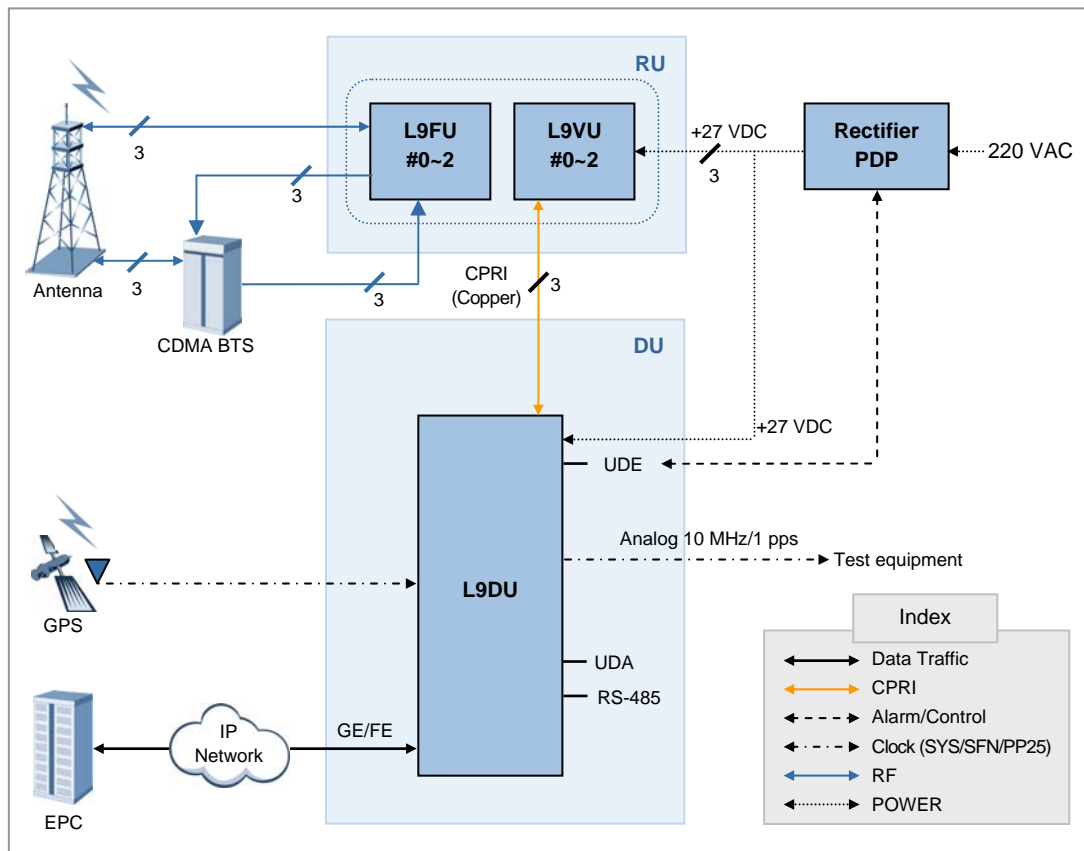


Figure 3.2 Internal Configuration of Macro Outdoor Cabinet

3.1.1 Digital Unit (L9DU)

The LTE eNB Digital Unit (L9DU), which is the main control block of the LTE eNB system, operates and maintains the eNB system, processes backhaul interfacing between EPCs, and provides the system processors with communication paths. In addition, the L9DU generates and supplies clocks and processes channels for subscriber signals.

Below are the major functions of the L9DU.

- Has the height of 2U and mounted in a 19-in rack
- Mounted in an outdoor rack
- Consists of L9DA and L9DB
- Supports the copper CPRI.
- Uses fan cooling
- Supports max. 5 MHz 3Sector with 2T2R

The major functions of the boards that constitute the L9DU are given below.

Items	Description
L9DA	LTE eNB Digital board Assembly <ul style="list-style-type: none"> - Performs the main processor functions of the system. - Call processing, resource assignment, operation, and maintenance - GTP, PDCP, OAM, RRC, RRM processing - Receives GPS signals and generates and supplies clocks. (Sync In & Out) - Collects alarms and reports them to the LSM - Supports the backhaul (GE/FE) - Supports the fan alarms - Processes subscriber data traffic - Processes RLC, MAC/PHY - Processes OFDMA/SC-FDMA Channel - Provides User-Defined Alarm (UDA) - Uses a mini champ for UDA I/O (6 Rx ports, 2 Tx ports) - Controls the ECM - Provides signals for using a measuring instrument (10 MHz, 1 pps)
L9DB	LTE eNB Digital Backplane board Assembly <ul style="list-style-type: none"> - Backplane board for the digital main block - Connects the traffic, control signals, and clock signals of the L9DA - Supplies power to the L9DA - Transmits the alarm information for the fan module to the L9DA

L9DA

Below are the major functions of the L9DA.

- **Main Controller Function**

The L9DA, the main processor of the LTE eNB system, is the board which performs the topmost functions in the eNB, and sets up a communication path between the UE and EPC, carries out the Ethernet switch function within the eNB, and carries out the system operation and maintenance functions. In addition, the L9DA manages the status for all hardware/software in the eNB, allocates and manages resources, collects alarms, and reports all status information to the LSM.

Also, it initializes the IF FPGA and Ethernet switches to manage boards.
- **Clock Generation and Distribution Function**

The L9DA is equipped with the Universal Core Clock Module (UCCM) for receiving GPS signals. The UCCM allows the blocks of the eNB to operate under a synchronized clock system. The UCCM generates analog 10 MHz clocks (for measuring instruments or attendants) and digital clocks [PP2S (even clock), digital 10 MHz] using synchronization signals received from the GPSR and transmits them to the L9DA.

The UCCM generates system clocks (30.72 MHz), PP2S (even clock), and System Frame Number (SFN) to synchronize the signals received by a board and then distributes them to the hardware blocks within the system. These clocks are used to maintain internal synchronization in the eNB and operate the system. And, the UCCM also transmits time information and location information through the TOD path.

If the UCCM fails to receive GPS signals due to an error during system operation, it carries out the holdover function that supplies the normal clocks that have been provided for a specific period of time.
- **Network Interface Function**

The L9DA interfaces directly with the EPC via Gigabit Ethernet or Fast Ethernet.

If the network interface is provided directly to the EPC via Ethernet, a total of 4 ports, 2 L9DU optic ports, and 2 copper ports are supported. If necessary, the optic module can be changed to the LC connector type or SC connector type. In case of the copper ports, the cable configuration changes depending on the supported speed and distance. And, if either optic or copper ports are used, the other type of ports is used for the Ethernet path (for example, UDE).
- **Subscriber Channel Processing Function**

The L9DA is equipped with the modem which supports the LTE standard physical layer. The L9DA performs OFDMA/SC-FDMA channel processing and DSP processes RLC/MAC. The modem modulates the packet data received from the upper processor and transmits them to the RF part via Common Public Radio Interface (CPRI). In the other direction, it demodulates the packet data received from the RF part, converts them to the format which is defined in the LTE standard physical layer specifications, and transmits them to the upper processor.

L9DA Interface Types is as follows.

Interface Type	Connector Type	Quantity	Description
Copper Back-Haul	RJ-45	2	1000Base-T
Optic Back-Haul	SFP	2	1000Base-LX/SX
SW Debug	USB	2	UART CPU/DSP Debug
SW Debug	RJ-45	1	10/100/1000Base-T
GPS In	SMA	1	GPS Input (to UCCM)
Ref. Clock Out	SMA	1	Analog 10 MHz Output
	SMA	1	1pps Out
CPRI	Copper	6	L9VU IF
UDE	RJ-45	2	10/100/Base-TX User Defined Ethernet
UDA	Mini Champ	1	Rx 6Port, Tx 2Port
Rectifier IF	RJ-45	1	RS-485
Reset	Reset	1	System reset
LED	LED	3	SYS, GPS, OBH
27VDC	3W3	1	Input power

3.1.2 Radio Unit

The RF units of the rack type are divided into the L9VU unit which consists of a power supplier, power amplifier and transceiver, and the L9FU unit which consists of a filter and LNA. The L9VU and L9FU are mounted in an outdoor rack.

Below are Major Functions of the LTE eNB RF Unit.

Type	Specification	Remarks
L9VU	LTE eNB Amp, Transceiver Unit - Supports 1Carrier 5 MHz 2Tx2Rx - Maximum output 60W + 60W per 1Carrier (for the antenna port at the outside of the rack) - Up/Down RF conversion - Amplifies the RF signal level	-
L9FU	LTE eNB Filter Unit - Tx: 2135 to 2140 MHz, Rx: 1730 to 1740 MHz - Performs the Low Noise Amplifier (LNA) function - Suppresses spurious waves from the bandwidth - Distributes the received signals to share the SIMO antenna	Las Vegas area

L9VU

Below are the major functions of L9VU.

- Supports the 2Tx2Rx MIMO
The L9VU is a unit in which a power supplier, transceiver, and power amplifier are unified. Each L9VU supports the RF path of 2Tx2Rx. The maximum output is 60W/path for the antenna port at the outside of the rack.
- DAC/ADC and power amplification
For the L9VU downlink path, the baseband signals received from the L9DA via the CPRI (copper) interface are converted to analog signals through the Digital to Analog Converter (DAC). The frequency of those analog signals is up converted through the modulator and then those signals are amplified into RF signals with larger power through the power amplifier.
In case of the uplink path of the L9VU, the frequency of the signals amplified low noise from the L9FU is down converted through the demodulator. Those down converted frequency signals are converted to baseband signals through the Analog to Digital Converter (ADC). The signals converted to baseband signals are sent to the L9DA via the CPRI interface. The control signals of the L9VU are transmitted through the control path in the CPRI. If a new LTE base station is installed in the existing CDMA base station and an antenna is shared between the DMA/LTE base stations, the L9VU operates with the configuration of 1Tx2Rx.
- Energy Saving
To save energy, the L9VU changes the output to traffic changes so that there is no big drop in the efficiency of the system.

L9FU

Below are the major functions of the L9FU.

- Suppresses spurious waves from the bandwidth
The L9FU is a unit in which a band-pass filter and LNA are unified. Each L9FU supports the RF path of 2Tx2Rx. For the L9VU downlink path, the RF signals power-amplified from L9VU satisfy the spectrum mask specified for each area through the filter part and then they are sent to the antenna. In case of the uplink path of the L9FU, the RF signals received through the filter part are amplified low noise in the LNA and sent to the L9VU.
- Antenna Sharing
Below is the configuration for sharing an antenna between the CDMA 1x and LTE base stations. The L9FU LNA out1 port of the LTE base station is connected to the MCR (transceiver) Rx2 port of the CDMA 1x base station using an external cable and the signals received in the LTE base station are transmitted to the CDMA 1x base station. In the same way, the duplex filter J6 port of the CDMA 1x base station is connected to the L9VU Rx2 port of the LTE base station using an external cable and the signals received in the CDMA 1x base station are transmitted to the LTE base

station. To minimize degradation of the noise figure performance for the existing CDMA 1x base station being operated, the size of the received signals is adjusted using a variable attenuator within the L9FU.

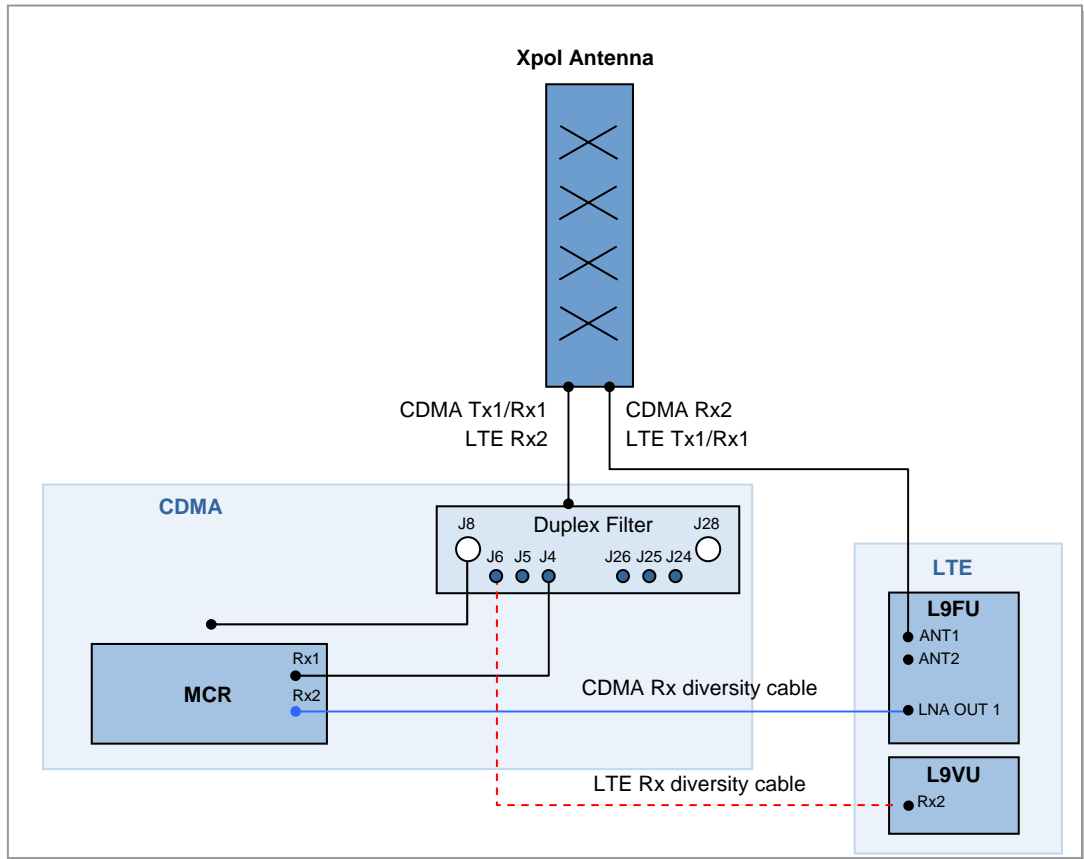


Figure 3.3 RF Configuration for Antenna Sharing

Below are L9VU and L9FU Interface Types.

Interface Type	Connector Type	Quantity	Description
CPRI	Copper	2	L9DU interface, Cascaded RU
Antenna	N-type female	2	2Tx2Rx
LNA out	SMA female	2	1x BTS interface
DC power	-	1	+27VDC
Tx monitoring	SMA female	2	PA coupled output monitoring port
LED	LED	1	Status alarm

3.1.3 Cooling Architecture

The eNB maintains the inside temperature of the system at an appropriate range using four system cooling FANs, so that the system can operate normally when the outside temperature and load of the system changes.

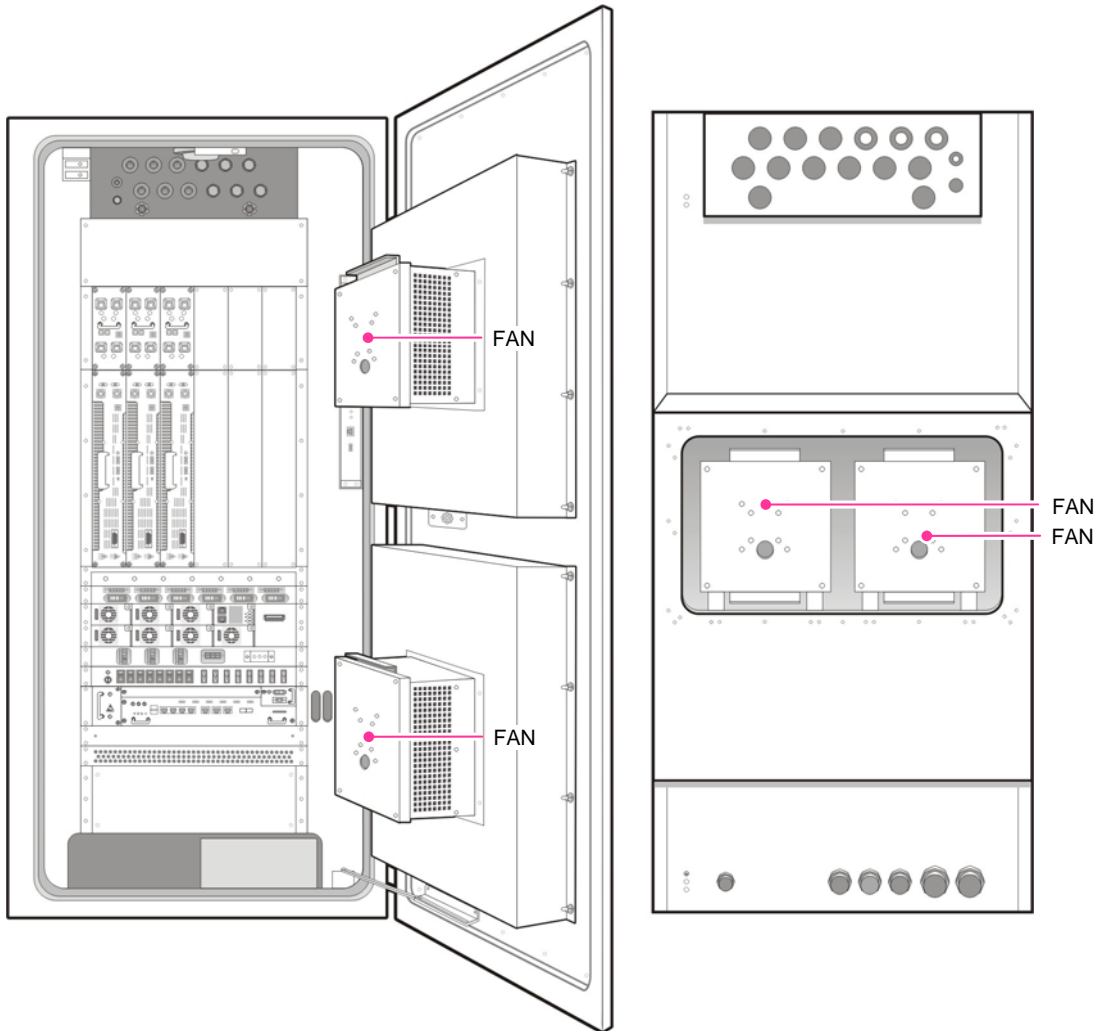


Figure 3.4 Configuration of FANs

3.1.4 Environment Sensors

Environment sensors are mounted on as figure below.

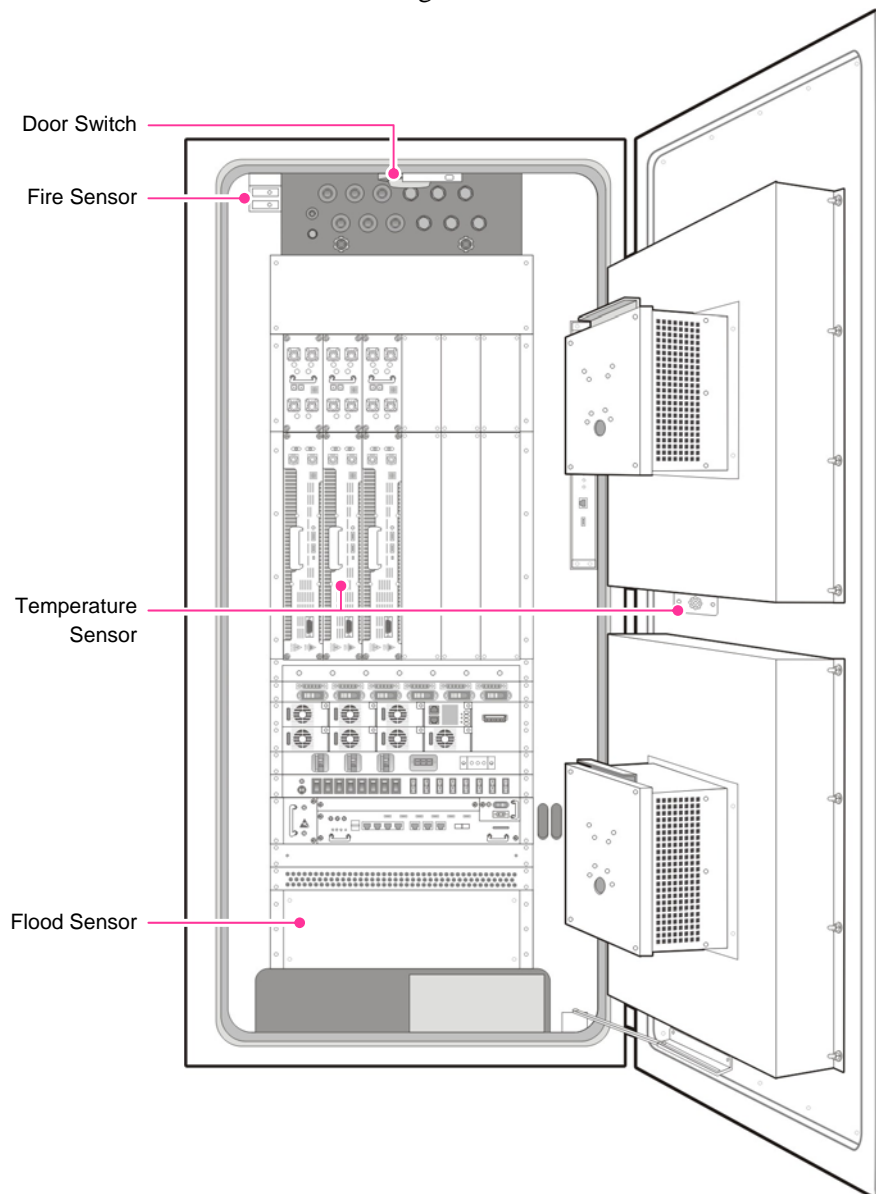


Figure 3.5 Configuration of Environment Sensors

Items	Description
Temperature Sensor	Detects whether the temperature of system maintains within operation condition.
Flood Sensor	Detects whether the system is flooded.
Fire Sensor	Detects whether a fire break out.
Door Switch	Detects whether door opens or close.

3.2 Software Structure

The components of the LTE eNB software is shown below.

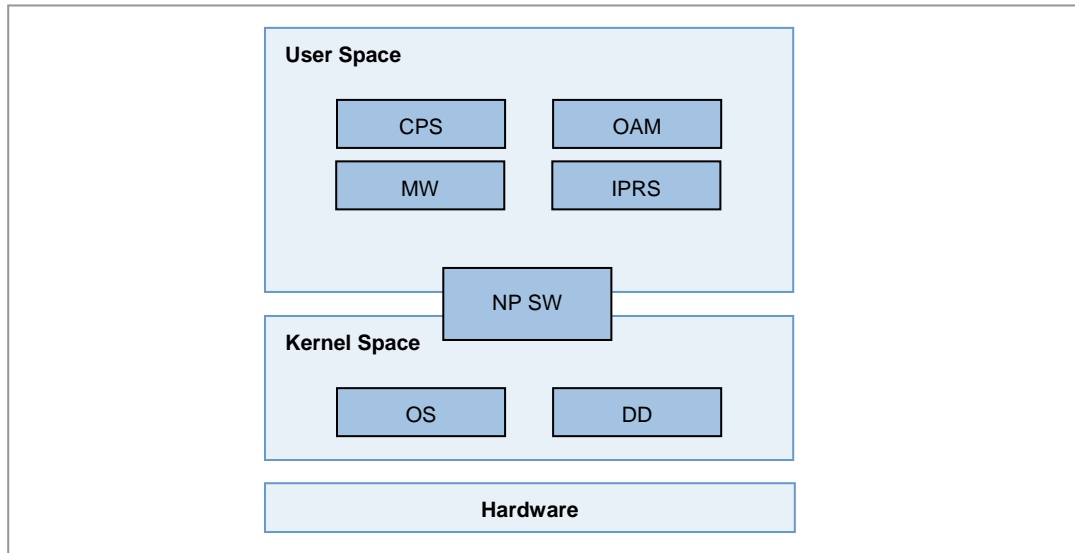


Figure 3.6 Software Structure

3.2.1 Operating System (OS)

In Samsung SW architecture, OS consists of 3 part, Linux Kernel Core (LKC), Board Support Package (BSP) and Samsung in-house kernel module.

LKC is a native Linux kernel that provides general OS functions such as memory management, file management and etc.

BSP is a software package for OS to control Samsung HW platform.

Samsung provides in-house kernel module for Inter Process Communication (IPC), virtual interface management, system resource management and controlling simple HWs such as LED and etc.

3.2.2 Network Processing Software (NP SW)

NP SW processes the eNB data plane. The main functions of NP SW are L2 and L3 packet processing including Link Aggregation (LAG) processing, Virtual LAN (VLAN) processing, IP forwarding, Access Control List (ACL) processing, QoS processing, IP Security (IPSec) processing, and GTP tunneling/detunneling.

All the NP SW functions are implemented as thin data plane software modules with no help of complicated OS functions, which maximizes the data plane performance.

On top of the NP SW, there is a control software module to control and manage the NP SW. The module provides the interfaces to other software modules, various database management for NP SW and management functions like the initialization and status monitoring of NP SW.

3.2.3 Device Driver (DD)

DD controls a particular type of device that is attached to Samsung HW platform. In Samsung SW architecture, DD mainly manages network devices such as switch devices, MAC devices and PHY devices.

3.2.4 Middleware (MW)

MW helps the smooth operation between OS and application under various types of hardware environment, and to achieve this, MW provides various services: Message delivery service between applications, event notification service, High Availability (HA) service for duplex managing and data backup, debugging utility services.

3.2.5 IP Routing Subsystem (IPRS)

IPRS executes the IP routing protocol function. IPRS collects and manages the system configuration and status data necessary for IP routing operation, and based on the data, it generates the routing table via the routing protocol, and makes packet forwarding possible.

3.2.6 Call Processing Software (CPS)

CPS is the call processing software, which is composed of control plane and user plane. Control plane processes call setup/control and user plane processes user data traffic. CPS consists of the following software modules such as ECMB, ECCB, GTPB, PDCB, RLCB and MACB.

eNB Common Management Block (ECMB)

ECMB includes the following functions.

- eNB initialization and common channel establishment function
- System information transmission

eNB Call Control Block (ECCB)

ECCB includes the following functions.

- Radio resource management
- Basic call access control
- Handover call control
- S1/X2-AP junction

GTP Block (GTPB)

GTPB includes GTP-U tunneling function for S1/X2 function.

PDCB Block (PDCB)

PDCB includes the following functions

- Packet header compression/decompression
- Ciphering/integrity

RLC Block (RLCB)

RLCB includes the following functions

- AM/UM/TM mode
- Segmentation/Reassembly
- ARQ

MAC Block (MACB)

MACB includes the following functions

- Mapping between logical channel and transport channel
- Multiplexing and De-multiplexing
- Random Access
- Hybrid ARQ
- Scheduling

3.2.7 Operation and Maintenance (OAM)

The OAM provides the interface (SNMP, FTP, HTTP) with LTE System Manager (LSM) or Web based-Element Maintenance Terminal (Web-EMT).

In addition, this performs the functions of initializing the system, collecting the statistics for various performance data, managing the system configuration and resources, managing the status of the software resources and the hardware resources, managing the failure and performing the diagnostics for the operation and the management.

OAM is composed of Management Interface (MIF) and OAM operating in main processor board. OAM gives the following system management functions.

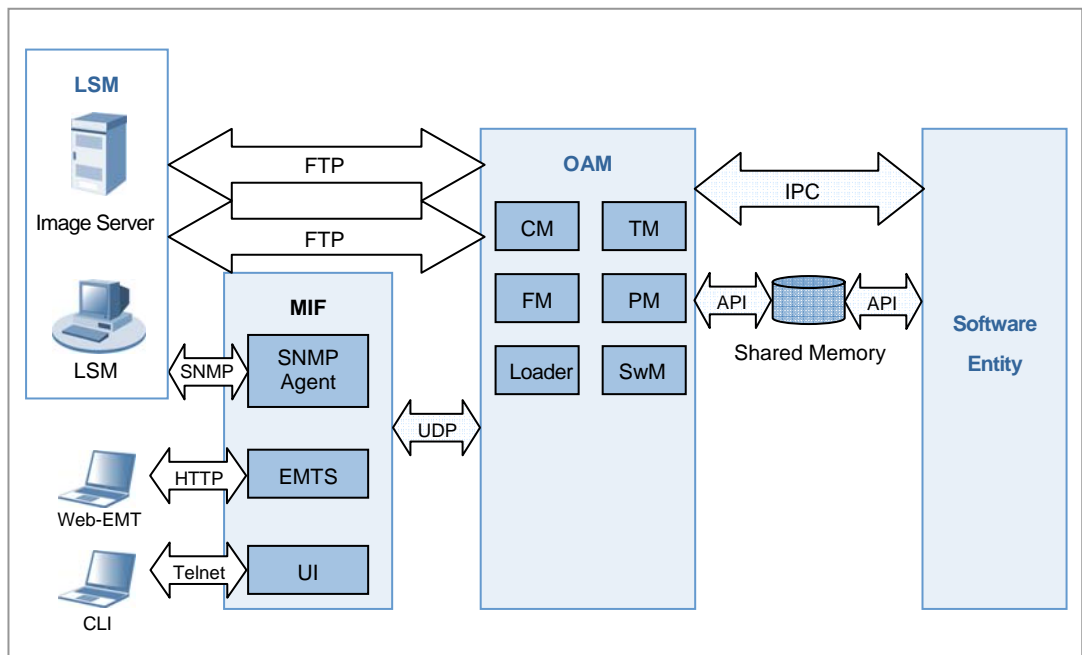


Figure 3.7 OAM Block

The detailed structure and interface of each block are as follows.

3.2.7.1 Maintenance Interface (MIF)

MIF includes SNMP agent and web server function. It also provides interface between Element Management System (EMS) or Web based-Element Maintenance Terminal (Web-EMT) and System OAM.

SNMP Agent

SNMP Agent performs SNMP agent role for supporting standard SNMP. It also provides interface with LSM which can perform eNB information retrieval/modification related commands using get/get-next/get-bulk/set/trap defined in SNMP.

The main functions of SNMP Agent are as follows.

- Provides interface between EMS and OAM
- SNMP message processing
- Performs the operator commands received from EMS and send SNMP response to the LSM
- SNMP notification function about eNB modification and fault

Element Maintenance Terminal Server (EMTS)

EMTS plays role of HTTP server to support the Web-EMT interface. It also provides the secured communication with Web-EMT using Secure Socket Layer (SSL) protocol.

The main functions of EMTS are as follows.

- HTTP server function for Web-EMT
- User authentication function through the eNB or EMS

3.2.7.2 Functionalities of OAM

Configuration Management (CM)

- System modification
- System monitoring
- System control
- Configuration data control
- Inventory data control
- System time control
- Plug & play

Fault Management (FM)

- Alarm monitoring
- Alarm Information change
- Minimization of service impact in fault

Performance Management (PM)

- Performance data collection control
- Performance data management
- Threshold alarm management

Loader

- Setting IP address from IS (Image Server)
- File contents download from IS
- Monitor the SwM and rebooting in abnormal state

Software Management (SwM)

- Monitor the operation of software block
- Restart system
- Software upgrade
- Firmware upgrade

Test Management (TM)

- Test job start and end by an operator command
- Test operation condition set/monitor
- Test operation state monitor
- Periodic automatic test/diagnostics

Trace Management (TRM)

- Trace control
- Trace data management

Log Management (LOG)

- Event log collection
- Event log data management
- Event reporting

Security Management (SM)

- User account
- Authentication/authorization
- Access log

CHAPTER 4. Message Flow

This section presents call flows and functional descriptions of Attach, Service Request, and Detach procedures and also covers the Intra E-UTRAN Handover procedures.

4.1 Attach Procedure

A UE needs to register with the network to receive services that require registration. This registration is described as Network Attachment. The UE enters the registered state by a successful registration with an Attach procedure to E-UTRAN.

The MME enters the registered state by an Attach procedure via E-UTRAN.

In the registered state, the UE can receive services that require registration in the Evolved Packet System (EPS). Figure of Attach procedure illustrates a call flow for the Attach procedure, and table of attach procedure shows functional description for each step of the procedure.

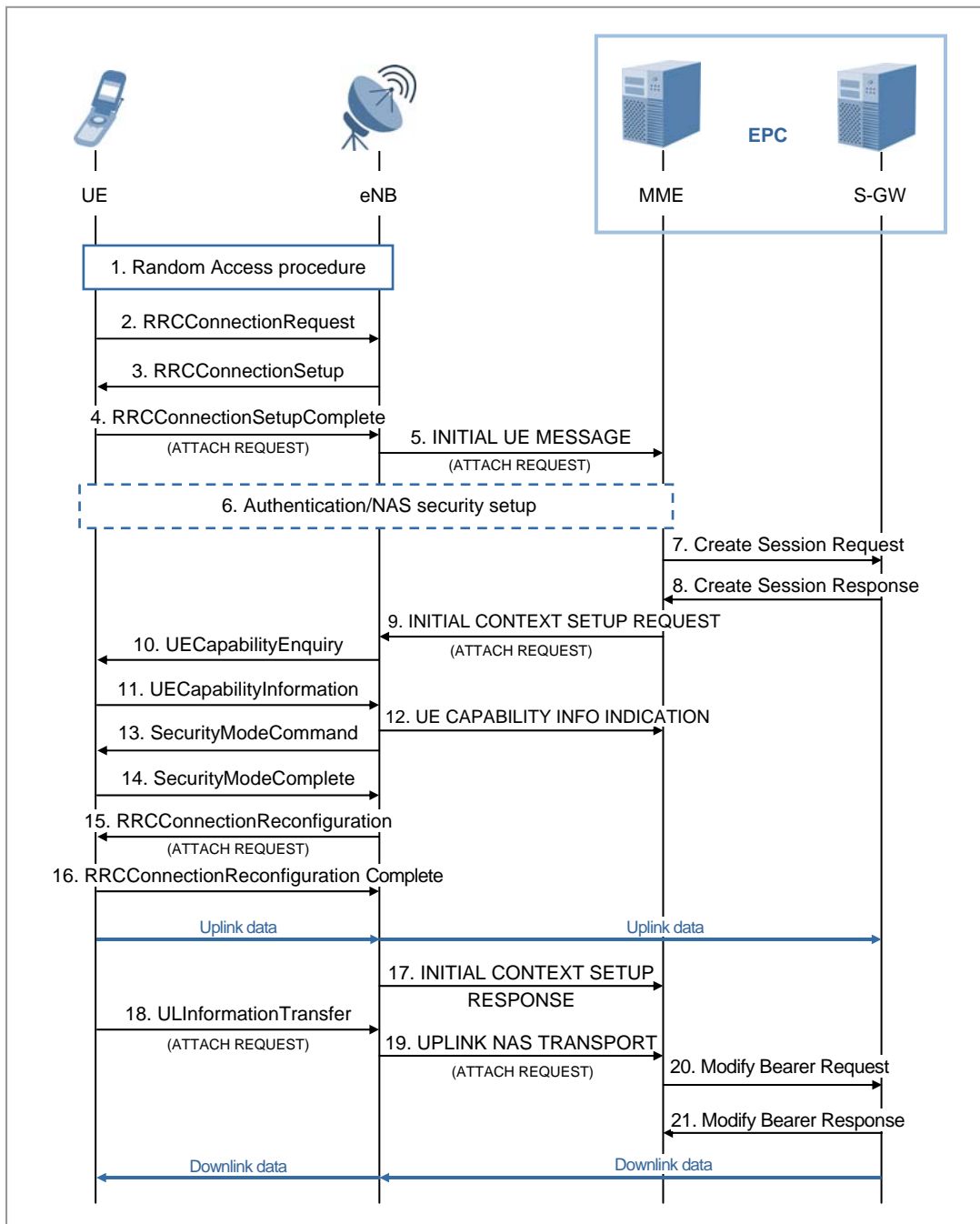


Figure 4.1 Attach procedure

Below is Attach procedure.

Steps	Description
1	The UE performs the Random Access procedure (see Section 5.1 in TS 36.321) with an eNB.
2-4	The UE initiates the RRC Connection Establishment procedure (see Section 5.3.3 in TS 36.331). The UE sends a NAS message ATTACH REQUEST to the eNB encapsulated in an RRC message RRCConnectionSetupComplete.
5	The eNB derives an MME from RRC parameters. The eNB forwards the ATTACH REQUEST message to the MME contained in an S1-MME control message INITIAL UE MESSAGE.
6	If no UE context for the UE exists anywhere in the network, if the ATTACH REQUEST message was not integrity protected, or if the check of the integrity failed, then authentication and NAS security setup to activate integrity protection and NAS ciphering are mandatory. The UE performs the EPS Authentication and Key Agreement (AKA) procedure (see Section 6.1.1 in TS 33.401) with the MME. The MME uses the NAS Security Mode Command (SMC) procedure (see Section 7.2.4.4 in TS 33.401) to establish a NAS security association between the UE and MME.
7-8	The MME selects a P-GW and an S-GW. The MME sends a Create Session Request message to the S-GW. The S-GW creates a new entry in its EPS bearer table. After this step, the S-GW buffers any downlink packets it may receive from the P-GW until it receives the Modify Bearer Request message in step 17 below. The S-GW returns a Create Session Response message to the MME.
9	The MME sends an ATTACH ACCEPT message to the eNB contained in an S1-MME control message INITIAL CONTEXT SETUP REQUEST. This S1 control message also includes the AS security context information for the UE, which triggers the RRC level AS SMC procedure in steps 10-11.
10-12	If no UE Radio Capability information is included in INITIAL CONTEXT SETUP REQUEST message, this triggers the eNB to request the UE Radio Capability from the UE and upload it to the MME in the S1 interface UE CAPABILITY INFO INDICATION message.
13-14	The eNB sends a SecurityModeCommand message to the UE, and the UE replies with a SecurityModeComplete message. Downlink ciphering at the eNB shall start after sending the SecurityModeCommand message. Uplink deciphering at the eNB shall start after receiving of the SecurityModeComplete message. Uplink ciphering at the UE shall start after sending the SecurityModeComplete message. Downlink deciphering at the UE shall start after receiving of the SecurityModeCommand message.
15-16	The eNB sends an RRCConnectionReconfiguration message to the UE including the ATTACH ACCEPT message. The UE sends an RRCConnectionReconfigurationComplete message to the eNB. After the ATTACH ACCEPT message, the UE can then send uplink packets towards the eNB which will then be tunneled to the S-GW and P-GW.
17	The eNB sends an INITIAL CONTEXT RESPONSE message to the MME.

(Continued)

Steps	Description
18-19	The UE sends an ULInformationTransfer message to the eNB, which includes an ATTACH COMPLETE message. The eNB forwards the ATTACH COMPLETE message to the MME in an UPLINK NAS TRANSPORT message.
20-21	Upon reception of both, the INITIAL CONTEXT RESPONSE message in step 14 and the ATTACH COMPLETE message in step 16, the MME sends a Modify Bearer Request message to the S-GW. The S-GW acknowledges by sending a Modify Bearer Response message to the MME. The S-GW can then send its buffered downlink packets to the eNB.

4.2 Service Request Procedure

Two service request procedures are provided when the UE accesses the EPS through E-UTRAN. The first service request procedure is UE triggered Service Request procedure and the other service request procedure is network triggered Service Request procedure.

UE triggered Service Request procedure

A UE is in idle state when no NAS signaling connection between UE and network exists.

There exists no UE context in E-UTRAN for the UE in the idle state.

There is no S1-MME and no S1-U connection for the UE in the idle state.

The UE in the registered and idle state shall perform a Service Request procedure in order to establish the radio bearers when uplink user data is to be sent.

The UE and the MME shall enter the connected state when the signaling connection is established between the UE and the MME. Figure of UE triggered Service Request procedure illustrates a call flow for the UE triggered Service Request procedure, and table of UE triggered Service Request procedure shows functional description for each step of the procedure.

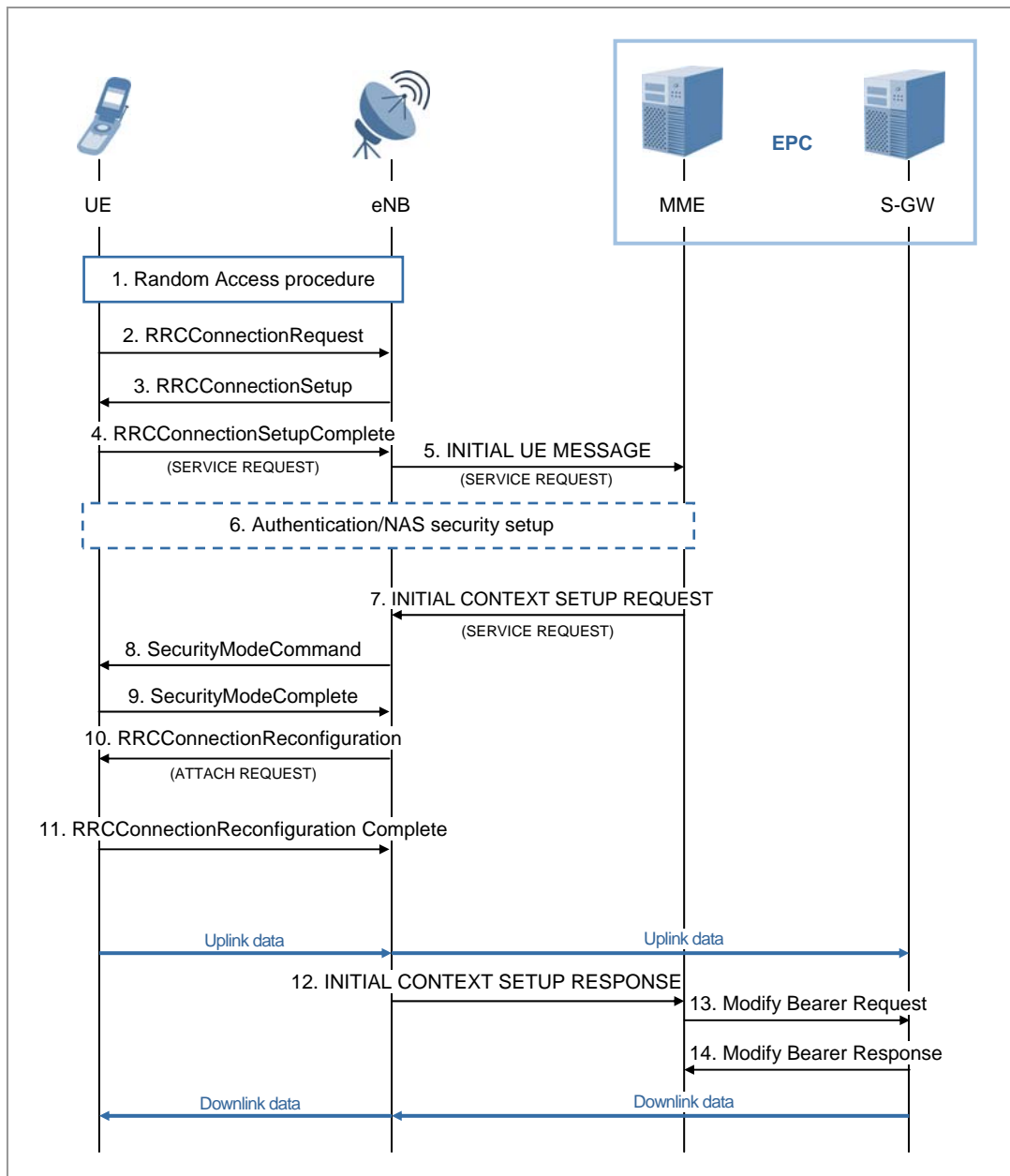


Figure 4.2 UE triggered Service Request procedure

Below is UE triggered Service Request procedure.

Steps	Description
1	The UE performs the Random Access procedure with an eNB.
2-4	The UE sends a NAS message SERVICE REQUEST towards the MME encapsulated in an RRC message to the eNB.
5	The eNB forwards the SERVICE REQUEST message to the MME encapsulated in an S1-AP message INITIAL UE MESSAGE.
6	Step 6 in table of Attach procedure.
7	The MME sends an S1-AP message INITIAL CONTEXT SETUP REQUEST to the eNB. This step activates the radio and S1 bearers for all the active EPS bearers.
8-11	The eNB establishes RRC radio bearers. The user plane security is established at this step. The uplink data from the UE can now be forwarded by the eNB to the S-GW. The eNB sends the uplink data to the S-GW which forwards it to the P-GW.
12	The eNB sends an S1-AP message INITIAL CONTEXT SETUP COMPLETE to the MME.
13-14	The MME sends a Modify Bearer Request message per PDN connection to the S-GW. The S-GW is now able to transmit downlink data towards the UE. The S-GW sends a Modify Bearer Response to the MME.

Network triggered Service Request procedure

When the S-GW receives a downlink data packet for a UE known as not user plane connected, the MME needs to signal with the UE in the idle state, or the S-GW receives control signaling, the MME pages the UE via eNBs. The UE in the registered and idle state shall answer to paging from the MME by performing a Service Request procedure. Figure of Network triggered Service Request procedure illustrates a call flow for the network triggered Service Request procedure, and table of Network triggered Service Request procedure shows functional description for each step of the procedure.

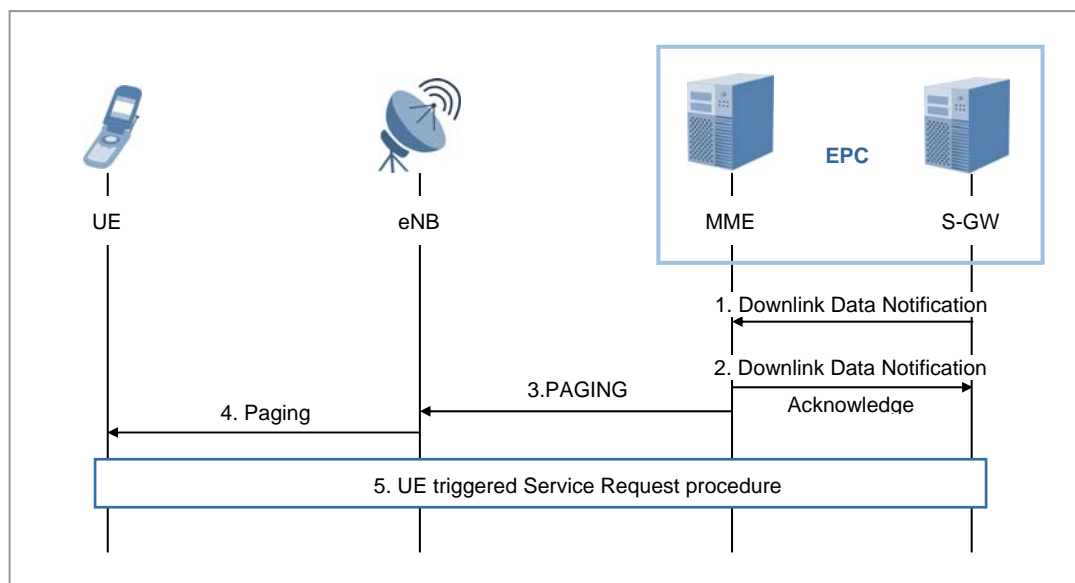


Figure 4.3 Network triggered Service Request procedure

Below is Network triggered Service Request procedure.

Steps	Description
1-2	When the S-GW receives a downlink data packet for a UE known as not user plane connected, the S-GW sends a Downlink Data Notification message to the MME for which it has control plane connectivity for the given UE. The MME responds to the S-GW with a Downlink Data Notification Acknowledge message. If the S-GW receives additional downlink data packets for this UE, the S-GW buffers these downlink data packets and the S-GW does not send a new Downlink Data Notification.
3	If the UE is registered in the MME, the MME sends a PAGING message to each eNB belonging to the tracking area (s) in which the UE is registered.
4	If eNBs receive PAGING messages from the MME, the UE is paged by the eNBs.
5	When UE is in the idle state, upon reception of Paging indication in E-UTRAN access, the UE initiates the UE triggered Service Request procedure. The S-GW transmits downlink data towards the UE, via the RAT which performed the Service Request procedure.

4.3 Detach Procedure

The Detach procedure allows:

- The UE to inform the network that it does not want to access the EPS any longer
- The network to inform the UE that it does not have access to the EPS any longer.

The UE is detached either explicitly or implicitly:

- Explicit detach: The network or the UE explicitly requests detach and signal with each other.
- Implicit detach: The network detaches the UE, without notifying the UE. This is typically the case when the network presumes that it is not able to communicate with the UE, e.g. due to radio conditions.

Two detach procedures are provided when the UE accesses the EPS through E-UTRAN. The first detach procedure is UE initiated Detach procedure and the other detach procedure is network (MME) initiated Detach procedure.

UE initiated Detach procedure

Figure of UE initiated Detach procedure illustrates a call flow for the UE initiated Detach procedure, and table of UE initiated Detach procedure shows functional description for each step of the procedure.

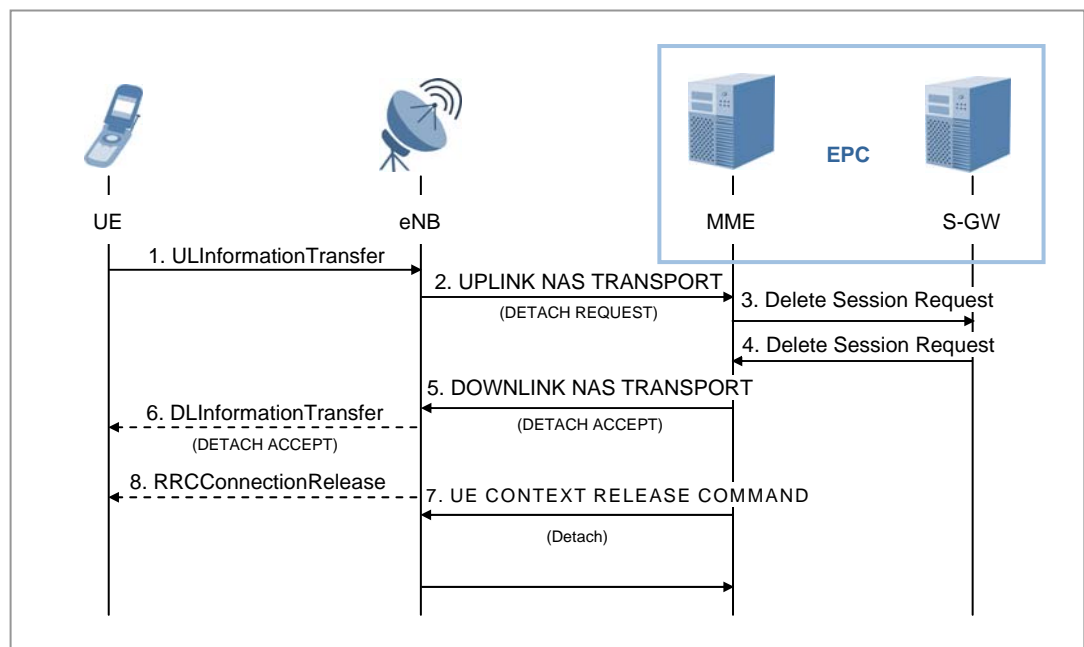


Figure 4.4 UE initiated Detach procedure

Below is UE initiated Detach procedure.

Steps	Description
1-2	The UE sends a NAS message DETACH REQUEST to the MME. This NAS message is used to trigger the establishment of the S1 connection if the UE was in idle mode.
3	The active EPS bearers and their context information in the S-GW regarding this particular UE and related to the MME are deactivated by the MME sending a Delete Session Request message per PDN connection to the S-GW.
4	When the S-GW receives the Delete Session Request message from the MME, the S-GW releases the related EPS bearer context information and responds with a Delete Session Response message.
5-6	If the detach is not due to a switch off situation, the MME sends a NAS message DETACH ACCEPT to the UE.
7	The MME releases the S1-MME signaling connection for the UE by sending a UE CONTEXT RELEASE COMMAND message to the eNB with Cause IE set to 'Detach'.
8	If the RRC connection is not already released, the eNB sends an RRCConnectionRelease message to the UE in acknowledged mode. Once the message is acknowledged by the UE, the eNB releases the UE context.
9	The eNB confirms the S1 release by returning a UE CONTEXT RELEASE COMPLETE message to the MME. With this, the signaling connection between the MME and the eNB for that UE is released. This step shall be performed promptly after step 7.

MME initiated Detach procedure

Figure of MME initiated Detach procedure illustrates a call flow for the MME initiated Detach procedure, and table of MME initiated Detach procedure shows functional description for each step of the procedure.

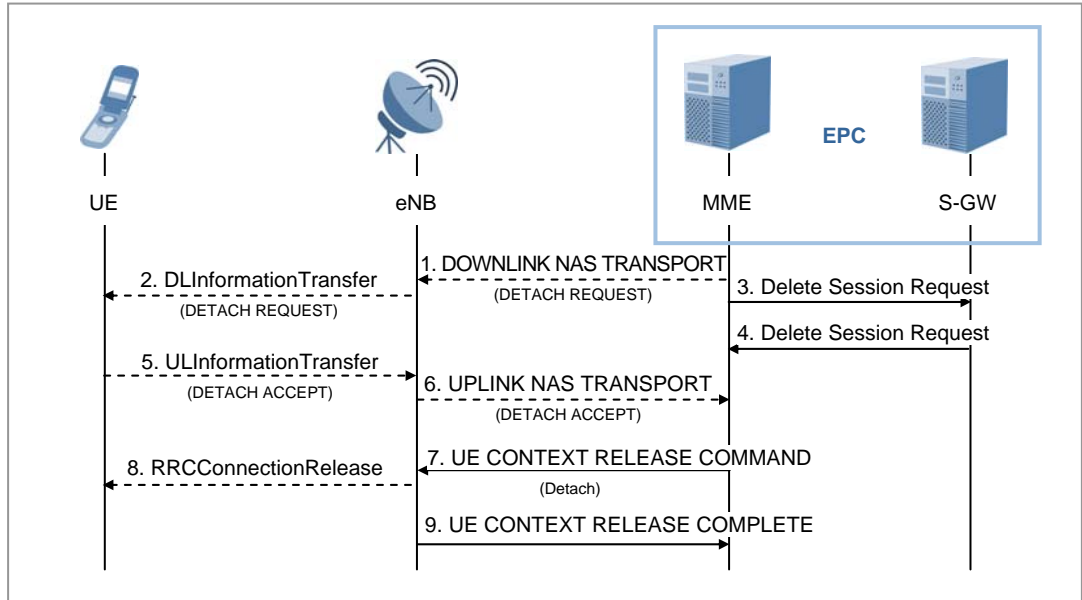


Figure 4.5 MME initiated Detach procedure

Below is MME initiated Detach procedure.

Steps	Description
1-2	The MME may implicitly detach a UE, if it has not had communication with UE for a long period of time. The MME does not send a DETACH REQUEST message to the UE for implicit detach. If the UE is in connected state the MME may explicitly detach the UE by sending the DETACH REQUEST message to the UE.
3-4	Steps 3-4 in table of UE initiated Detach procedure.
5-6	If the UE receives the DETACH REQUEST message from the MME in step 2, the UE sends a DETACH ACCEPT message to the MME any time after step 2. The eNB forwards this NAS message to the MME.
7	After receiving the DETACH ACCEPT message and the Delete Session Response message, the MME releases S1 for the UE by sending a UE CONTEXT RELEASE COMMAND message to the eNB with Cause IE set to 'Detach'.
8-9	Steps 8-9 in table of UE initiated Detach procedure.

4.4 Intra E-UTRAN Handover Procedure

We present X2-based Handover procedure (TS 36.300), S1-based Handover procedure (TS 23.401), and CDMA2000 HRPD Handover procedure (TS 23.402) in this section.

X2 based handover procedure

The X2-based Handover procedure is used to hand over a UE from a source eNB to a target eNB using the X2 reference point. In this procedure the MME is unchanged.

In addition to the X2 reference point between the source and target eNB, the procedure relies on the presence of S1-MME reference point between the MME and the source eNB as well as between the MME and the target eNB. Figure of X2 based handover procedure illustrates a call flow for the X2-based Handover procedure, and table of X2 based handover procedure shows functional description for each step of the procedure.

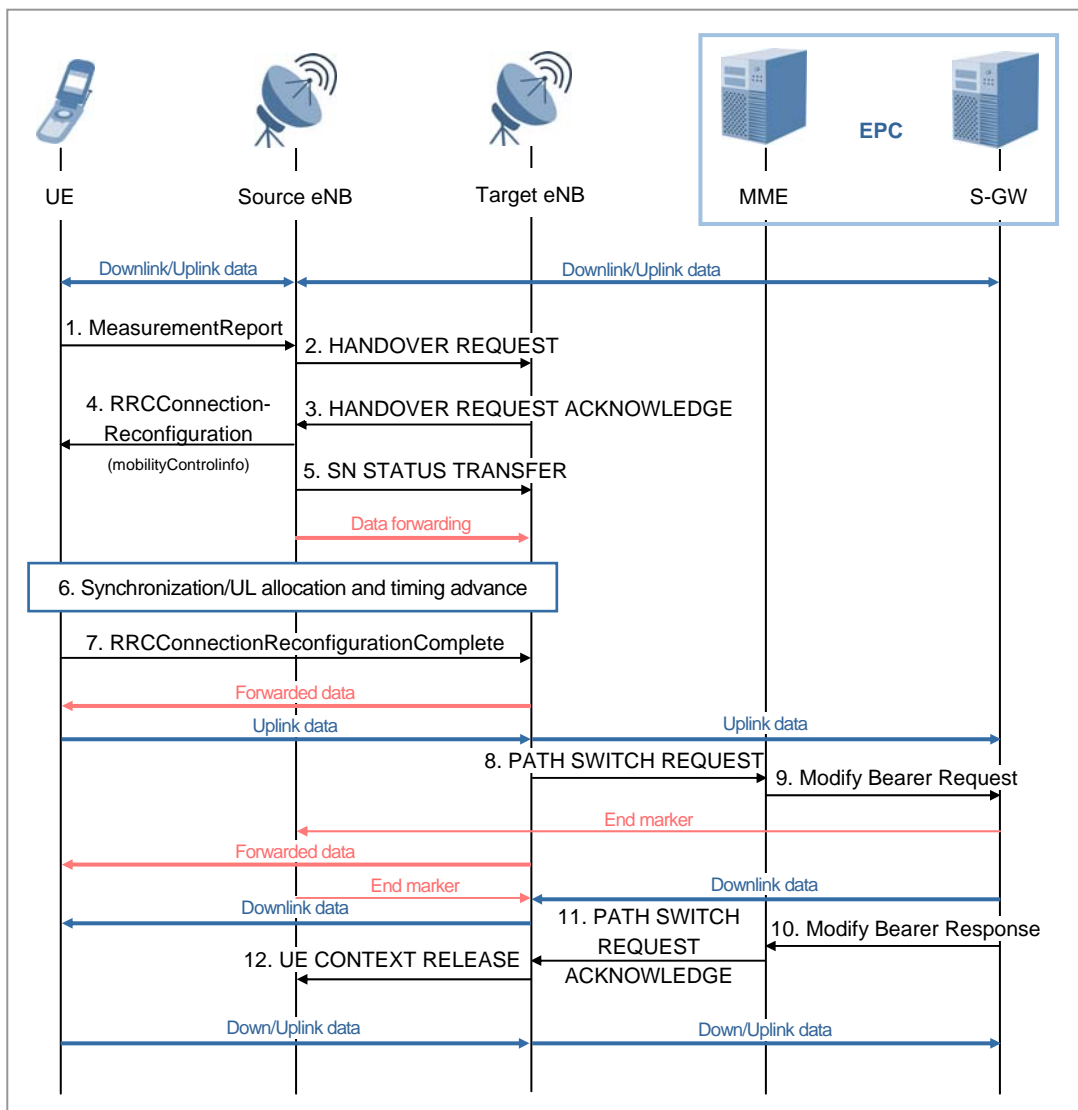


Figure 4.6 X2 based handover procedure

Below is X2 based handover procedure.

Steps	Description
1	The UE is triggered to send a MeasurementReport message by the rules set (i.e., system information, specification, and other things). The source eNB makes decision based on the MeasurementReport message and RRM information to hand over the UE.
2	The source eNB issues a HANDOVER REQUEST message to the target eNB passing necessary information to prepare the handover at the target side. Admission control may be performed by the target eNB dependent on the received E-RAB QoS information.
3-4	The target eNB prepares the handover and generates an RRC message RRCConnection-Reconfiguration including the mobilityControlInfo IE to perform the handover. The target eNB sends a HANDOVER REQUEST ACKNOWLEDGE message to the source eNB including the RRCConnectionReconfiguration message. The source eNB sends the RRCConnectionReconfiguration message with necessary parameters to the UE. The UE is commanded by the source eNB to perform the handover.
5	The source eNB sends an SN STATUS TRANSFER message to the target eNB to convey the uplink PDCP SN receiver status and the downlink PDCP SN transmitter status of E-RABs for which PDCP status preservation applies. The source eNB forwards the downlink data packets to the target eNB, and the target eNB buffers the packets.
6	After receiving the RRCConnectionReconfiguration message including the mobility-ControlInfo IE, the UE performs synchronization to the target eNB and accesses the target cell via Random Access CHannel (RACH). The target eNB responds with UL allocation and timing advance.
7	When the UE has successfully accessed the target cell, the UE sends an RRCConnection-ReconfigurationComplete message to the target eNB to indicate that the handover procedure is completed for the UE.
8	The target eNB sends a PATH SWITCH REQUEST message to the MME to inform that the UE has changed cell.
9-10	The MME sends a Modify Bearer Request message to the S-GW. The S-GW switches the downlink data path to the target side. The S-GW sends one or more 'end marker' packets on the old path to the source eNB and then can release any user plane resources towards the source eNB. The S-GW sends a Modify Bearer Response message to the MME.
11	The MME confirms the PATH SWITCH REQUEST message with a PATH SWITCH REQUEST ACKNOWLEDGE message.
12	By sending a UE CONTEXT RELEASE message, the target eNB informs success of handover to the source eNB and triggers the release of resources by the source eNB. Upon reception of the UE CONTEXT RELEASE message, the source eNB can release radio and control plane related resources associated to the UE context.

S1 based handover procedure

The S1-based Handover procedure is used when the X2-based handover cannot be used. A UE performs the handover from the source eNB to the target eNB using the S1-MME reference point. This procedure may relocate the MME.

The MME should not be relocated during inter-eNB handover unless a UE leaves the MME Pool Area where the UE is served. In this section, we assume that the UE does not leave the MME Pool Area during the handover.

The source eNB decides which of the EPS bearers are subject for forwarding of packets from the source eNB to the target eNB. Packet forwarding can take place either directly from the source eNB to the target eNB, or indirectly from the source eNB to the target eNB via the S-GW. The availability of a direct forwarding path is determined in the source eNB and indicated to the MME. If X2 connectivity is available between the source and target eNBs, a direct forwarding path is available. If a direct forwarding path is not available, indirect forwarding may be used. The MME uses the indication from the source eNB to determine whether to apply indirect forwarding. Figure of S1 based handover procedure illustrates a call flow for the S1-based Handover procedure, and table of S1 based handover procedure shows functional description for each step of the procedure.

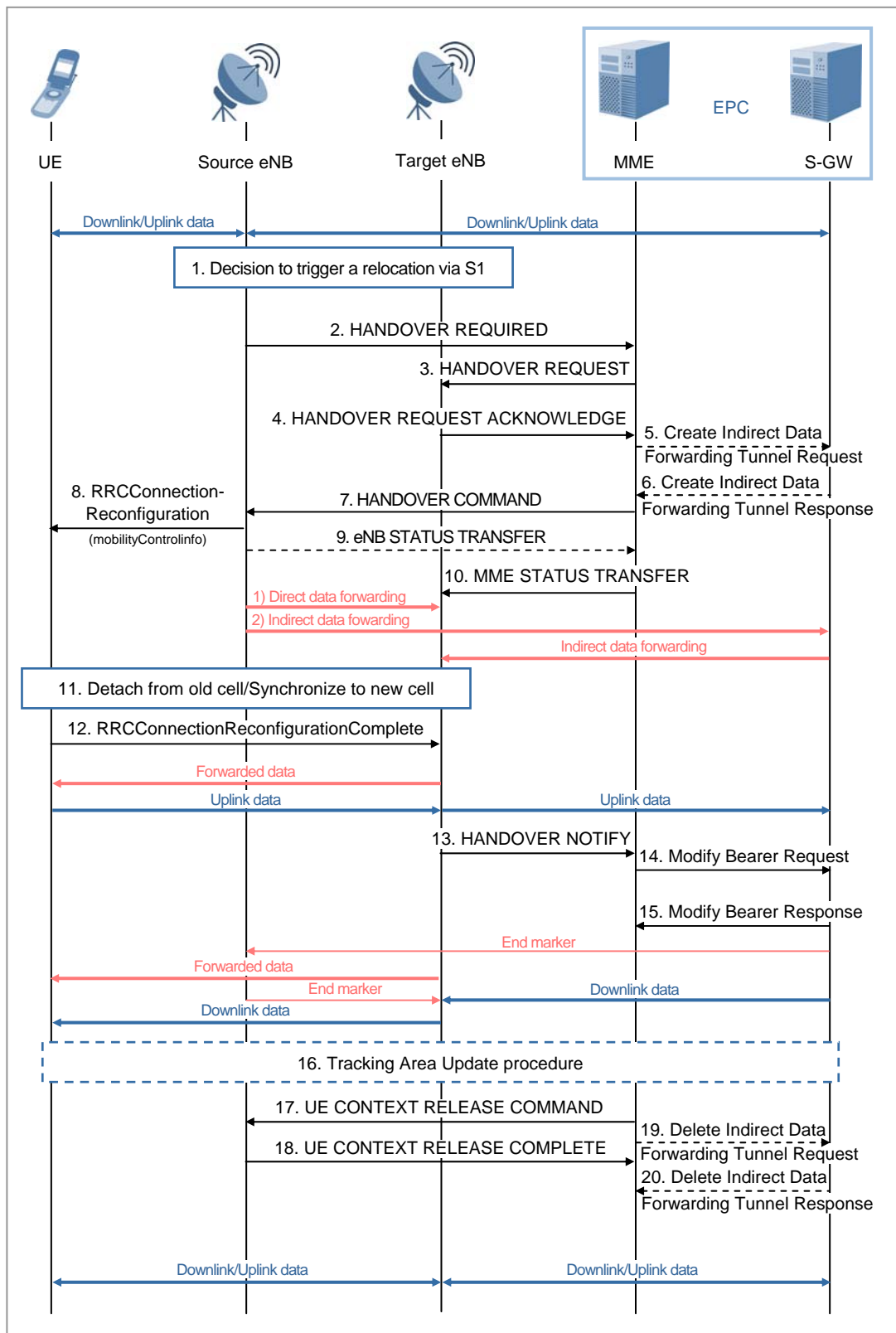


Figure 4.7 S1 based handover procedure

Below is S1 based handover procedure.

Steps	Description
1	The source eNB decides to initiate an S1-based handover to the target eNB. This can be triggered e.g. by no X2 connectivity to the target eNB, or by an error indication from the target eNB after an unsuccessful X2-based handover, or by dynamic information learnt by the source eNB.
2	The source eNB sends a HANOVER REQUIRED message to the MME. The source eNB indicates which bearers are subject to data forwarding and whether direct forwarding is available from the source eNB to the target eNB. This indication from source eNB can be based on e.g., the presence of X2.
3-4	The MME sends a HANOVER REQUEST message to the target eNB. This message creates the UE context in the target eNB, including information about the bearers, and the security context. The target eNB sends a HANOVER REQUEST ACKNOWLEDGE message to the MME.
5-6	If indirect forwarding applies, the MME sends a Create Indirect Data Forwarding Tunnel Request to the S-GW. The S-GW responds with a Create Indirect Data Forwarding Tunnel Response message to the MME.
7-8	The MME sends a HANOVER COMMAND message to the source eNB. The source eNB constructs an RRC message RRCConnectionReconfiguration using the Target to Source Transparent Container IE in the HANOVER COMMAND message and sends the RRC message to the UE.
9-10	The source eNB sends an eNB/MME STATUS TRANSFER message to the target eNB via the MME to convey the PDCP and HFN status of the E-RABs for which PDCP status preservation applies. The source eNB may omit sending this message if none of the E-RABs of the UE shall be treated with PDCP status preservation. The source eNB should start forwarding of downlink data from the source eNB towards the target eNB for bearers subject to data forwarding. This may be either direct or indirect forwarding.
11	The UE performs synchronization to the target eNB and accesses the target cell via RACH. The target eNB responds with UL allocation and timing advance.
12	After the UE has successfully synchronized to the target cell, the UE sends an RRCConnectionReconfigurationComplete message to the target eNB to confirm the handover. Downlink packets forwarded from the source eNB can be sent to the UE. Also, uplink packets can be sent from the UE, which are forwarded to the S-GW.
13	The target eNB sends a HANOVER NOTIFY message to the MME. Timers in the MME are started to supervise when resources in the source eNB and the temporary resources used for indirect forwarding in the S-GW shall be released.
14	The MME sends a Modify Bearer Request message to the S-GW for each PDN connection. Downlink packets from the S-GW are immediately sent on to the target eNB.
15	The S-GW sends a Modify Bearer Response message to the MME. The S-GW shall send one or more 'end marker' packets on the old path immediately after switching the path in order to assist the reordering function in the target eNB.

(Continued)

Steps	Description
16	The UE initiates a Tracking Area Update procedure when one of the conditions listed in Section 5.3.3.0 of TS 23.401 applies.
17-18	When the timer started in step 13 expires the MME sends a UE CONTEXT RELEASE COMMAND message to the source eNB. The source eNB releases its resources related to the UE and responds with a UE CONTEXT RELEASE COMPLETE message.
19-20	If indirect forwarding was used then the expiry of the timer at the MME started in step 13 triggers the MME to send a Delete Indirect Data Forwarding Tunnel Request message to the S-GW to release the temporary resources used for indirect forwarding that were allocated at step 5. The S-GW responses with a Delete Indirect Data Forwarding Tunnel Response message to the MME.

4.5 Network Synchronization Signal Flow

The LTE eNB supports GPSR in synchronization mode. In GPS synchronization mode, the UCCM receives the synchronization signals from the GPS and generates clocks and distributes them within the L9DU.

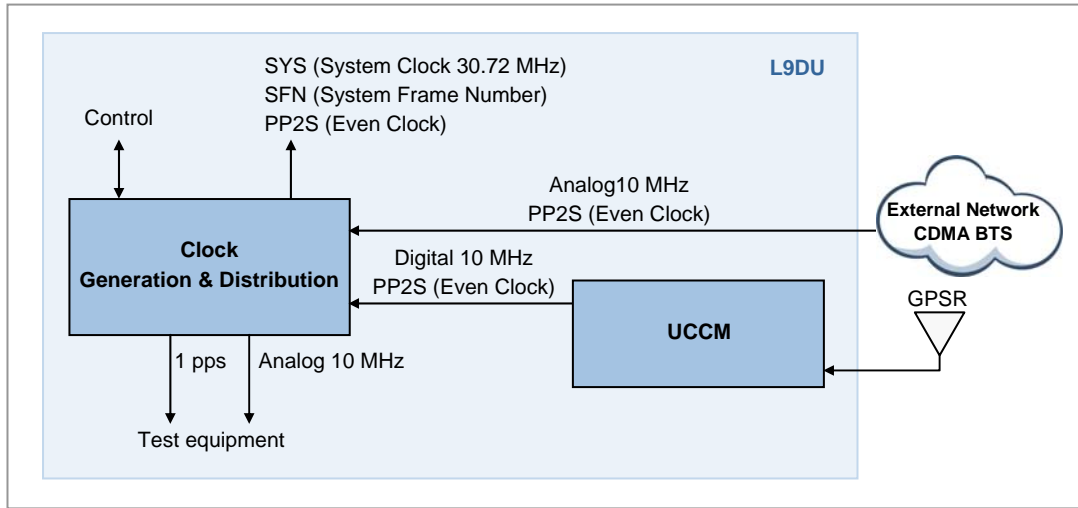


Figure 4.8 DU Synchronization Signal Flow

The synchronization signals are transmitted from the DU to the RU via the CPRI interface, and clocks are extracted from the CPRI signals and used as synchronization signals for the RU.

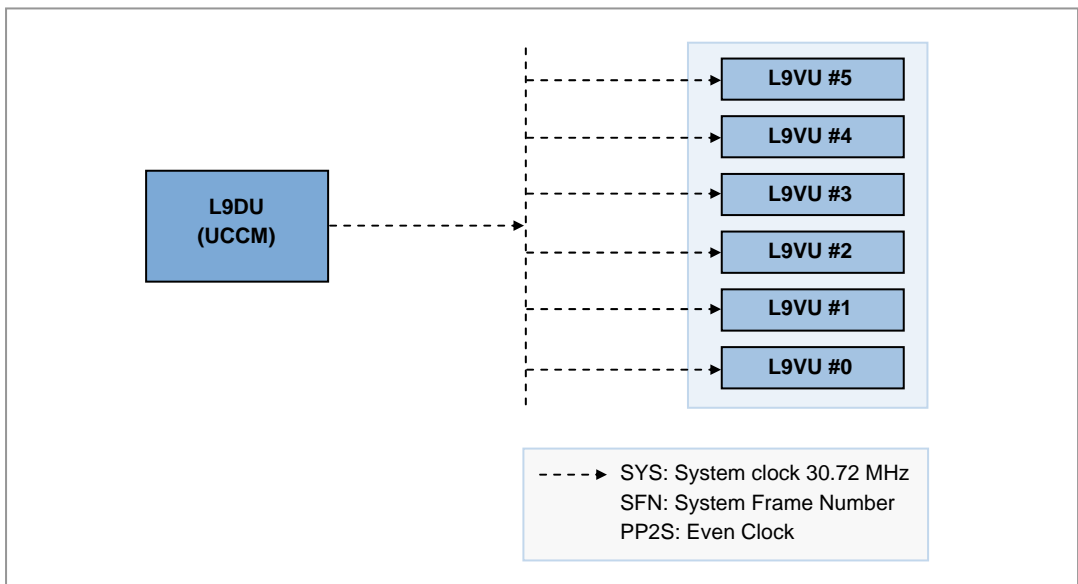


Figure 4.9 RU Synchronization Signal Flow

4.6 Alarm and Reset Signal Flow

In LTE eNB, when an environmental fault occurs or H/W is mounted or unmounted, it is reported using an alarm signal. All alarms are collected in the DU and reported to the management system, LSM. The alarms collected in the DU are as follows: The DU can provide through the UDA the alarms the user wants to provide. The DU provides the environmental alarms (flooding, door, fire, temperature, humidity, etc.) through the ECM and can control the fan. When the operator wants to reset a board or unit, he carries out a remote reset through the DU.

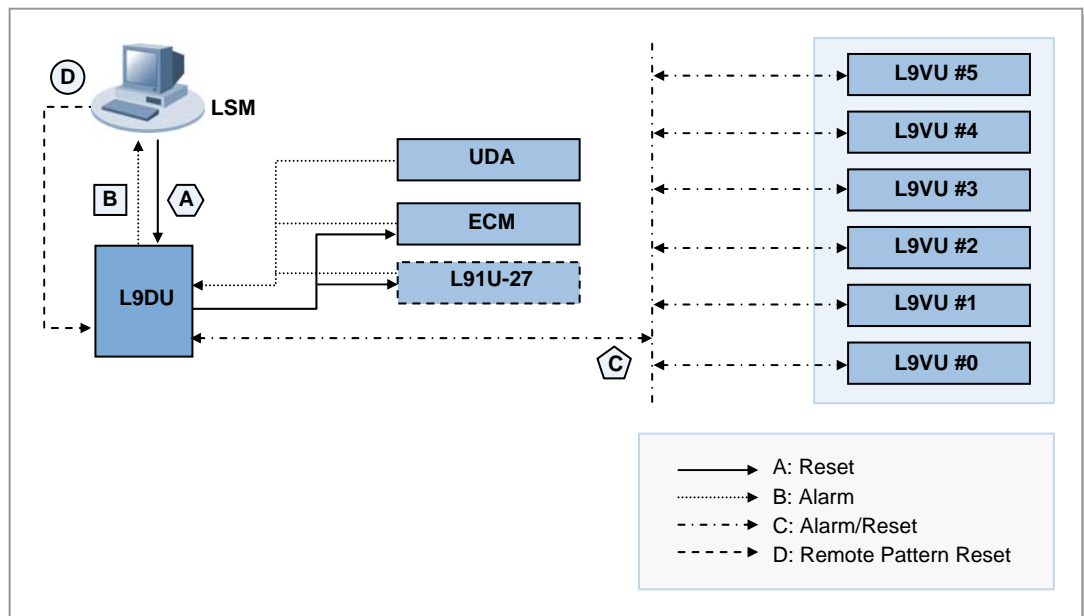


Figure 4.10 Alarm and Reset Signal Flow

4.7 Loading Flow

Loading is the procedure for downloading the necessary software executables and data from the upper system so that each processor and device of the system can be operated normally, or the procedure for executing the related software executables from the non-volatile storage media within the system. Loading is performed when the system is initialized or restarted. The loading for a board is performed when it is mounted to the system, hardware reset is performed, and it is restarted by the operator's decision.

The loading process during the eNB initialization is as follows.

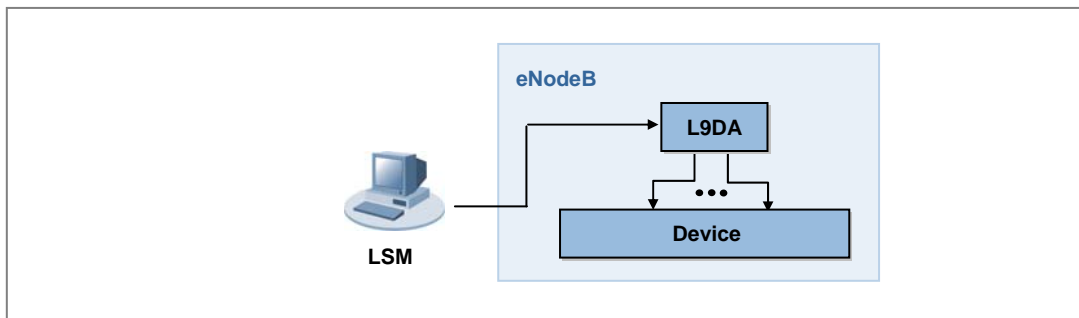


Figure 4.11 Loading Flow

Below is the signal flow for loading.

- 1) The LSM initializes the L9DA.
- 2) The L9DA initializes sub devices using the software downloaded by the LSM.

When loading is performed while the eNB is operating because the software has changed, package version replacement or block change, etc. is applied depending on the scope of the software changes. Also, the L9DA loads and stores the changed program during operation and then replaces the previous version program with it when the processor is restarted.

The operator can view the information for the program loaded in eNB using the system output window of the LSM.

4.8 Operation and Maintenance Signal Flow

The eNB collects various events (statistics, status, faults etc.) that occur within the system and reports them to the LSM. The LSM displays them in the system output window or the alarm status window so that the operator can know the status of each system within a station.

The statistics events are collected and transmitted to the LSM every five (5) minutes, while other operation and maintenance events are reported in real time.

The flow of the eNB operation and maintenance signals is as follows.

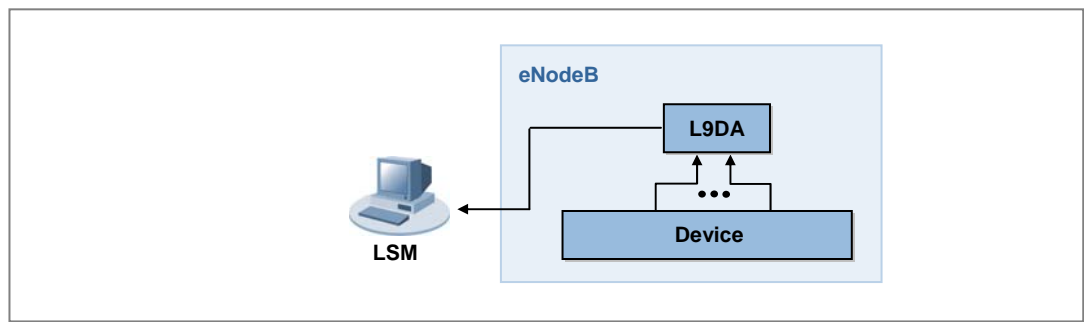


Figure 4.12 Operation/Maintenance Signal Flow

The signal flow for the operation and maintenance is given below.

- 1) Each device reports various events (status, faults, etc.) to the L9DA.
- 2) The L9DA collects the reported events and reports them to the LSM.



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CHAPTER 5. Additional Functions and Tools

5.1 Command Line Interface (CLI)

The CLI is used to operate and maintain eNB. The operator must log in to the eNB via telnet from a PC that can be connected to that eNB via Ethernet, and then the operator should run the CLI program within that eNB to execute the text-based operation and maintenance commands.

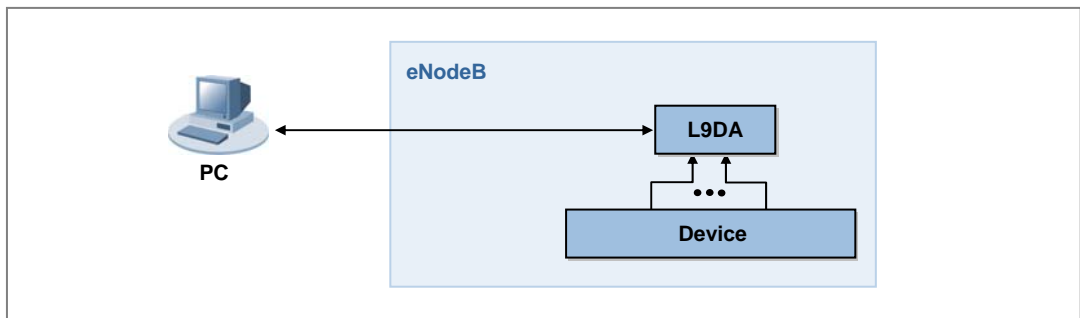


Figure 5.1 Connecting to the CLI

Below are the functions the CLI provides.

Loading

The CLI provides the function that loads a program necessary for the eNB. Therefore, the CLI can initialize the eNB normally without synchronizing with the LSM and can load a specific device selectively. And, it can reset or restart each board of the eNB.

Configuration management

The CLI provides the function that executes the Man-to-Machine Commands (MMC) that allow viewing and changing the configuration information for the eNB.

Status Management

The CLI provides the function that manages the status for the processors and various devices of the eNB.

Fault Management


The CLI checks whether there are any faults with the processors and various devices of the eNB and provides the operator with the location and log of each fault. Since the CLI can display both of the hardware and software faults, the operator can know all faults that occur in the eNB.

Diagnosis and Test

The CLI provides the function that diagnoses the connection paths, processors, and various devices that are being operated in the eNB, and provides the test function that can detect a faulty part. The major test functions that the CLI can perform include measuring the sending output and the antenna diagnosis function, etc.



MPE Information

	<p>Warning: Exposure to Radio Frequency Radiation The radiated output power of this device is far below the FCC radio frequency exposure limits. Nevertheless, the device should be used in such a manner that the potential for human contact during normal operation is minimized. In order to avoid the possibility of exceeding the FCC radio frequency exposure limits, human proximity to the antenna should not be less than 1050cm during normal operation. The gain of the antenna is 20.5 dBi. The antenna(s) used for this transmitter must not be co-located or operating in conjunction with any other antenna or transmitter.</p>
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ABBREVIATION

3

3GPP 3rd Generation Partnership Project

A

AAA Authentication, Authorization and Accounting
 ACL Access Control List
 ADC Analog to Digital Converter
 AKA Authentication and Key Agreement
 ARQ Automatic Repeat Request
 AWS Advanced Wireless Services

B

BSP Board Support Package

C

CGF Charging Gateway Functionality
 CLI Command Line Interface
 CM Configuration Management
 CN Core Network
 CPLD Complex Programmable Logic Device
 CPRI Common Public Radio Interface
 CPS Call Processing Software
 CS Chipselect

D

DAC Digital to Analog Converter
 DD Device Driver
 DHCP Dynamic Host Configuration Protocol
 DNS Domain Name Service

E

ECCB eNB Call Control Block
 ECMB eNB Common Management Block

ABBREVIATION

EIR	Equipment Identity Register
EMS	Element Management System
EMTS	Element Maintenance Terminal Server
eNB	E-UTRAN NodeB
EPC	Evolved Packet Core
EPS	Evolved Packet System
E-UTRA	Evolved Universal Terrestrial Radio Access
E-UTRAN	Evolved Universal Terrestrial Radio Access Network

F

FM	Fault Management
FTP	File Transfer Protocol

G

GPRS	General Packet Radio Service
GTP	GPRS Tunneling Protocol
GTPB	GTP Block
GTP-U	GPRS Tunneling Protocol – User
GW	Gateway

H

HA	High Availability
HARQ	Hybrid Automatic Repeat Request
HSS	Home Subscriber Server
HTTP	Hypertext Transfer Protocol

I

IPC	Inter Process Communication
IPRS	IP Routing Subsystem
IPSec	IP Security

L

L9VU	LTE eNB Amp, Transceiver Unit
L9FU	LTE eNB Filter Unit
L9DA	LTE eNB Digital board Assembly
L9DB	LTE eNB Digital Backplane board assembly
L9DU	LTE eNB Digital Unit
LAG	Link Aggregation
LKC	Linux Kernel Core
LOG	Log Management
LSM	LTE System Manager
LSS	LTE SON server
LTE	Long Term Evolution

M

MAC	Medium Access Control
MACB	MAC Block
MIF	Management Interface
MIMO	Multiple Input Multiple Output
MME	Mobility Management Entity
MS	Mobile Station
MW	Middleware

N

NAS	Non Access Stratum
NP	Network Processing

O

OAM	Operation and Maintenance
OCS	Online Charging System
OFDM	Orthogonal Frequency Division Multiplexing
OFDMA	Orthogonal Frequency Division Multiple Access
OS	Operating System

P

PCEF	Policy and Charging Enforcement Function
PCRF	Policy Charging & Rule Function
PDCB	PDCP Block
PDCP	Packet Data Convergence Protocol
PDN	Packet Data Network
PDU	Protocol Data Unit
P-GW	PDN GW
PM	Performance Management
PMIP	Proxy Mobile IP

Q

QAM	Quadrature Amplitude Modulation
QoS	Quality of Service

R

RLC	Radio Link Control
RLCB	RLC Block
RRC	Radio Resource Control

S

SC-FDMA	Single Carrier - Frequency Division Multiple Access
SCTP	Control Transmission Protocol
SDMA	Spatial Domain Multiple Access

ABBREVIATION

SFN	System Fame Number
SFTP	Secure FTP
SGSN	Serving GPRS Support Node
S-GW	Serving GW
SM	Security Management
SNMP	Simple Network Management Protocol
SOAP	Simple Object Access Protocol
SSL	Secure Socket Layer
SwM	Software Management

T

TL1	Transaction Language 1
TM	Test Management
TRM	Trace Management

U

UCCM	Universal Core Clock Module
UDA	User-Defined Alarm
UDP	User Datagram Protocol
UE	User Equipment
UTRAN	UMTS Terrestrial Radio Access Network

U

VLAN	Virtual LAN	UDA	User-Defined Alarm
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W

Web-EMT	Web based-Element Maintenance Terminal
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MetroPCS User Manual

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