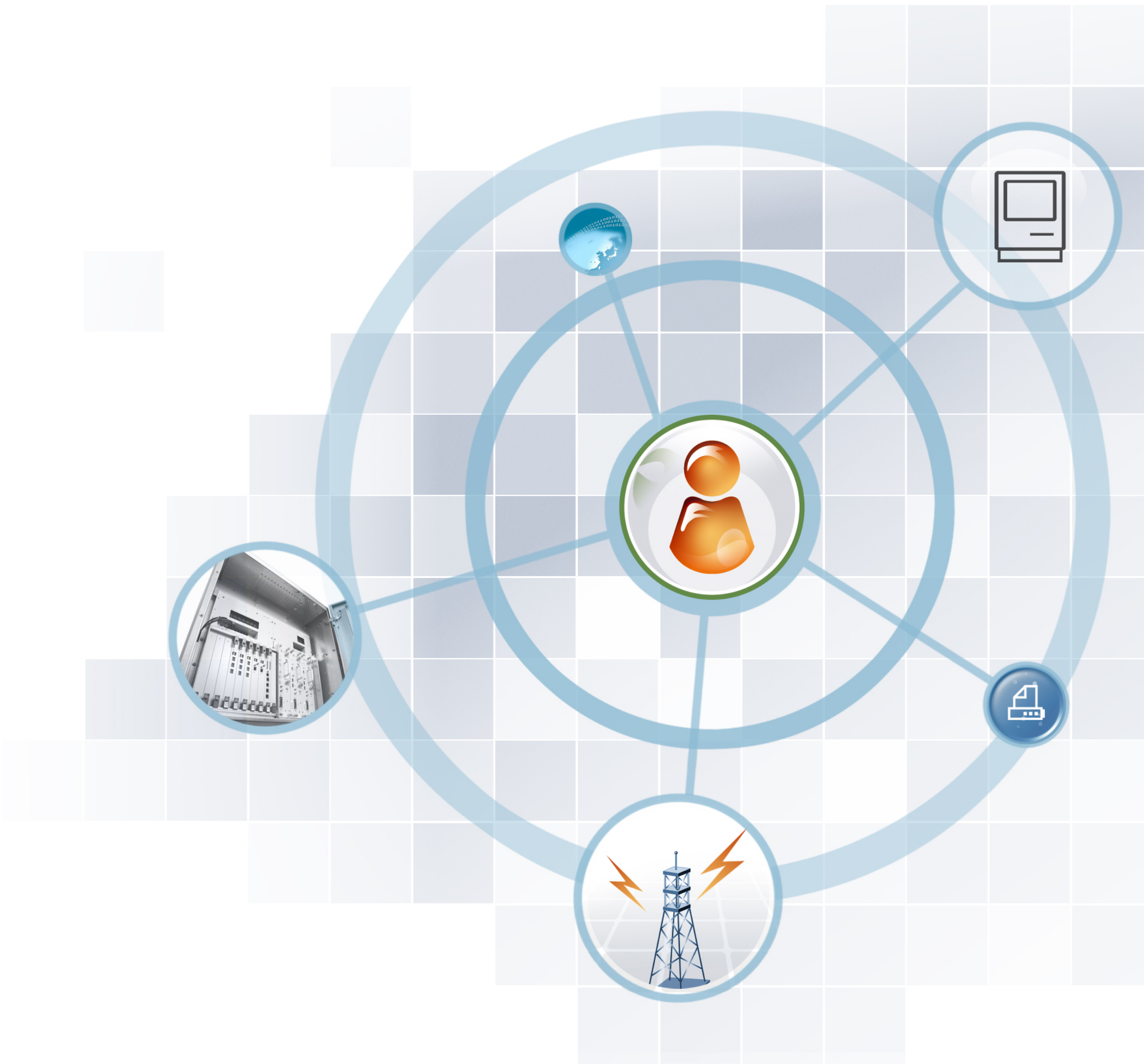
2600-00ESBTGA2

Ver. 1.0

Mobile WiMAX/TD-LTE BS TD-LTE Flexible

System Description



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INTRODUCTION

Purpose

This description describes the characteristics, functions and structures of the TD-LTE Flexible system(SLS-BD104), which is the base station for Mobile WiMAX/TD-LTE multi-mode.

Document Content and Organization

This description is composed of five chapters and an abbreviation as follows:

CHAPTER 1. Overview of WiMAX/TD-LTE Multi-Mode

- WiMAX/TD-LTE Multi-Mode Introduction
- Components of WiMAX/TD-LTE Multi-Mode Network

CHAPTER 2. Overview of System

- System Introduction
- Major functions
- Resources
- Interface between the Systems

CHAPTER 3. System Structure

- Hardware Structure
- Software Structure

CHAPTER 4. Message Flow

- Call Processing Message Flow
- Network Synchronization Message Flow
- Alarm Message Flow
- Loading Message Flow
- Operation and Maintenance Message Flow

CHAPTER 5. Additional Functions and Tools

- Web-EMT

ABBREVIATION

Describes the acronyms used in this description.

Conventions

The following types of paragraphs contain special information that must be carefully read and thoroughly understood. Such information may or may not be enclosed in a rectangular box, separating it from the main text, but is always preceded by an icon and/or a bold title.

NOTE

NOTE
Indicates additional information as a reference.

Revision History

EDITION	DATE OF ISSUE	REMARKS
1.0	04. 2012.	First Edition

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CHAPTER 1. Overview of WiMAX/TD-LTE Multi-Mode

1.1 WiMAX/TD-LTE Multi-Mode Introduction

Mobile communications have been expanding from voice services to data services as it evolves from the first-generation analog mobile communication through the second-generation digital mobile communication, the third-generation CDMA2000 and to the fourth-generation Mobile WiMAX/LTE. As the convergence of wired and wireless services is widely available and new handset devices such as smartphones are gaining popularity, there is an ever increasing demand for communication technologies that can facilitate high-speed wireless transmission of data. Mobile communication networks continue to evolve with new communication technologies, and new handsets are made available, which support various technologies.

The Mobile WiMAX/TD-LTE multi-mode system meets the changing requirements of the mobile communication industry as it supports a wide variety of communication technologies. It enables provision of Mobile WiMAX and TD-LTE services with a single system.

The communication technologies supported by the WiMAX/TD-LTE multi-mode system are as follows.

- WiMAX IEEE 802.16e
  Samsung WiMAX system is the wireless network system that supports IEEE 802.16 base service. The IEEE 802.16 standard is the basis of Mobile WiMAX, and includes IEEE Std 802.16-2004 defining fixed wireless internet access service and IEEE Std 802.16, P802.16-2004/Cor2/D3 defining the technologies supporting mobility, which include handover, paging. The Mobile WiMAX system uses the Orthogonal Frequency Division Multiple Access (OFDMA) transmission technology based on the Time Division Duplex (TDD) method, so the system provides high-speed data services and wider coverage than existing wireless LANs.
  In addition, system performance and capacity have increased as a result of high-performance hardware; it is capable of providing various high-speed data functions and services.
- Long Term Evolution (LTE)
  The Samsung LTE system is a wireless network system supporting 3GPP LTE based services. Having improved the disadvantages of low transmission speed and the high cost of the data services provided by the existing 3GPP mobile communication system, it is a next generation wireless network system that can provide high-speed data services at a low cost regardless of time and location.

The Samsung LTE system supports the downlink Orthogonal Frequency Division Multiple Access (OFDMA) transmission technology and the uplink Single Carrier (SC) FDMA transmission technology in TDD mode, and supports scalable bandwidths for supporting various spectrum allocations to provide high-speed data services.
In addition, system performance and capacity have increased as a result of high-performance hardware; it is capable of providing various high-speed data functions and services.

The main features of the WiMAX/TD-LTE multi-mode system are as follows.

- Expansion to 4G Service
  The WiMAX/TD-LTE multi-mode system is capable of providing existing Mobile WiMAX services using the common platform without the need of installing any additional equipment. With addition of TD-LTE channel card and software upgrades, it can also provide TD-LTE services.
  Therefore, the WiMAX/TD-LTE multi-mode system provides an efficient way of installing a TD-LTE network by using the existing cables, rectifiers, batteries and other devices.
- Green Solution
  The WiMAX/TD-LTE multi-mode system accommodates the Mobile WiMAX system and the TD-LTE system in one structure, reducing the number of devices required.
  In particular, the Samsung TD-LTE Flexible system separates the transmission/reception processing unit and the RF unit using Remote RF Head (RRH) mechanism for natural cooling, resulting in reduction of equipment footprint, power consumption and carbon dioxide emission.
- Efficient Backhaul Operation
  The WiMAX/TD-LTE multi-mode system helps reduce backhaul operation costs since it physically integrates multiple communication technologies in its backhaul network operation. The WiMAX/TD-LTE multi-mode system is capable of logically separating networks based on the communication technologies. It also helps maintain a high level of efficiency in backhaul operation by minimizing traffic interference between the technologies.

> NOTE
>
> **TD-LTE Flexible System**
> TD-LTE Flexible system is the base station of Samsung's multi-mode system. It functions as RAS in Mobile WiMAX and as eNB in TD-LTE. It is controlled by a higher NE (ACR in Mobile WiMAX and EPC in TD-LTE) and connects WiMAX/TD-LTE calls to Mobile Station (MS).

The functions of the WiMAX/TD-LTE multi-mode system for each communication technology are as follows.

Mobile WiMAX System Functions

The figure below shows the functions of the Access Service Network (ASN) systems (ACR and RAS) based on Profile C.
Each block name complies with the standard of Mobile WiMAX NWG.

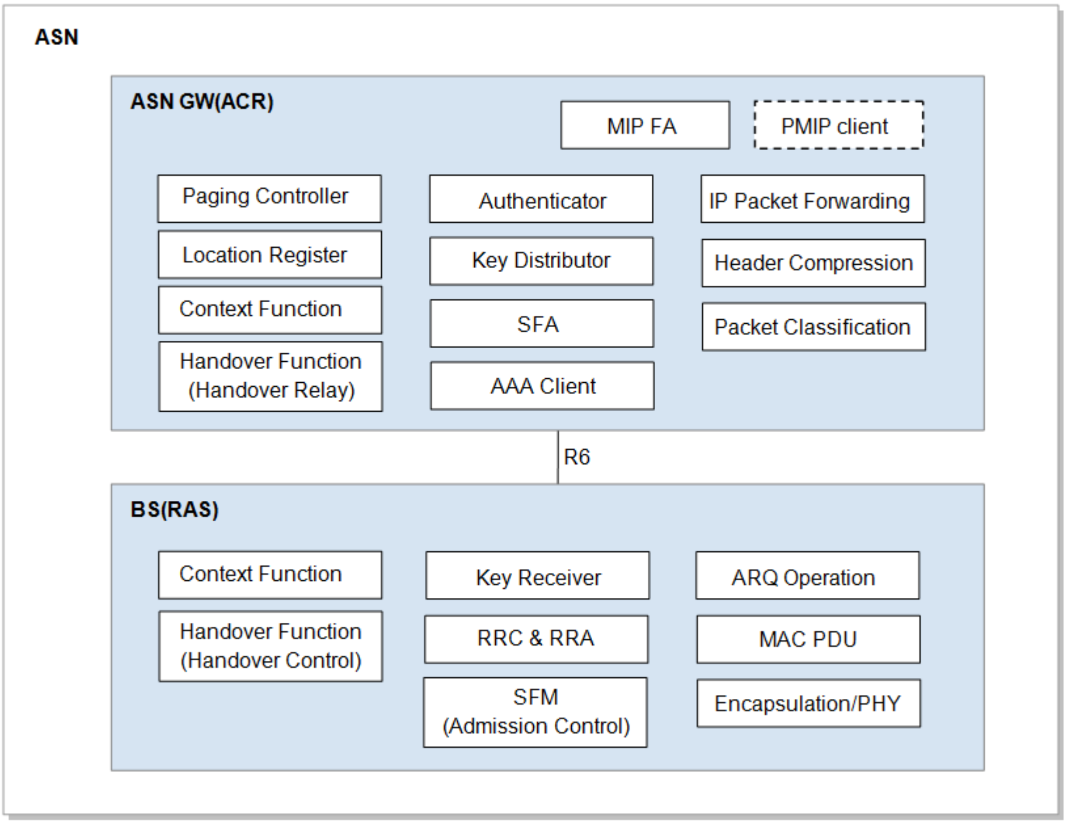

Figure 1.1 Configuration of Mobile WiMAX System Functions (Based on Profile C)

The ASN-GW(ACR) supports the Convergence Sublayer (CS) and performs the packet classification and Packet Header Suppression (PHS) functions. When the ACR carries out the header compression function, it supports Robust Header Compression (ROHC) defined in the NWG standard. In addition, the ACR performs the paging controller and location register functions for a Mobile Station (MS) in Idle Mode.
In authentication, the ACR performs the authenticator function and carries out the key distributor function to manage the higher security key by interworking with the AAA server as an AAA client. At this time, RAS performs the key receiver function to receive the security key from the key distributor and manage it.
The ACR interworks with the AAA server of Connectivity Service Network (CSN) for authentication and charging services and with the HA of CSN for Mobile IP (MIP) service. The ACR as FA of MIP supports Proxy MIP (PMIP).
The BS(RAS) performs the Service Flow Management (SFM) function to create/change/release connections for each Service Flow (SF) and the admission control

function while creating/changing connections. In regard to the SFM function of the RAS, the ACR carries out the SF Authentication (SFA) and SFID management functions. The ACR carries out the SFA function to obtain the QoS information from Policy Function (PF) and apply it in the SF creation and performs the SFID management function to create/change/release SFID and map SF according to the packet classification.
In handover, the RAS performs the handover control function to determine the execution of the handover and deal with corresponding handover signaling. The ACR confirms the neighbor RAS list and relays the handover signaling message to the target system. At this time, the ACR and the RAS carries out the context function to exchange the context information between the target system and the serving system.
The RAS performs the Radio Resource Control (RRC) and RR Agent (RRA) functions to collect/manage the radio resource information (e.g., BSID) from MSs and the RAS itself.

LTE System Functions

The diagram below illustrates the functions of the eNB in E-UTRAN as well as the MME, Serving Gateway (S-GW), and PDN-Gateway (P-GW) according to the 3GPP standard. The eNB mainly manages a Connected Mode User Equipment (UE) at the Access Stratum (AS) level; the MME mainly manages the Idle Mode UE at the Non-Access Stratum (NAS) level; the S-GW and the P-GW perform management of user data and work with other networks at the NAS level.
The functions of the eNB, MME, S-GW, and P-GW are as follows.

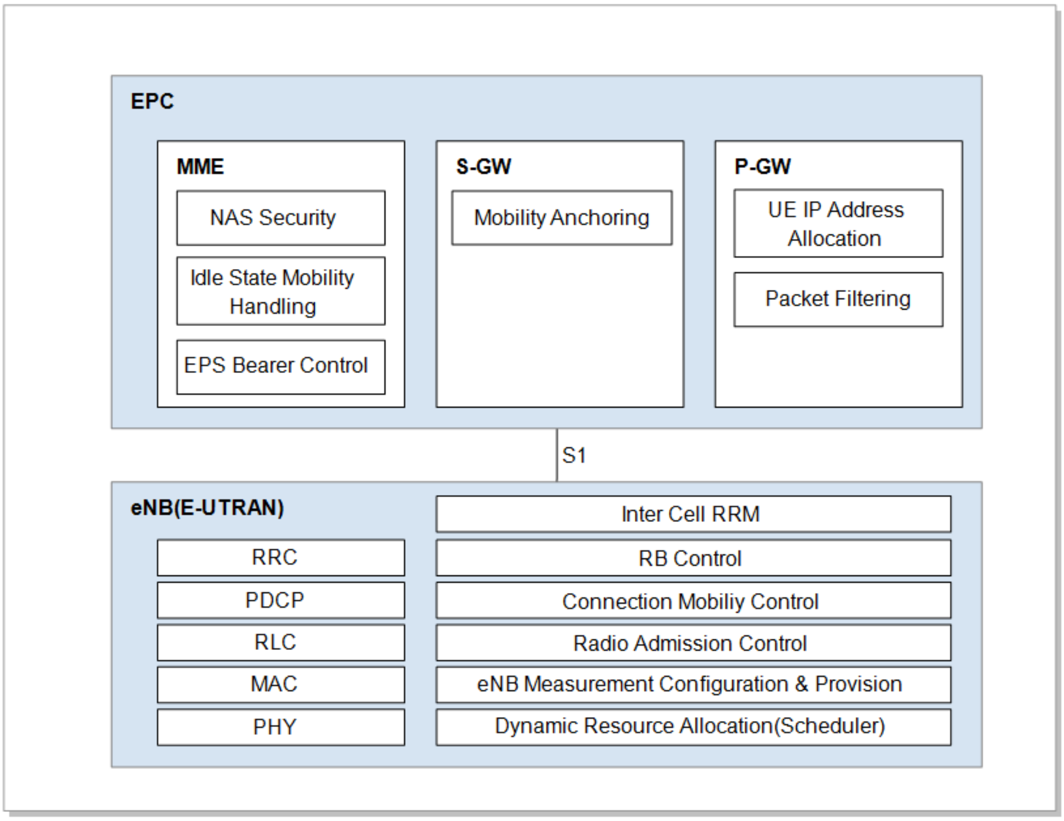

Figure 1.2 Configuration of LTE System Functions

The Mobility Management Entity (MME) interworks with the E-UTRAN (eNB) for handling the following messages.

- S1-AP signaling message of SCTP base: Controls connections between the MME and the eNB
- NAS signaling message of SCTP base: Controls mobility and connections between the UE and the EPC

Interworking with the HSS, the MME can obtain, change, and authenticate subscriber information. Interworking with the S-GW, the MME can also request allocation, release, and change of bearer paths for data routing and forwarding using the GTP-C protocol.
The MME can provide mobility, handover, CS fallback, and SMS services in interoperation with a 2G or 3G system such as SGSN and MSC.
The MME carries out the functions of inter-eNB mobility, idle mode UE reachability, Tracking Area (TA) list management, P-GW/S-GW selection, authentication, and bearer management. The MME supports mobility upon inter-eNB handover, and supports the inter-MME handover. It also supports the SGSN selection function upon handover to a 2G or 3G 3GPP network.
The S-GW carries out the mobility anchor function upon inter-eNB handover and inter-3GPP handover, and processes routing and forwarding of packet data. The S-GW allows the operator to set different charging policies by UE, PDN or QCI, and provides the functions for managing and changing the packet transport layers for uplink/downlink data. The S-GW also supports GTP and PMIP by interoperating with the MME, P-GW, and SGSN.
The P-GW establishes charging and bearer rules according to the policies as it interoperates with the PCRF. It can manage and change charging and transfer rate depending on the service level.
The P-GW provides the packet filtering function for each subscriber, and allocates an IP address to each UE. The P-GW can manage and change the packet transport layers for downlink data.
The eNB is responsible for Evolved-UTRAN (E-UTRAN) which is the wireless access network in the LTE system. The eNBs are interconnected over the X2 interface and their connections to Evolved Packet Core (EPC) are provided over the S1 interface.
In eNB, the wireless protocol layers mainly consist of Layer 1, Layer 2, and Layer 3. Layer 3 accommodates the RRC layer, and Layer 2 accommodates three sublayers: the MAC sublayer, RLC sublayer, and the PDCP sublayer, with the following independent functions.

- The RRC layer corresponds to Layer 3 of the wireless protocol. The RRC layer mainly performs mobility management within the wireless access network, maintenance and control of the Radio Bearer (RB), RRC connection management, and system information transmission, etc.
- The PDCP sublayer mainly carries out the IP packet header compression function, security functions such as ciphering and integrity check, and the selective transmission function for enhancing efficiency of wireless and wired resources at handover.
- The RLC sublayer performs segmentation and reassembly on the data received from the PDCP sublayer into the size specified by the MAC sublayer, restoration of the transmission by resending in case of transmission failure at lower-level layers (ARQ), and re-ordering of the HARQ operation of the MAC sublayer.

- The MAC sublayer distributes wireless resources to each bearer according to its priority, and carries out the multiplexing function and the Hybrid ARQ (ARQ) function for the data received from the multiple upper logical channels.

NOTE

Network System Function
For the detailed description about the system functions, refer to the system description for each system provided by Samsung.

1.2 WiMAX/TD-LTE Multi-Mode Network Configuration

The WiMAX/TD-LTE multi-mode system provides simultaneous support for Mobile WiMAX access service based on IEEE 802.16/16e and TD-LTE access based on 3GPP LTE air.

The network structure supported by the WiMAX/TD-LTE multi-mode system is as follows.

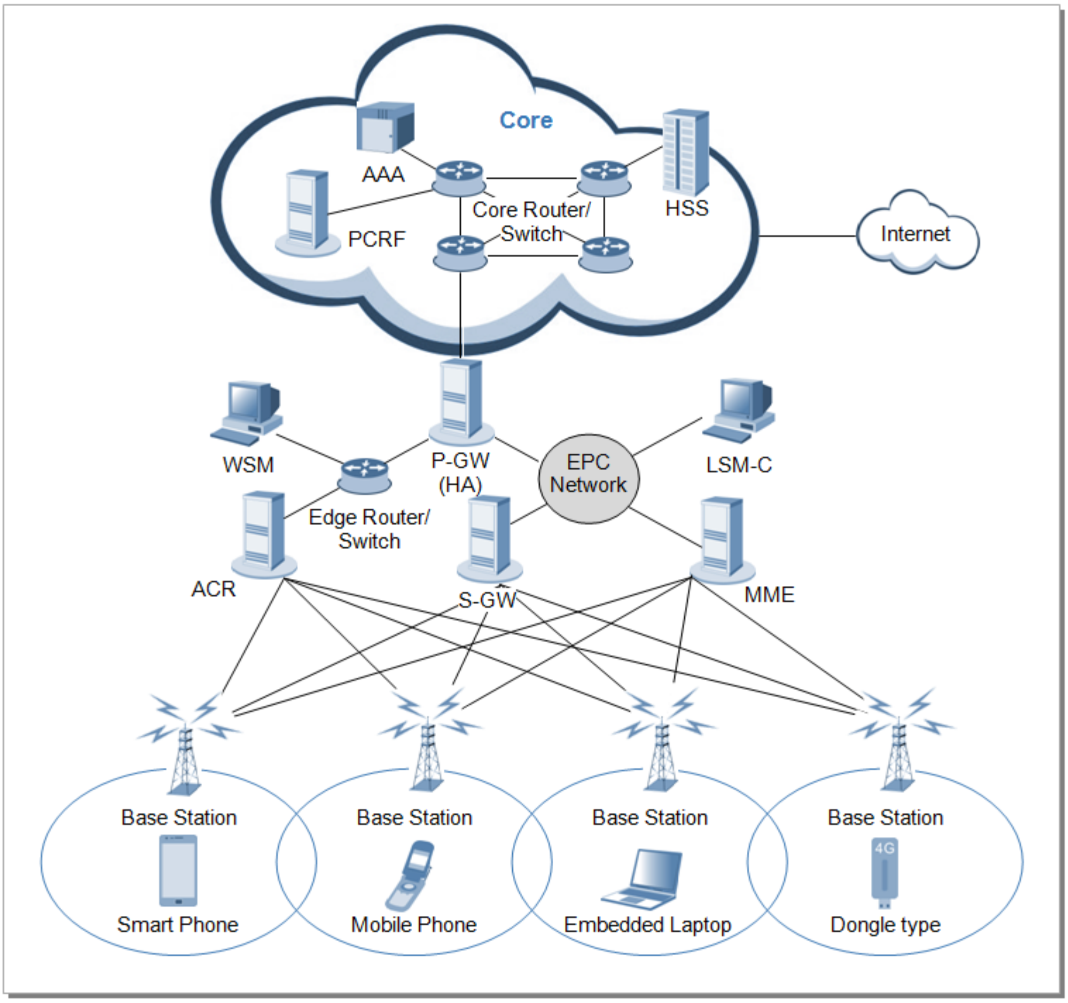

Figure 1.3 Network Configuration (Mobile WiMAX + TD-LTE)

The Mobile WiMAX system defined by the WiMAX forum standard refers to the ASN based on IEEE 802.16/16e. The internal elements of the ASN include the RAS which plays the 802.16 Medium Access Control (MAC)/Physical Layer (PHY) functions with MS and the ACR(ASN-GW) which is responsible for various control functions and interoperation with the CSN, which is the core network of wireless service provider.

The TD-LTE system consists of base station(eNB) and packet core(EPC). The network consisting multiple eNBs and EPCs (MME, S-GW/P-GW) is a subnet of the Packet Data Network (PDN). It provides interface between the UE and the external network.

The WSM supports operation and maintenance of the WiMAX/TD-LTE multi-mode system and the ACR. EPC, the packet core equipment of the TD-LTE, is operated and maintained by a separate LSM-C.

Base Station: Mobile WiMAX + TD-LTE

This system provides the RAS function of Mobile WiMAX and the eNB function of TD-LTE.

- RAS function of Mobile WiMAX
  RAS as the system between ACR and MS has the interface with ACR and provides the wireless connection to MS under IEEE 802.16 standards to support wireless communication service for subscribers.
  RAS carries out wireless signal exchange with MS, modulation/demodulation signal processing for packet traffic signal, efficient use of wireless resources, packet scheduling for Quality of Service (QoS) assurance, assignment of wireless bandwidth, Automatic Repeat request (ARQ) processing and ranging function. In addition, RAS controls the connection for packet calls and handover.
- eNB function of TD-LTE
  The eNB system is positioned between the EPC and the UE. It establishes wireless connections with the UE and processes packet calls according to the LTE air specification. The eNB is responsible for transmission of wireless signals, modulation and demodulation of packet traffic, packet scheduling for efficient use of wireless resources, HARQ/ARQ processing, the Packet Data Convergence Protocol (PDCP) function of packet header compression, and wireless resource control functions. Moreover, the eNB performs handover interworking with the EPC.

Access Control Router (ACR): Mobile WiMAX

ACR, which is the system between CSN and base station, enables several BSs to interwork with IP network, sends/receives traffic between external network and MS, and controls QoS. Also, the ACR provides interface for the NE(AAA server, etc.) of the CSN.

Evolved Packet Core (EPC): TD-LTE

The EPC is a system positioned between the base station and PDN, and consists of the MME and S-GW/P-GW. The MME processes control messages with the base station using the NAS signaling protocol, and processes the control plane, such as mobility management of the UE, Tracking Area (TA) list management, and bearer and session management.
The S-GW carries out the anchor function in the user plane between the 2G/3G access system and the LTE system, and manages and changes the packet transport layer for downlink/uplink data.
The P-GW allocates an IP address to the UE. For mobility between the TD-LTE system and the non-3GPP access system, the P-GW carries out the anchor function and manages and changes the charging and the transmission rate according to the service level.

Mobile WiMAX System Manager (WSM): Mobile WiMAX + TD-LTE

The WSM provides an integrated OAM interface for system management which the operator can use for operation and maintenance of the base station (WiMAX + TD-LTE) and the ACR. It also provides functions for software management, configuration management, performance management and fault management.

Home Agent (HA): Mobile WiMAX + TD-LTE

HA accesses other networks or private networks and enables Mobile IP (MIP) users to access internet. HA interworks with ACR that performs Foreign Agent (FA) function for Mobile IPv4 and interworks with MS to exchange data for Mobile IPv6.
In TD-LTE, the P-GW performs the HA function and interworks with the S-GW.

Authentication, Authorization and Accounting (AAA) Server: Mobile WiMAX + TD-LTE

AAA server interfaces with ACR and carries out subscriber authentication and accounting functions.
The AAA server interfaces with ACR(Mobile WiMAX)/P-GW(TD-LTE) via Diameter protocol and provides Extensible Authentication Protocol (EAP) certification.

Home Subscriber Server (HSS): Mobile WiMAX + TD-LTE

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 and supplementary services, and provides a routing function to the called subscriber.

Policy Charging & Rule Function (PCRF) Server: Mobile WiMAX + TD-LTE

The PCRF server 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. The IP edge includes the Policy and Charging Enforcement Function (PCEF), which allows application of policy rules received from the PCRF server to each service flow.
The PCRF server interfaces with the ACR and the EPC over the Diameter protocol and the Gx method respectively. It relays QoS configuration and charging rules for each user session to the ACR and the EPC.

LTE System Manager-Core (LSM-C): TD-LTE

The LSM-C provides an operator interface which the operator can use for operation and maintenance of the EPC. It also provides functions for software management, configuration management, performance management and fault management.

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CHAPTER 2. Overview of System

2.1 System Introduction

The TD-LTE Flexible system is a WiMAX/TD-LTE multi-mode base station. It is controlled by the ACR/EPC for connecting WiMAX/TD-LTE calls to the MS.
The TD-LTE Flexible system interfaces with MSs using WiMAX air channels based on the WiMAX specification (IEEE 802.16) or LTE air channels based on the 3GPP LTE Rel.8/9 specification. It provides high-speed data service and multimedia service in wireless broadband.
To this end, the TD-LTE Flexible system 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), Automatic Repeat request (ARQ) processing, ranging function, connection control function to transmit the information on the TD-LTE Flexible system and set/hold/disconnect the packet call connection, handover control, control station such as ACR/EPC interface function, power control function and system operation management function.
The TD-LTE Flexible system securely and rapidly transmits and receives various control signals and traffic signals by interfacing with the control station by the method selected by the operator among Fast Ethernet or Gigabit Ethernet.
Physically, the TD-LTE Flexible system consists of a Digital Unit (DU) and a Remote Radio Head (RRH). The RRH is located remotely from the DU. One DU can be connected to up to 3 RRHs.
The TD-LTE Flexible system supports up to 2 Carrier/3Sector service. The RRH is operated as follows.

- RRH-2WB(4Tx/4Rx RF path): Dual Mode
  - WiMAX 2Tx/2Rx(2x2 MIMO) + TD-LTE 2Tx/2Rx(2x2 MIMO)
  - 5 W + 5 W @ WiMAX 10 MHz channel BW
  - 10 W + 10 W @ TD-LTE 20 MHz channel BW

An RRH is a standalone RF unit. It is installed on an outdoor wall, pole or stand.
The main features of the TD-LTE Flexible system are as follows.

Common Platform

The digital boards mounted in the TD-LTE Flexible system share a common DU platform and each DU can accommodate channel cards for operating various communication technologies.
The RRH of the TD-LTE Flexible system can simultaneously provide WiMAX and TD-LTE communication technologies operating in the same frequency range.

Separate DU and RRH Structure

As the TD-LTE Flexible system consists of a DU and an RRH, it is easy to set up a network and it is easy to change the network configuration. For connections between the DU and RRH, data traffic signals and OAM information are sent/received through the 'Digital I/Q and C & M' interface based on the Common Public Radio Interface (CPRI). Physically, optic cables are used.
Each of the DU and RRH receives -48 VDC of power for its operation from different rectifier.

- Easy Installation
  The optic interface component that interfaces with the DU and the RF signal processing component is integrated into the RRH, which becomes a very small and very light single unit. Therefore, the RRH can be installed on a wall, pole or stand.
  Moreover, as the distance between the RRH and antenna is minimized, the loss of RF signals due to the antenna feeder cable can be reduced so that more enhanced RF receiving performance than the existing rack-type base station can be provided.
- Natural Cooling
  Because the RRH is installed outdoors and has an efficient design, it can radiate heat efficiently without any additional cooling system. Therefore, no additional maintenance cost is needed for cooling the RRH.
- Loopback Test
  The TD-LTE Flexible system provides the loopback test function to check whether communication is normal on the 'Digital I/Q and C & M' interface line between the DU and RRH.
- Remote Firmware Downloading
  The operator can upgrade the RRH and its service by replacing its firmware. Without visiting the field station, the operator can download firmware to the RRH remotely using a simple command from the base station operation server(WSM). In this way, operators can minimize the number of visits to the field station, reducing maintenance costs and allowing the system to be operated with greater ease.
- Monitoring Port
  Operators can monitor the information for an RRH using its debug port.
- Smooth Migration
  The DU of the TD-LTE Flexible system supports migration from Mobile WiMAX to TD-LTE by adding channel cards and upgrading the software.
  The RRH, on the other hand, only requires software upgrade for evolving into 4G mobile communication in the same frequency range or even simultaneous operation of 3G and 4G mobile communications.

Features of Mobile WiMAX System

- Features of Mobile WiMAX System
  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.

- Supporting Broadband Channel Bandwidth
  The TD-LTE Flexible system supports broadband bandwidth of 5MHz/10MHz per Mobile WiMAX carrier and high-speed large-scale packet service.
- Support of MIMO
  The TD-LTE Flexible system supports 2x2 MIMO through the 4Tx/4Rx RF path of the RRH-2WB. The following methods are available in MIMO:

Direction	MIMO	Description
Downlink	Space Time Coding (STC)	Method for raising reliability of link
	Spatial Multiplexing (SM)	Method for raising data transmission rate
Uplink	Collaborative SM (CSM)	Method for doubling the frequency efficiency

- Support of Frequency Reuse Pattern (FRP)
  The TD-LTE Flexible system supports FRP N=1 that provides the service to 3-sector by using a carrier and FRP N=3 that provides the service to 3-sector by using different carriers. A service provider can efficiently operate its own frequency resources by using the FRP function.

Features of LTE System

- Application of the OFDMA/SC-FDMA Method
  The TD-LTE Flexible system performs downlink OFDMA/uplink SC-FDMA channel processing, which supports LTE standard physical layers.
  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.
  The uplink SC-FDMA, while similar to the modulation and demodulation method of the OFDMA, performs a Discrete Fourier Transform (DFT) for each user in transmitter modulation and it reversely performs an Inverse Discrete Fourier Transform (IDFT) in receiving demodulation for minimizing the Peak to Average Power Ratio (PAPR) at the transmitter and continuously allocates frequency resources allocated to individual users. This has the effect of reducing power consumption of the UE.
- Supporting Broadband Channel Bandwidth
  The TD-LTE Flexible system supports broadband bandwidth of 20MHz per LTE carrier and high-speed large-scale packet services.
- Support of MIMO
  The TD-LTE Flexible system supports 2x2 MIMO through the multiple antennas. The following methods are available in MIMO:

Direction	MIMO	Description
Downlink	Space Frequency Block Coding (SFBC)	This technology implements the Space-Time Block Coding (STBC) on frequency instead of on time to increase reliability of the link. It uses the same method as STBC (Alamouti codes).
	Spatial Multiplexing (SM)	Various data is separated and sent to multiple antenna paths for increased peak data rate. (Each path uses the same time/frequency resource.) – Single User (SU)-MIMO: The SM between the base station and one UE, for increasing peak data rate for one UE. – Open-loop SM: The SM method which operates without the Precoding Matrix Indicator (PMI) feedback of the UE when the UE's channel is changing too fast or unknown due to fast UE movement. – Closed-loop SM: The SM method (codebook-based precoding) that operates by receiving the PMI feedback of the UE from the base station when the UE moves slowly enough for the channel information to be obtained.
Uplink	UL Transmit Antenna Selection	1 RF chain/2 Tx antennas are used, and the base station informs the UE which Tx antenna is to be used. (Closed-loop selection of Tx antenna)
	Multi-User (MU) MIMO or Collaborative MIMO	The peak data rate of each UE does not increase but the cell throughput is increased. On the uplink, two UEs use the same time/frequency resources for transmitting different data at the same time. The base station uses one Tx antenna and selects two orthogonal UEs.

NOTE

Availability of System Features and Functions
For availability and provision schedule of the features and functions described in this system description, please refer to separate documentations.

2.2 Main Functions

The TD-LTE Flexible system is the base station with support for WiMAX/LTE communication technologies. It provides physical layer functions and call processing functions for each communication technology. It also provides integrated IP processing and operation & maintenance function regardless of the communication technology being used. The main functions of the TD-LTE Flexible system are as follows:

- Physical layer processing function
- Call processing function
- IP processing functions
- Auxiliary device interface function
- Convenient operation and maintenance function

2.2.1 Physical Layer Processing Function (WiMAX)

OFDMA Ranging

The ranging supported by the OFDMA system is roughly divided by the uplink timing synchronization method and the contention based bandwidth request method.

- Uplink Timing Synchronization
  In the uplink timing synchronization method, the TD-LTE Flexible system detects the timing error of the uplink signal by using the ranging code transmitted from MS and transmits the timing correction command to each MS to correct the transmission timing of the uplink. The uplink timing synchronization method has initial ranging, periodic ranging, handover ranging, etc.
- Contention Based Bandwidth Request
  In the contention based bandwidth request method, the TD-LTE Flexible system receives the bandwidth request ranging code from each MS and allocates uplink resources to the corresponding MS to enable to transmit the bandwidth request header. The contention based bandwidth request method has bandwidth request ranging or something.

Channel Encoding/Decoding

The TD-LTE Flexible system carries out the Forward Error Correction (FEC) encoding for the downlink packet created in the upper layer by using Convolutional Turbo Code (CTC). On the contrary, it decodes the uplink packet received from the MS after demodulating.

Modulation/Demodulation

The TD-LTE Flexible system carries out the FEC encoding for the downlink packet created in the upper layer and modulates the encoded packet into the QAM signal. In addition, the TD-LTE Flexible system demodulates and decodes the uplink packet received from MS.

OFDMA Sub-carrier Allocation

The subchannelization is the process to tie the sub-carriers of OFDMA as a transmission unit after grouping them by a certain rule. The TD-LTE Flexible system performs the subchannelization to mitigate the interference between cells.
The TD-LTE Flexible system maps the column of the modulated downlink QAM symbol structure with each sub-carrier and carries out the subchannelization when the column of the QAM symbol structure is transmitted to the MS over the wireless line. In such way, the TD-LTE Flexible system transmits the column of the QAM symbol structure to the MS via the sub-carriers pertained to each subchannel.

DL/UL MAP Construction

The TD-LTE Flexible system informs the air resources for the uplink and the downlink to the MS by using DL/UL MAP. The DL/UL MAP consists of the scheduling information of the TD-LTE Flexible system and includes various control information for the MS.

Power Control

The TD-LTE Flexible system carries out the power control function for the uplink signal received from multiple MSs and then set the power intensity of the uplink signal to a specific level.
The TD-LTE Flexible system transmits the power correction command to each MS and then makes the MS power intensity be the level required in the TD-LTE Flexible system when the MS transmits the modulated uplink signal in a specific QAM modulation method.

Hybrid-ARQ (H-ARQ) Operation

H-ARQ is the physical layer retransmission method using the stop-and-wait protocol.
The TD-LTE Flexible system carries out the H-ARQ function and raises data throughput by re-transmitting or combining the frame from the physical layer to minimize the effect attending to the change of air channel environment or the change in the interference signal level.

MIMO

The TD-LTE Flexible system provides the MIMO function as follows according to Mobile WiMAX Wave 2 Profile:

- Downlink
  - Matrix A (STC): Transmission ratio of the Matrix A or STC is 1 and equal to that of Single Input Single Output (SISO). However The Matrix A or the STC reduces the error of the signal received from the MS by raising the stability of the signal received from the MS by means of the Tx diversity. This technology is, also, effective in low Signal to Noise Ratio (SNR) and provides excellent performance even when the MS moves in high speed.
  - Matrix B (SM, vertical encoding): Matrix B or SM method raises the effectiveness of the frequency by raising the transmission ratio in proportion to the number of antenna in comparison with SISO. This technology is effective when the reception SNR is high.

- Uplink
  - Collaborative SM: Collaborative SM is the technology that doubles the frequency efficiency in view of the TD-LTE Flexible system as two MSs with each individual antenna send data simultaneously by using the same channel.

The TD-LTE Flexible system provides the adaptive MIMO switching function, which dynamically selects the SM or STC method for the downlink MIMO function. The TD-LTE Flexible system performs switching based on a value calculated by reflecting the Carrier to Interference and Noise Ratio (CINR) and transmission success rate sent by an MS.

2.2.2 Physical Layer Processing Function (LTE)

Downlink Reference Signal Creation and Transmission

The reference signal is used to demodulate downlink signals in the UE, and to measure the characteristics of the channel for scheduling, link adaptation, and handover, etc.
There are two downlink reference signals: cell-specific reference signal and UE-specific reference signal.

- Cell-specific reference signal: Used to measure the quality of the channel, calculate the MIMO rank, perform MIMO precoding matrix selection, and measure the strength of the signals for handover.
- UE-specific reference signal: Used to measure channel quality for demodulation of the data located in the PDSCH resource block of a specific UE when operating beamforming transmission mode.

Downlink Synchronization Signal Creation and Transmission

A synchronization signal is used to perform the initial synchronization when the UE starts to communicate with the TD-LTE Flexible system. There are two types of synchronization signals: Primary Synchronization Signal (PSS) and Secondary Synchronization Signal (SSS). The UE can obtain the cell identify information through the synchronization signal. It can obtain other information about the cell through the broadcast channel. Since synchronization signals and broadcast channels are transmitted in the 1.08 MHz range, which is right in the middle of the cell's channel bandwidth, the UE can obtain the basic cell information such as cell ID regardless of the transmission bandwidth of the TD-LTE Flexible system.

Channel Encoding/Decoding

The TD-LTE Flexible system carries out the channel encoding/decoding function for correcting the channel errors which occur on a air channel. In LTE, the turbo coding and the 1/3 tail-biting convolutional coding are used. Turbo coding is mainly used for transmission of large data packets on downlink and uplink, while convolutional coding is used for control information transmission on downlink and uplink and broadcast channel.

Modulation/Demodulation

When receiving downlink data from the upper layer, the TD-LTE Flexible system processes it through the baseband procedure of the physical layer and then transmits it via a air channel. At this time, to send the baseband signals as far as they can go via the air channel, the system modulates them and sends them on a specific high frequency bandwidth. As for the uplink, the TD-LTE Flexible system demodulates the data received from the UE via the air channel into baseband signal and then decodes it.

Resource Allocation and Scheduling

When the TD-LTE Flexible system is operating as LTE, the OFDMA method is used for downlink and the SC-FDMA method is used for uplink as multiple access methods. By allocating the 2-dimensional resources of time and frequency to multiple UEs without overlay, both methods enable the system to communicate with multiple UEs simultaneously. When the system is operating in MU-MIMO mode, the same resource also may be used for multiple UEs simultaneously. Such allocation of cell resources to multiple UEs is called scheduling, and each cell has its own scheduler for this function.

The LTE scheduler of the TD-LTE Flexible system allocates resources to maximize the overall throughput of the cell by considering the channel environment of each UE, the data transmission volume required, and other QoS elements. Moreover, to reduce interferences with other cells, the scheduler of a cell can share information with the scheduler of other cells via the X2 interface.

Link Adaptation

The air channel environment can become faster or slower, better or worse depending on various factors. The system is capable of increasing the transmission rate or maximizing the total cell throughput in response to the changes in the channel environment, and this is called link adaptation.

In particular, the Modulation and Coding Scheme (MCS) is used for changing the modulation method and channel coding rate according to the channel status. If the channel environment is good, the MCS increases the number of transmission bits per symbol using a high-order modulation, such as 64QAM. If the channel environment is bad, it uses a low-order modulation, such as QPSK and a low coding rate to minimize channel errors. Moreover, in the environment where MIMO mode can be used, the system works in MIMO mode to increase the peak data rate of subscribers, and can greatly increase the cell throughput.

If the channel information obtained is incorrect or modulation method of higher order or higher coding rate than the given channel environment is used, errors may occur. In such cases, the errors can be corrected by the HARQ function.

H-ARQ

The H-ARQ is a retransmission method in the physical layer, which uses the stop-and-wait protocol. The TD-LTE Flexible system provides the H-ARQ function to retransmit or combine frames in the physical layer so that the effects of air channel environment changes or interference signal level changes can be minimized, consequently enhancing throughput.

The LTE uses the Incremental Redundancy (IR)-based H-ARQ method and regards the Chase Combining (CC) method as a special case of the IR method.
The TD-LTE Flexible system uses the asynchronous method for downlink and the synchronous method for uplink.

Power Control

When transmitting a specific data rate, too high a power level may result in unnecessary interferences and too low a power level may result in an increased error rate, causing retransmission or delay. Unlike other methods such as CDMA, power control is relatively less important in LTE. Nevertheless, adequate power control can enhance performance of the LTE system.
For LTE uplink, since SC-FDMA is used, the near-far problems which occur in the CDMA do not occur. Nevertheless, high levels of interferences from neighboring cells can degrade the uplink performance. Therefore, the UEs should use adequate power levels for data transmission in order not to interfere with neighboring cells. Likewise, the power level for each UE could be controlled for reducing the inter-cell interference level.
For downlink in LTE, the TD-LTE Flexible system can reduce inter-cell interference by transmitting data at adequate power levels according to the location of the UE and the MCS, enhancing overall cell throughput.

ICIC

Since UEs within a cell in LTE use orthogonal resources with no interference between the UEs, there is no intra-cell interference. However, if different UEs in neighboring cells use the same resource, interference may occur. This happens more seriously between the UEs located on the cell edge, resulting in serious degradation at cell edge.
The technique used to relieve such inter-cell interference problem on the cell edge is Inter-Cell Interference Coordination (ICIC). ICIC allows interference signals to be transmitted to other cells in the cell edge area in as small an amount as possible by allocating a basically different resource to each UE that belongs to a different cell and by carrying out power control according to the UE's location in the cell.
The TD-LTE Flexible systems use the X2 interface for exchanging scheduling information with one another for preventing interferences by resource conflicts at cell edges. If the interference of a neighboring cell is too strong, the system informs the other system to control the strength of the interference signal. Therefore, the ICIC function is used for enhancing the overall cell performance.

MIMO

The TD-LTE Flexible system supports various MIMO functions mentioned above using the 2 Tx/2 Rx antennas of the RRH for providing high-performance data service.

2.2.3 Call Processing Function (WiMAX)

Cell Initialization Function

The TD-LTE Flexible system announces the MAC Management message such as DCD/UCD/MOB_NBR-ADV to the cell area in service periodically to enable the MS receiving the message to carry out the appropriate call processing function.

Call Control and Wireless Resource Allocation Function

The TD-LTE Flexible system enables an MS to enter to or exit from the network. When an MS enters to or exit from the network, the TD-LTE Flexible system transmits/receives the signaling message required for call processing via R1 interface with the MS or R6 interface with ACR.
The TD-LTE Flexible system allocates various management/transport Connection Identifier (CID) required for the network entry and service to an MS. When the MS exit from the network, the TD-LTE Flexible system collects and release the allocated CID.

Handover

The TD-LTE Flexible system carries out the signaling and bearer processing for inter-sector HO (Handover), inter-ACR HO and inter-carrier HO. At this time, ACR relays the handover message between serving RAS and target RAS through the R6 interface.
To minimize the traffic disconnection in inter-RAS HO, the TD-LTE Flexible system performs the data switching function. In handover, the TD-LTE Flexible system enables the serving RAS to switch the user data in queuing to the target RAS and, therefore, the MS to recover the traffic without loss.

> NOTE
>
> **Handover Procedure**
> For the detailed handover procedure, refer to 'Handover' section.

Support of Sleep Mode

Sleep Mode is the mode defined to save the MS power under IEEE 802.16 standard and indicates the status that air resources allocated to an MS are released when the MS does not need traffic reception/transmission temporarily. If the MS in Sleep Mode needs the traffic reception/transmission, the MS returns to the normal status immediately.
Both Idle Mode and Sleep Mode are modes to save the MS power. The Idle Mode release all service flows allocated to an MS, while the Sleep Mode releases only the air resources between the MS and RAS temporarily, continuously keeping the service flow information allocated to the MS.
The TD-LTE Flexible system carries out the related call processing function by receiving/sending the signaling message required for the status transition into Sleep Mode of MS and the return from the Sleep Mode to Awake Mode of MS.

Admission Control (AC) Function

If the TD-LTE Flexible system receives the call setup request, such as network entry, Quick Connection Setup (QCS) and handover, from an MS, it monitors the traffic and signaling load for each subcell and the number of user in Active/Sleep Mode and performs the AC function to prevent the system overload.
AC can be roughly divided into AC by MS and AC by service flow.

- AC by MS
  If the number of users who the subcell is in Active/Sleep Mode exceeds the threshold when the TD-LTE Flexible system receives the call setup request from an MS, it rejects the call setup request of the MS.
- AC by service flow
  When service flow is added, the TD-LTE Flexible system checks if the air resources of the requested subcell exceed the threshold and determines the creation of the service

MAC ARQ Function

The TD-LTE Flexible system carries out the ARQ function of the MAC layer. In packet data exchange, the transmission side transmits ARQ block which SDU is divided into, and retransmits the packet according to the ARQ feedback information received from the reception side to raise the reliability of data communication.
The TD-LTE Flexible system carries out the following function for the service flows applying ARQ:

- MAC Management creation and transmission concerned with ARQ operation
- Feedback processing depending on ARQ types
- Block processing (fragmentation/reassemble/retransmission) depending on ARQ types
- ARQ timer/window management

QoS Support Function

The packet traffic exchanged between ACR and TD-LTE Flexible system is delivered to the modem in the TD-LTE Flexible system. At this time, the TD-LTE Flexible system allocates the queue in the modem to each service flow that QoS type is specified to observe the QoS constraint given for each QoS class or service flow and performs the strict-priority scheduling according to the priority.
The modem that receives the packet traffic performs the scheduling by using the uplink/downlink algorithm, such as Proportional Fair (PF) or Round Robin (RR) and transmits the scheduled allocation information to an MS through DL/UL MAP.
The MS receiving the DL/UL MAP checks the air resources allocated to the MS and modulates/demodulates the downlink packet or transmits the uplink packet from the allocated uplink area.
Since the TD-LTE Flexible system provides the QoS monitoring function, it can compile statistics on packets unsatisfying the latency requested from the QoS parameter according to TDD frames and report the statistics to an operator via the OAM interface.

2.2.4 Call Processing Function (LTE)

Cell Information Transmission

In the cell area being served, the TD-LTE Flexible system periodically broadcasts a Master Information Block (MIB) and the System Information Blocks (SIBs), which are system information, to allow the UE that receives them to perform proper call processing.

Call Control and Air Resource Assignment

The TD-LTE Flexible system allows the UE to be connected to or to be released from the network.
When the UE is connected to or released from the network, the TD-LTE Flexible system sends and receives the signaling messages required for call processing to and from the UE via the Uu interface, and to and from the EPC via the S1 interface.
When the UE connects to the network, the TD-LTE Flexible system carries out call control and resource allocation required for service. When the UE is released from the network, it collects and releases the allocated resources.

Handover

The TD-LTE Flexible system supports intra-frequency or inter-frequency handover between intra-eNB cells, X2 handover between eNBs, and S1 handover between eNBs, and carries out the signaling and bearer processing functions required for handover. At intra-eNB handover, handover-related messages are transmitted via internal eNB interfaces; at X2 handover, via the X2 interface; at S1 handover, via the S1 interface.
The TD-LTE Flexible system carries out the data retransmission function to minimize user traffic disconnections at X2 and S1 handovers. The source eNB provides two methods of using the X2 interface for direct retransmission to the target eNB and using the S1 interface for indirect retransmission. The TD-LTE Flexible system uses the data retransmission function to ensure that the UE receives the traffic without any loss at handover.

Admission Control (AC) Function

The TD-LTE Flexible system provides capacity-based admission control and QoS-based admission control for a bearer setup request from the EPC so that the system is not overloaded.

- Capacity-based AC
  There is a threshold for the maximum number of connected UEs (new calls/handover calls) and a threshold for the maximum number of connected bearers that can be allowed in the TD-LTE Flexible system. When a call setup is requested, the permission is determined depending on whether the connected UEs and bearers exceed the thresholds.
- QoS-based AC
  The TD-LTE Flexible system provides the function for determining whether to permit a call depending on the estimated Physical Resource Block (PRB) usage of the newly requested bearer, the PRB usage status of the bearers in service, and the maximum acceptance limit of the PRB (per beater type, QCI, and UL/DL).

RLC ARQ Function

The TD-LTE Flexible system carries out the ARQ function for the RLC Acknowledged Mode (AM) only. When receiving and sending packet data, the RLC transmits the SDU by dividing it into units of RLC PDU in the sending end and the packet is retransmitted according to the ARQ feedback information received from the receiving side for increased reliability of the data communication.

QoS Support Function

The TD-LTE Flexible system receives the QoS Class Identifier (QCI), in which the QoS characteristics of the bearer are defined, Guaranteed Bit Rate (GBR), Maximum Bit Rate (MBR), and Aggregate Maximum Bit Rate (AMBR) from the EPC. It provides the QoS for the wireless section between the UE and the eNB and the backhaul section between the eNB and the S-GW.

- In the wireless section, it performs retransmission to rate control according to the GBR/MBR/AMBR values, to schedule considering packet delay budget and priority of bearer defined in the QCI, and to satisfy the Packet Loss Error Rate (PLER).
- In the backhaul section, it performs QCI-based packet classification, QCI to DSCP mapping, and marking for the QoS. It provides queuing depending on mapping results, and each queue transmits packets to the EPC according to a strict priority, etc.

In EMS, in addition to the QCI predefined in the specifications, an operator specific QCI and a QCI-to-DSCP mapping can be set.

2.2.5 IP Processing Functions

IP QoS Function

Since the TD-LTE Flexible system supports Differentiated Services (DiffServ), it can provide the backhaul QoS in the communication with ACR.
It supports 8-class DiffServ and supports the mapping between the DiffServ service class and the service class of the user traffic received from an MS. In addition, the TD-LTE Flexible system supports the mapping between Differentiated Services Code Point (DSCP) and 802.3 Ethernet MAC service class.

IP Routing Function

Since the TD-LTE Flexible system provides several Ethernet interfaces, it stores the routing table with the information on the Ethernet interface to route IP packets. The routing table of the TD-LTE Flexible system is configured depending on operator's setting and the configuration and the setting of the routing table are similar to the standard setting of the router.
The TD-LTE Flexible system supports the static routing configuration only and not the router function for the traffic received from the outside. When the TD-LTE Flexible system connects an auxiliary device, it supports the IP packet routing function for the auxiliary device by using Network Address Translation (NAT).

Ethernet/VLAN Interface Function

The TD-LTE Flexible system provides the Ethernet interface and supports the static link grouping function, Virtual Local Area Network (VLAN) function and Ethernet CoS function under IEEE 802.3ad for the Ethernet interface. At this time, the MAC bridge function defined in IEEE 802.1D is excluded.

The TD-LTE Flexible system enables several VLAN IDs to be set in one Ethernet interface and maps the DSCP value of IP header with the CoS value of Ethernet header in Tx packet to support Ethernet CoS.

2.2.6 Auxiliary Device Interface Function

The TD-LTE Flexible system provides the Ethernet interface to connect auxiliary devices and allocates IP addresses by operating as a DHCP server for the auxiliary devices. In addition, the TD-LTE Flexible system provides the traffic path to transmit/receive the maintenance traffic between an auxiliary device and the remote auxiliary device monitoring server.

If the auxiliary device uses a private IP address, the TD-LTE Flexible system carries out the NAT function to change the address into a public IP address (i.e., the IP address of the TD-LTE Flexible system) for the communication with an external monitoring server.

2.2.7 Maintenance Function

The TD-LTE Flexible system interworking with the management system carries out the following maintenance functions: system initialization and restart, management for system configuration, management for the operation parameters, failure and status management for system resources and services, statistics management for system resources and various performance data, diagnosis management for system resources and services and security management for system access and operation.

Graphic and Text-based Console Interface

WSM manages the entire TD-LTE Flexible system and ACR by using Database Management System (DBMS) and TD-LTE Flexible system interworks with this WSM. In addition, TD-LTE Flexible system interworks with the console terminal for directly accessing the NE as well as WSM by operator to perform the operation and maintenance function.

For operator’s convenience and working purpose, the operator can select graphic-based console interface (Web-based Element Maintenance Terminal, Web-EMT) or text-based console interface (Integrated Management Interface Shell, IMISH). The operator can access the console interface with no separate software and log in to Web-EMT through Internet Explore and IMISH through Secure Shell (SSH) on the command window.

The operator can carry out the retrieval and setup of the configuration and the operation information and monitoring about faults, status and statistics via console terminal. However, the operator can carry out grow/degrow of resources and setting of the neighbor list and paging group which have correlation between several NEs only via the WSM.

Operator Authentication Function

The TD-LTE Flexible system provides the authentication and the permission management functions for the operator who manages the system. The operator accesses the TD-LTE Flexible system by using the operator's ID and password via IMISH and the TD-LTE Flexible system assigns the operation right in accordance with the operator's level.
The TD-LTE Flexible system carries out the logging function for successful access, access failure and login history.

Maintenance Function with Enhanced Security Function

When communicating with the WSM, the TD-LTE Flexible system supports SNMPv2c and Simple Network Management Protocol version 3 (SNMPv3), and FTP and SSH File Transfer Protocol (SFTP) for security. When communicating with the console terminal, it supports Hyper Text Transfer Protocol over SSL (HTTPs) and Secure Shell (SSH).

On-line Software Upgrade

When a software package is upgraded, the TD-LTE Flexible system can upgrade the package while running old version of software package. The package upgrade is progressed in the following procedure: 'Add New Package → Change to New package → Delete Old Package'.
In package upgrade, the service is stopped temporarily because the old process is terminated and the new process is started in the 'Change to New package' stage. However, since OS is not restarted, the service will be provided again within a few minutes.
After upgrading software, the TD-LTE Flexible system updates the package stored in a non-volatile storage. In addition, the TD-LTE Flexible system can re-perform the 'Change to New package' stage to roll back into the previous package before upgrade.

Call Trace Function

The TD-LTE Flexible system supports the call trace function for a specific MS. The operator may enable trace for a specific MS through the ACR or the MME. The trace execution results such as signaling messages are sent to the WSM, the operating server.

Detailed Information for Each Session and Service Flow (PSMR/PSFMR)

The TD-LTE Flexible system collects and stores detailed information of all sessions (Per Session Measurement Record, PSMR) and detailed information of all service flows (Per Service Flow Measurement Record, PSFMR) to provide it to an external log server. When a session or service flow is created, the TD-LTE Flexible system starts to collect relevant information, and when the session or service flow terminates, the system creates and stores a message in a file so that the external log server can collect the message.
The information collected by the ACR includes session termination time, initial and final handover information (handover types, cell information), and the MAC address and IP address allocated to the MS. The TD-LTE Flexible system collects such information as MS MAC addresses, continued session time, continued service flow time, turnaround time for network entry, CID, SFID, initial and final wireless quality information (RSSI, CINR, Tx power), and throughput information.

The ACR deliver the information collected by ACR to the TD-LTE Flexible system, and the TD-LTE Flexible system creates and stores a file for each period.

Threshold Cross Alert (TCA) Control

The TD-LTE Flexible system defines under/over threshold for statistics. When a statistical value collected at Bucket Interval (15, 30, and 60 minutes) is lower than the under threshold, it generates an under TCA alarm. When the value is higher than the over threshold, it generates an over TCA alarm. The alarms are reported to the WSM. TCA can enable or disable details of each statistical group and set a threshold per severity.

IEEE 802.3ah

The TD-LTE Flexible system provides IEEE 802.3ah Ethernet OAM for a backhaul interface. Although IEEE 802.3ah OAM pertains the PHY layer, it is located in the MAC layer so that it can be applied to all IEEE 802.3 PHYs. It creates or processes 802.3ah OAM frames according to the functions defined in the specification.
Ethernet OAM continuously monitors the connection between links at each end, and also monitors discovery, remote loopback, and error packets which deliver important link events such as Dying Gasp. It also includes a link monitoring function which delivers event notification in the event of threshold errors, and a variable retrieval function for 802.3ah standard MIB.
The TD-LTE Flexible system supports 802.3ah Ethernet OAM passive mode such as responding to 802.3ah OAM which is triggered in external active mode entities and loopback mode operation, and sending event notification.

Line Loopback Test between the DU and RRH

The TD-LTE Flexible system provides the loopback test function to check whether communication is normal on the ‘Digital I/Q and C & M’ interface line between the DU and RRH.

OAM Traffic Throttling

The TD-LTE Flexible system provides a function that suppresses OAM related traffic which can occur in the system depending on the operator command. The OAM related traffic includes fault trap messages for alarm reports and statistics files that are created periodically. In a fault trap, the operator can use an alarm inhibition command to suppress alarm generation for all or some of system fault traps. This helps control alarm traffic. In a statistics file, the operator can use commands for statistics collection configuration to control the size of statistics file by disabling collection functions of each statistics group.

Integrity Check

The TD-LTE Flexible system proactively checks whether system configuration or operation information (PLD) is in compliance with operator commands during system loading or operation, and also checks whether system settings are OK and there is no problem with call processing. If the result is not OK, it sends an alarm to the operator. That is, it checks whether system configuration meets the minimum configuration conditions for call processing or whether all operation information consists of valid values within an appropriate range. The result is reported to the operator to help with correction of errors.

Throughput Test

The TD-LTE Flexible system provides a throughput test for the backhaul. The TD-LTE Flexible system supports a server and client function for throughput tests.
The operator can set up target IP addresses, test duration, and bandwidths for throughput tests, and check throughput and loss as test results. However, as the throughput test affects system performance and call services, it is recommended not to perform the test during in-service.

System Log Control

The TD-LTE Flexible system provides a log and log control function per application. An application log can be created by an operator command or its debug level can be set. The operator can usually keep the log function disabled, and when the log function is necessary, he can change the debug level (Very Calm, Calm, Normal, Detail, Very Detail) to enable logging and log save functions.
However, enabling log functions for many applications while the TD-LTE Flexible system is running may affect the system performance.

Disabling Zero Code Suppression (ZCS)

The TD-LTE Flexible system collects statistics data and generates statistics files periodically. The WSM collects these statistics files. A statistics file is composed of the header used to indicate a statistics group and its detailed index (for example, a specific carrier, sector, CPU, port, etc.) and the statistics data for that index.
In a statistics period, the statistics data for a specific index can become zero in a statistics file in the following cases:

- When the index does not actually exist in the configuration.
- When the index exists in the configuration but its statistics data collected during that period is zero.

Therefore, the Disabling ZCS function, which sets the zero data flag in the sub index header, is provided to recognize the two cases separately.

2.3 Specifications

Capacity

The capacity of the TD-LTE Flexible system is as follows:

Category	System Capacity
Channel Bandwidth	– Mobile WiMAX: 10 MHz – TD-LTE: 20 MHz
RF Band	2,496~2,690MHz (BC41)
Maximum Number of Carriers/Sectors	2 Carrier/3 Sector
Interface between ACR and TD-LTE Flexible system	Select one of Fast Ethernet and Gigabit Ethernet
Channel Card Capacity	– Mobile WiMAX: 1 Carrier/1 Sector – TD-LTE: 1 Carrier/3 Sector
Output	Antenna Port-based – 5 W/Carrier/Path @ WiMAX 10 MHz – 10 W/Carrier/Path @ TD-LTE 20 MHz

Input Power

The table below lists the power standard for the TD-LTE Flexible system.

Category	Standard
System Input Voltage[a)]	-48 VDC(Voltage Variation Range: -40~-56 VDC)

a) Each of the DU and RRH receives -48 VDC of power for its operation.

Unit Size and Weight

The table below lists the size and weight of the TD-LTE Flexible system.

Category		Standard
Size [mm (in.)]	DU(W × D × H)	432(17.01) × 396(15.59) × 200(7.87)
	RRH-2WB(W × D × H)	354(13.94) × 112(4.41) × 504(19.84)
Weight [kg (lb.)]	DU	About 20 (44.09)
	RRH-2WB	About 20 (44.09)

Environmental Condition

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

- DU

Category	Range
Temperature Condition[a)]	0~50°C(32~122°F)
Humidity Condition[a)]	10~90% The moisture content must not exceed 0.024 kg(0.05 lb.) per 1 kg(2.2 lb.) of air.
Altitude	0~1,800 m(0~5,905 ft)
Vibration	GR-63-CORE Sec.4.4 – Earthquake – Office Vibration – Transportation Vibration
Sound Pressure Level	Max. 65 dBA at height of 1.5 m(4.92 ft) and distance of 0.6 m(1.97 ft)
EMI	FCC Title47 Part 15 Class A GR-1089-CORE Sec. 3.2 Emission Criteria

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.

- RRH

Category	Range
Temperature Condition[a)]	-40~+50°C(-104~122°F)
Humidity Condition[a)]	5~95%(Non-condensing) The moisture content must not exceed 30 g(0.07 lb.) per 1 m^3(35.31 ft^3) of air.
Altitude	-60~1,800 m(197~5,905 ft)
Vibration	GR-63-CORE Sec.4.4 – Transportation shock – Transportation vibration – Installation shock – Environmentally induced vibration – Earthquake resistance
Sound Pressure Level	Max. 65 dBA at distance of 1.5 m (5 ft) and height of 1.0 m (3 ft)
EMI	FCC Title47 Part 15 Class B EN 301 389 G1089-CORE(Issue 4)
US Federal Regulation	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 TD-LTE Flexible system in default.

Category	Description
Temperature Alarm	High Temperature, Low Voltage
Fan Fail	Fan Fail
Voltage Alarm	High Voltage, Low Voltage

GPSR Specification

The table below lists the GPS Receiver (GPSR) characteristics of TD-LTE Flexible system.

Category	Description
Received Signal from GPS	GPS L1 Signal
Accuracy/Stability	0.02 ppm

RF Specification

The table below lists the RF characteristics of the TD-LTE Flexible system.

Category	Description
Total Tx Output Power	– Mobile WiMAX: 10 W @avg power per carrier/sector – TD-LTE: 20 W @avg power per carrier/sector
Tx Constellation error	– Mobile WiMAX: In accordance with the 802.16e standard – TD-LTE: In accordance with the 3GPP LTE standard
RX Sensitivity	– Mobile WiMAX: In accordance with the 802.16e standard – TD-LTE: In accordance with the 3GPP LTE standard

2.4 Interface between Systems

Mobile WiMAX Interface Structure

The TD-LTE Flexible system interfaces with other RASs and ACRs when operating in WiMAX mode as illustrated below.

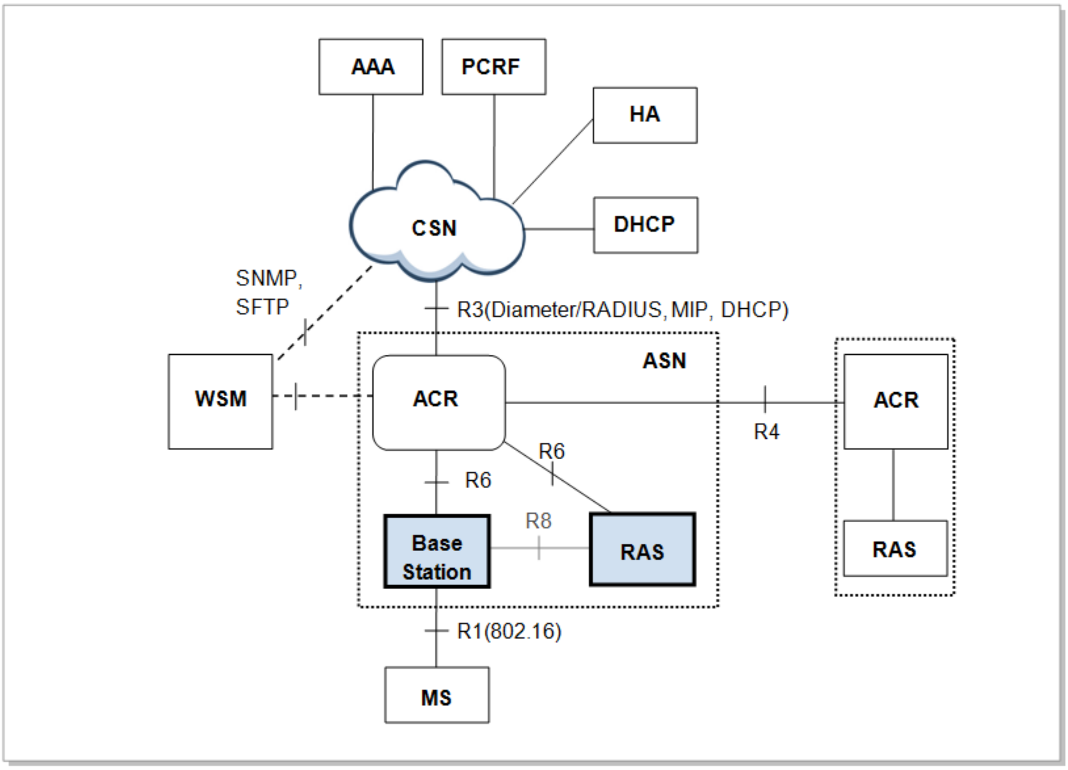

Figure 2.1 Interface between Systems (Mobile WiMAX)

- Interface between TD-LTE Flexible system and MS
  The TD-LTE Flexible system interfaces with an MS according to the IEEE 802.16 radio access standard to exchange the control signal and the subscriber traffic.
- Interface between TD-LTE Flexible system and ACR
  The interface between an ACR and the TD-LTE Flexible system in the same ASN is R6 and its physical access method is GE/FE. The R6 is the interface between ACR and RAS defined in Mobile WiMAX NWG and is composed of signaling plane (IP/UDP/R6) and bearer plane (IP/GRE).
- Interface between TD-LTE Flexible system and WSM
  The interface between the TD-LTE Flexible system and the WSM complies with SNMPv2c or SNMPv2c/SNMPv3, FTP/SFTP and proprietary standard of Samsung and its physical access method is GE/FE.

TD-LTE Interface Structure

The TD-LTE Flexible system interfaces with other eNBs and EPCs when operating in TD-LTE mode as illustrated below.

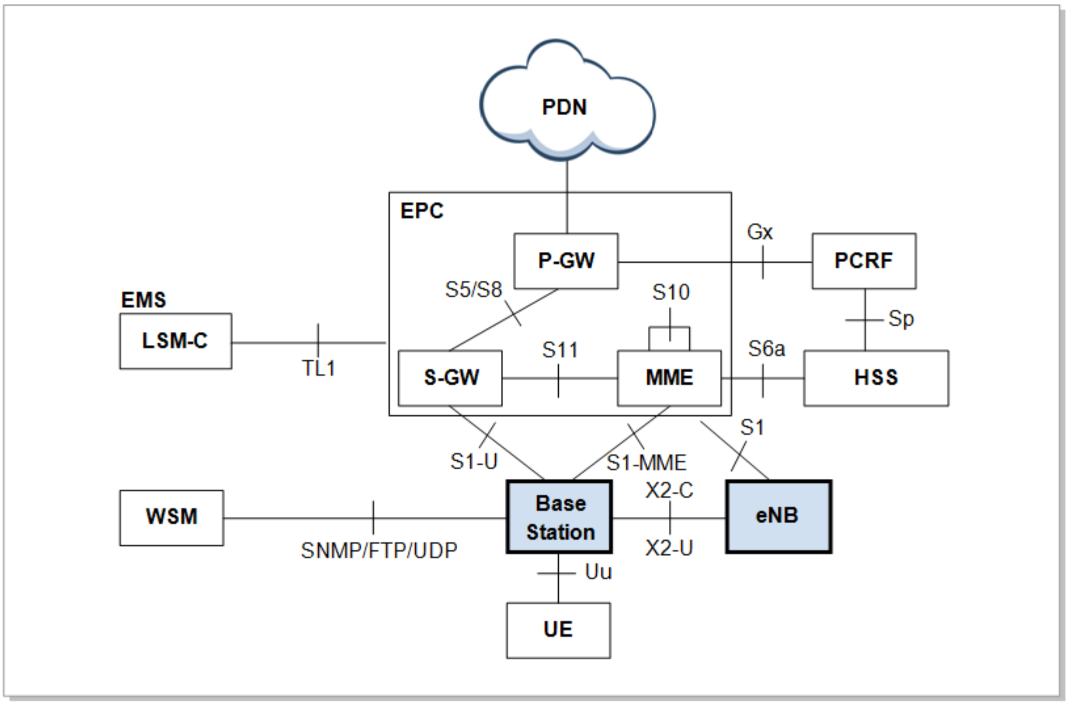

Figure 2.2 Interface between Systems (TD-LTE)

- Interface between TD-LTE Flexible system and UE
  The TD-LTE Flexible system interfaces with an UE according to the 3GPP LTE Uu radio access standard to exchange the control signal and the subscriber traffic.
- Interface between TD-LTE Flexible system and S-GW
  The interface between an S-GW and the TD-LTE Flexible system is 3GPP LTE S1-U and its physical access method is GE/FE.
- Interface between TD-LTE Flexible system and MME
  The interface between an MME and the TD-LTE Flexible system is 3GPP LTE S1-MME and its physical access method is GE/FE.
- Interface between TD-LTE Flexible system and WSM
  The interface between the TD-LTE Flexible system and the WSM complies with SNMPv2c or SNMPv2c/SNMPv3 which is IETF standard, FTP/SFTP and proprietary standard of Samsung and its physical access method is GE/FE.

Protocol Stack

- Protocol Stack between NEs (Mobile WiMAX)
  The figure below shows the protocol stack between NEs of Mobile WiMAX.

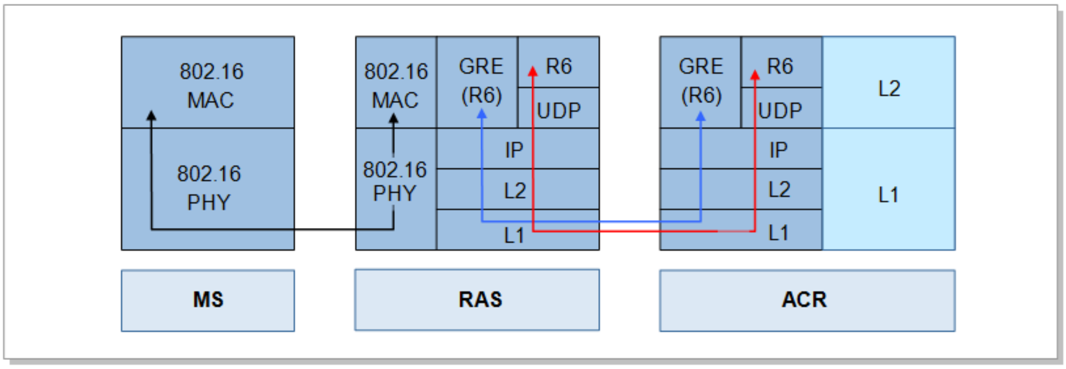

Figure 2.3 Protocol Stack between NEs(Mobile WiMAX)

The R6 signaling interface is executed on UDP/IP and the R6 traffic interface uses the GRE tunnel. The TD-LTE Flexible system interworks with the MS over the R1 interface in Mobile WiMAX mode according to the IEEE 802.16 specification. The R6 interface is used between the TD-LTE Flexible system and the ACR.

- Protocol Stack between UE and eNB(TD-LTE)

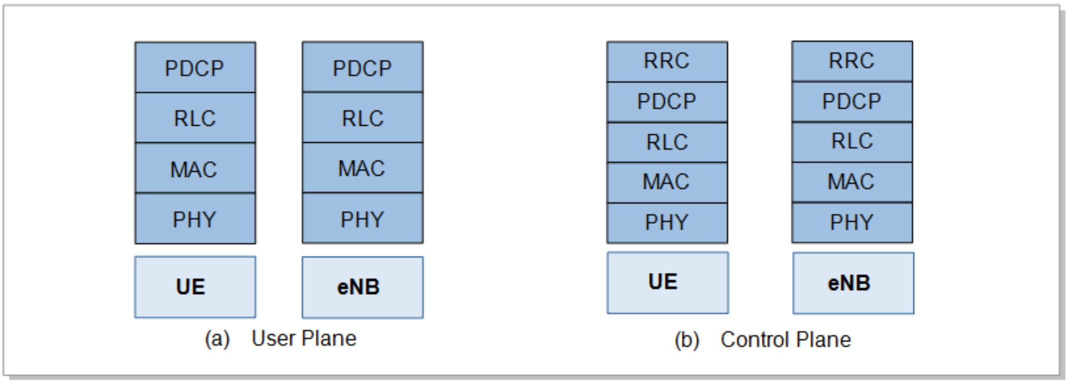

Figure 2.4 Protocol Stack between UE and eNB(TD-LTE)

The UE and the eNB are connected wirelessly over the LTE Uu interface.

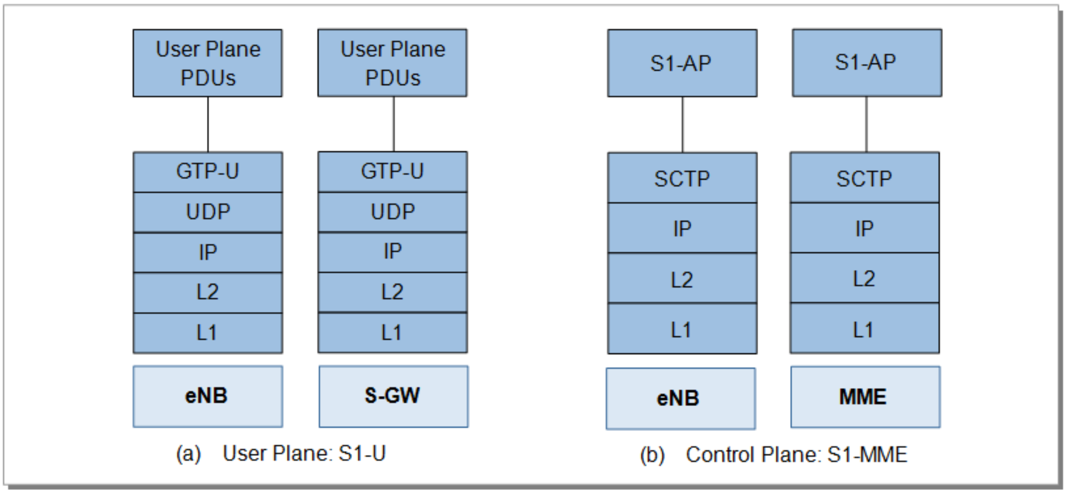

Figure 2.5 Protocol Stack between eNB and EPC(TD-LTE)

The eNB and the EPC are connected physically via FE/GE according to the LTE S1-U and S1-MME interfaces.

- Protocol Stack for Operation and Maintenance

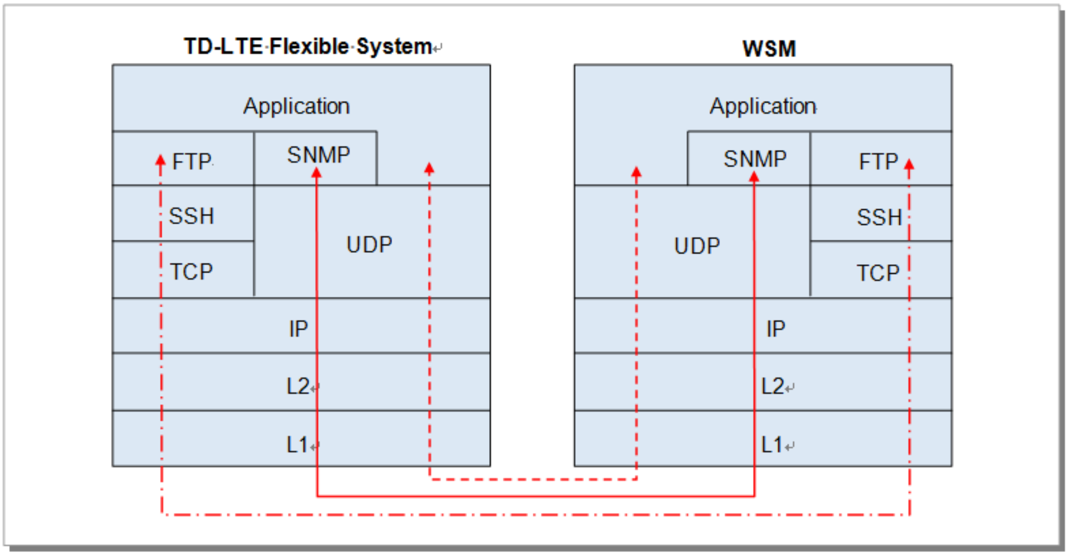

Figure 2.6 Protocol Stack between TD-LTE Flexible system and WSM

The TD-LTE Flexible system interworks with WSM in UDP/IP-based SNMP method to carry out the operation and maintenance functions. In particular, the TD-LTE Flexible system interworks with WSM in TCP/IP-based FTP/SFTP(FTP over SSH) method to collect the statistical data periodically, initialize & restart the system and download software.

Physical Interface Operation Method

The TD-LTE Flexible system provides Ethernet interface as an ASN interface and can select the type of interfaces depending on the network configuration. At this time, more than one type of interfaces cannot be operated simultaneously. The number of interfaces can be optionally managed depending on the capacity and the required bandwidth of the TD-LTE Flexible system.

The types of interfaces are as follows:

Interface Type		Number of Ports per System
Ethernet	100/1000 Base-T(RJ-45)	4
	1000 Base-X(SFP)	2
	100/1000 Base-T(RJ-45) (Simultaneous operation)	2

Ethernet interface operate several links as 802.3ad (static)-based static link aggregation. The operation and maintenance interface (interface with WSM) is operated in in-band method, which shares the common user traffic interface.

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CHAPTER 3. System Structure

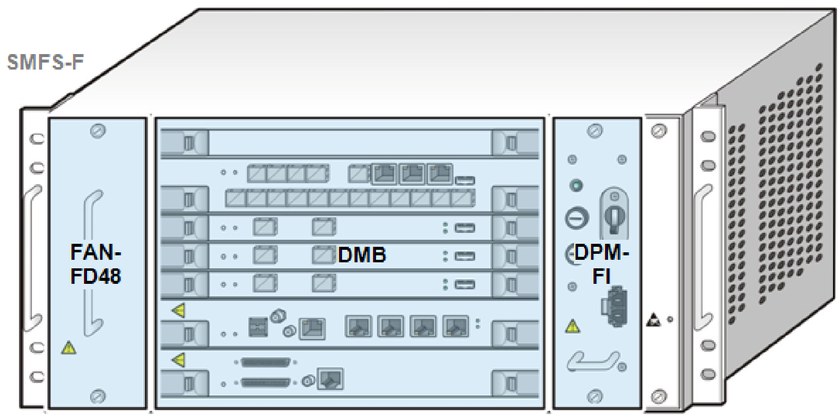
3.1 Hardware Structure

The TD-LTE Flexible system has a separate structure consisting of a DU and RRHs. Because up to three RRHs can be connected to a DU, the maximum 2Carrier/3Sector service is possible.

DU

The boards that make up the DU are mounted on the SMFS-F, which is a 19 in. indoor shelf. The SMFS-F can be mounted on a 19 in. indoor or outdoor commercial rack.

- Samsung Mobile WiMAX Flexible Shelf assembly-Front mount (SMFS-F)
  - Shelf for DU of TD-LTE Flexible system
  - Mounting is supported when mounted on a 19 in. rack.



DPM-FI	DC Power Module-Flexible Indoor
DMB	Digital Main Block
FAN-FD48	FAN Module-Flexible Digital unit -48 VDC

Figure 3.1 DU Configuration (SMFS-F)

The DU is composed of a Digital Main Block (DMB), DPM-FI, and FAN-FD48.

- DMB
  The DMB operates and maintains the TD-LTE Flexible system, enables the TD-LTE Flexible system to interface with ACR/EPC and provides the communication path between processors in the system.The DMB creates the reference clock, provides the

clock to the lower hardware block and performs the signal processing function for the subscriber signal.
The DMB also interfaces with the RRH to send and receive data traffic, and receives and controls alarms for the lower hardware blocks or modules, including the RRH.

- DPM-FI
  The DPM-FI receives DC power through a separate rectifier and distributes it to every board and module on the DU shelf. The operator can control DC power supply by turning the circuit breaker at the front of the DPM-FI on/off.
- FAN-FD48
  The FAN-FD48 is composed of a set of four fans and maintains the inside temperature of the DU within an appropriate range so that the TD-LTE Flexible system can operate normally.
  The FAN-FD48 detects the inside temperature of the DU using a built-in temperature sensor and sets the speed of the fan in accordance with the detected temperature.

RRH

The RRH is a single unit that can be installed on a wall or pole without an additional shelf or rack. The RRH is a unified RF module interfacing remotely with the DU through an optical cable. It is located at the front end of the antenna.

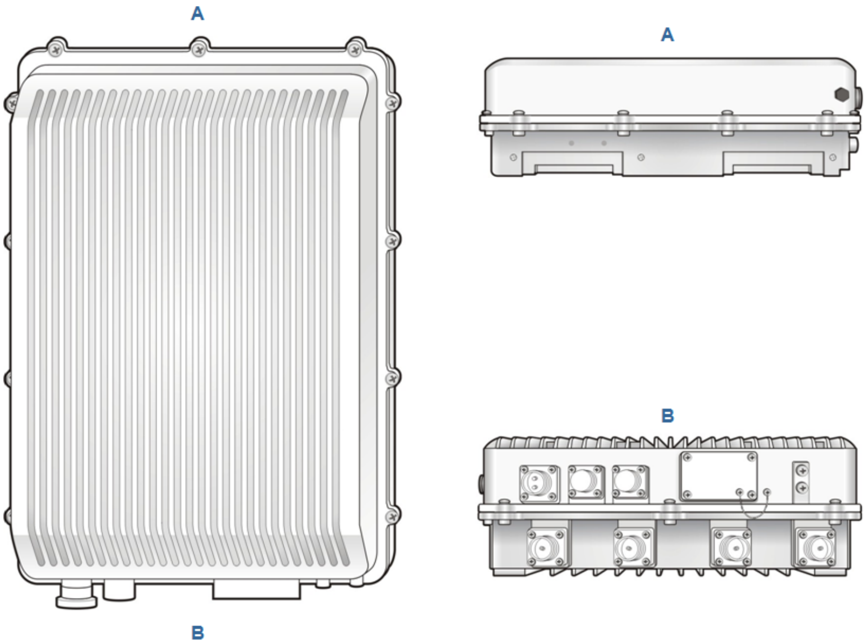


Figure 3.2 RRH-2WB Configuration

On a downlink, it converts the data traffic in the form of 'Digital I/Q and C & M' received from the channel card of the DU into RF signals and then sends them through an external antenna. Conversely, on an uplink, the RRH converts the RF signals received through the antenna into 'Digital I/Q and C & M' data traffic, and then sends them to the channel card of the DU.

The RRH also receives clock information from the DU through the ‘Digital I/Q and C & M’ interface, and sends/receives alarm/control messages.

Internal Configuration of System

Below are the internal configuration diagrams of the TD-LTE Flexible system.

> NOTE
>
> **RRH Types**
>
> Refer to ’RRH’ section for details on the RRH types.

- 2Carrier/3Sector MIMO (WiMAX/TD-LTE)

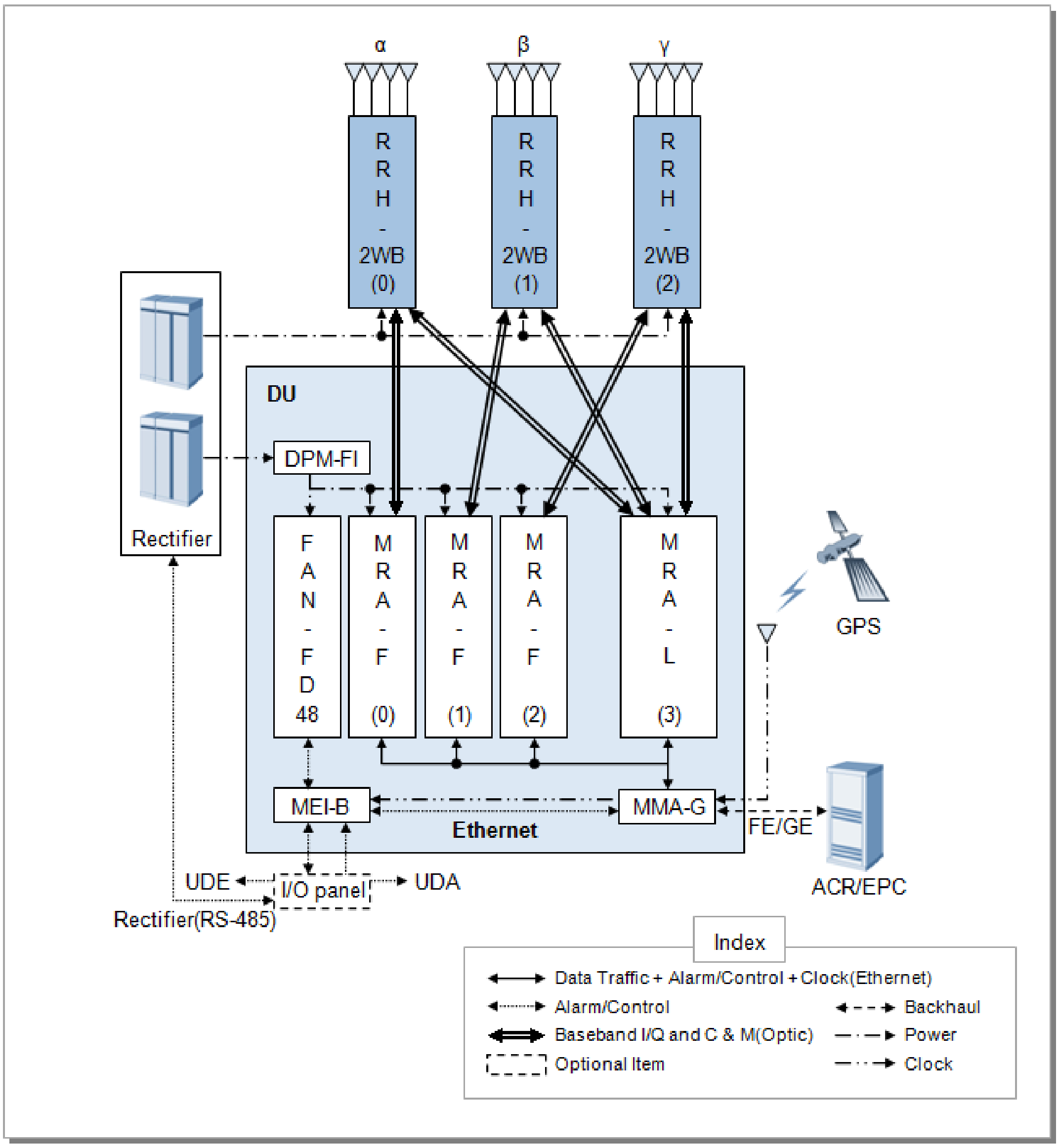


Figure 3.3 Internal Configuration of the System (MIMO)

> **Rectifier**
> The vendor must install the rectifier separately. Samsung can provide a commercial rectifier at the service provider's request. For the RS-485 interface service between the TD-LTE Flexible system and rectifier, the rectifier must meet the interface protocol specified by Samsung. For other operations, the TD-LTE Flexible system can communicate with the rectifier using User Defined Alarms (UDA).

NOTE

3.1.1 DMB

The Digital Main Block (DMB) supports the operation and maintenance of the TD-LTE Flexible system, interfacing between the TD-LTE Flexible system and ACR/EPC, and interfacing between the DU and RRH. It also collects and controls alarms for the lower boards and modules, including the inter-processor communication paths and RRH in the system. The DMB also generates and supplies clocks to the lower hardware blocks, including the RRH, and processes channels for subscriber signals.
When the TD-LTE Flexible system sends signals to an MS, the DMB performs the OFDMA signal processing on the traffic signals received from the ACR/EPC, converts them into optical signals using the 'Digital I/Q and C & M' converter, and then sends them to the remote RRH.
Conversely, when the TD-LTE Flexible system receives signals from an MS, the DMB receives 'Digital I/Q and C & M' signals from the remote RRH, performs the OFDMA signal processing on them, and then sends them to the ACR/EPC.

Main functions of DMB are as follows:

- Creation and distribution of the reference clock
- Fast Ethernet/Gigabit Ethernet interface with ACR/EPC
- Fault diagnosis and alarm collection and control
- Alarm report
- Channel resource management
- OFDMA signal processing
- Automatic Gain Control (AGC) for the received RF signal and Received Signal Strength Indicator (RSSI) support
- Supporting optical interfacing with the RRH and loopback test

The DMB is configured as shown in the figure below:

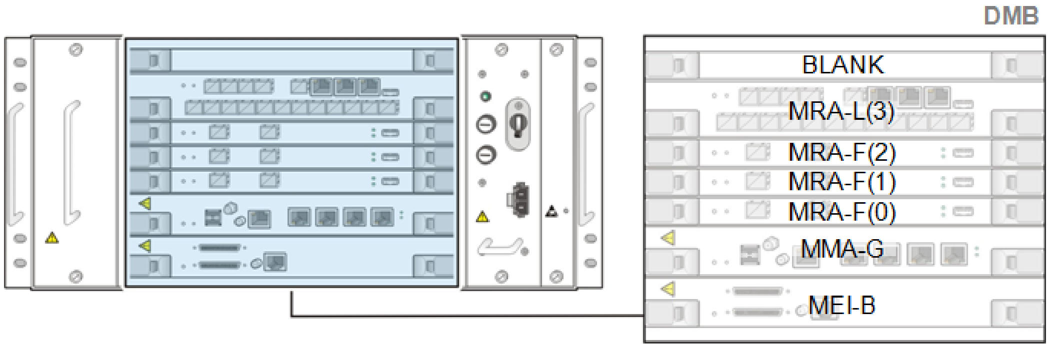


Figure 3.4 DMB Configuration

Board Name	Quantity (Sheet)	Function
MBB-F	1	Mobile WiMAX base station Backplane Board-Flexible – DMB backboard – Signal routing function for traffic, control signal, clock, power, etc.
MMA-G	1	Mobile WiMAX base station Main control board Assembly-General – Main system processor – Call processing, resource allocation and OAM – Reception of the GPS signal and creation and supply of the clock – Alarm collection and report to the upper – Supports FE/GE interface with ACR/EPC – Non-volatile memory support
MRA-F	Max. 3	Mobile WiMAX base station RAS board Assembly-Flexible – Supporting Mobile WiMAX of 10MHz channel bandwidth – Mobile WiMAX subscriber data traffic processing – OFDMA Processing – 1Carrier/1Sector MIMO – 'Digital I/Q and C & M' data formatting – Supporting optical interfacing with the RRH (E/O, O/E conversion) – Supporting loopback tests between the DU and the RRH
MRA-L	Max. 1	Mobile WiMAX base station RAS board Assembly-LTE – Supporting TD-LTE of 20 MHz channel bandwidth – TD-LTE data traffic processing and resource allocation(PDCP, IPSec, GTP, etc.) – OFDMA(DL), SC-FDMA(UL) processing – 1Carrier/3Sector MIMO (UL-SIMO) – 'Digital I/Q and C & M' data formatting – Supporting optical interfacing with the RRH (E/O, O/E conversion) – Supporting loopback tests between the DU and the RRH
MEI-B	1	Mobile WiMAX base station External Interface board assembly-Basic – Provides User Defined Alarm (UDA) – Alarm monitoring including fan alarm/high temperature

Mobile WiMAX base station Main control board Assembly-General (MMA-G)

The MMA-G provides a main processor function of the TD-LTE Flexible system, GPS signal receiving and clock distribution, and network interface functions.

- Main Processor Function
  The MMA-G is the board that carries out the role as the highest layer in the TD-LTE Flexible system and is equipped with the main processor. The main processor of the MMA-G performs the functions, such as communication path setting between MS and ACR/EPC, Ethernet switch function in the TD-LTE Flexible system, system operation and maintenance and TDD signal control.
  The MMA-G manages the status of all hardware and software in the TD-LTE Flexible system and reports each status information to WSM via ACR. In addition, the MMA-G allocates and manages the resources of the TD-LTE Flexible system and the connection of the MMA-G and a PC for the Web-EMT enables to maintain the TD-LTE Flexible system with no interworking with ACR.
- GPS Signal Reception and Clock Distribution Function
  The MMA-G is equipped with Universal Core Clock Module (UCCM) for GPS signal reception.
  The UCCM enables each block of the TD-LTE Flexible system to be operated in the synchronized clock system. The UCCM mounted on the MMA-G creates the system clocks [56 MHz, 12.5 Hz (80 msec), PP2S, analog 10 MHz, 61.44 MHz] by using the reference signal received from a GPS and distributes them to the hardware blocks in the system. These clocks are used to maintain the internal synchronization of the TD-LTE Flexible system and operate the system.
  If no GPS signal is received due to a fault when system operation, the UCCM carries out the holdover function to provide the normal clock for a certain time(24 hours) as provided in the existing system.
- Network Interface Function
  The MMA-G interfaces with an ACR/EPC in Gigabit Ethernet or Fast Ethernet method. The MMA-G can provide maximum two Gigabit Ethernet ports or four Fast Ethernet ports per board, and support the link aggregation redundancy method.
  The MMA-G can be divided as follows depending on the interface types provided by MMA-G, and service provider can choose the interface type.
  - MMA-GC: 100/1000Base-T Copper ports
  - MMA-GM: Two 100/1000Base-T ports and two 1000Base-X Small Form factor Pluggable (SFP) ports
- Operation Information Storage Function
  The MMA-G is equipped with non-volatile memories and offers the storage function of loading and operation information within the MMA-G.

Mobile WiMAX base station RAS board Assembly-Flexible (MRA-F)

The MRA-F is a Mobile WiMAX channel card which provides modem function and RRH interfacing function.

- Modem Function

The MRA-F is equipped with the modem supporting IEEE 802.16 Mobile WiMAX standard physical layer (PHY) and the modem performs the OFDMA signal processing function by the control of the MMA-G.
The MRA-F modulates the packet data received through the MMA-G, converts the modulated signal into the 'Digital I/Q and C & M' format and transmits to the RRH. In the contrary, the MRA-F demodulated the data received from the RRH after performing the AGC function, converts the data into the format defined in the IEEE 802.16 Mobile WiMAX physical layer standard and then transmits the converted data to the MMA-G via Ethernet.

- Optical interfacing with the RRH and Loopback Test
  As the MRA-F contains a built-in Electrical to Optic (E/O) conversion device and an Optic to Electrical (O/E) conversion device, it can send and receive 'Digital I/Q and C & M' signals of the optical signals between distant RRHs.
  The MRA-F can also run loopback tests to check whether the interface between the MRA-F and RRHs is in good condition for proper communication. The operator can run the loopback test if necessary using the WSM command.

Mobile WiMAX base station RAS board Assembly-LTE (MRA-L)

The MRA-L is a TD-LTE channel card which provides modem function and RRH interfacing function.

- Modem Function
  The MRA-L includes a modem with support for 3GPP LTE standard physical layer (PHY). It performs OFDMA/SC-FDMA channel processing and the DSP processes RLC/MAC. The modem of the MRA-L modulates the packet data received from upper processor and transmits it to the RRH through 'Digital I/Q and C & M' (CPRI). Reversely, it demodulates the packet data received from the RRH, converts it to the format defined in the LTE standard physical layer specifications, and transmits it to the upper processor through Ethernet.
- Optical interfacing with the RRH and Loopback Test
  As the MRA-L contains a built-in Electrical to Optic (E/O) conversion device and an Optic to Electrical (O/E) conversion device, it can send and receive 'Digital I/Q and C & M' signals of the optical signals between distant RRHs. The MRA-L can also run loopback tests to check whether the interface between the MRA-L and RRHs is in good condition for proper communication. The operator can run the loopback test if necessary using the WSM command.

Mobile WiMAX base station External Interface board assembly-Basic (MEI-B)

The MEI-B also collects alarms for the fan mounted on the DU to report to the MMA-G. The MEI-B provides the path on the alarm information generated in the external devices (additional devices provided by the operator) through UDA and selectively provided I/O panel.

3.1.2 RRH

The RRH is a remote RF device with simultaneous supports the Mobile WiMAX and TD-LTE services. Main functions of RRH are as follows:

- High-power amplification of RF transmission signal
- Interfaces optically with the channel card(MRA-F/MRA-L) of the DU using ‘Digital I/Q and C & M’ and carries out interfacing for traffic, alarms, control signals, and clock information.
- Upconversion/downconversion of frequency
- Gain control of RF Rx/Tx signal
- Rx/Tx RF signal from/to an antenna
- Suppression of out-of-band spurious wave emitted from RF Rx/Tx signal
- Low noise amplification of band-pass filtered RF Rx signal (Low Noise Amplifier, LNA)
- TDD switching function for Tx/Rx path
- Includes the filter part connected to the antenna

The RRH-2WB is the RF unit of the TD-LTE Flexible system. It supports transmission RF path of WiMAX and TD-LTE. This RF unit integrates the transceiver, power amplifier, TDD switch and filter in one module.
When simultaneously running WiMAX and TD-LTE, the operation configuration of the RRH-2WB is as follows.

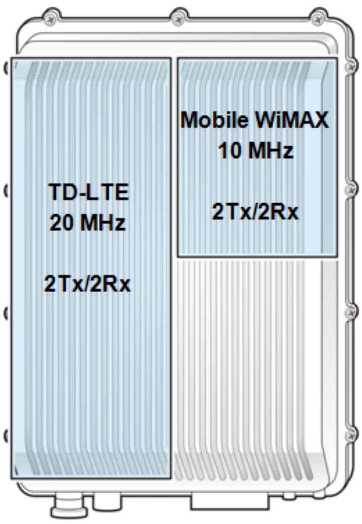


Figure 3.5 RRH-2WB Configuration for WiMAX + TD-LTE Operation

- 2T2R TD-LTE 20MHz + 2T2R WiMAX 10MHz (operating in the same sector)
- TD-LTE: 2,496~2,690 MHz, WiMAX: 2,496~2,690 MHz
- 10W+10W/Carrier @TD-LTE and 5W+5W/Carrier @WiMAX
- 2Tx/2Rx (2x2 MIMO)

In the case of downlink signals, the RRH converts baseband signals received through the ‘Digital I/Q and C & M’ interface from the channel card(MRA-F/MRA-L) into Optic to Electrical (O/E). The converted signals undergo Digital to Analog Conversion (DAC) to be converted to analog RF signals, and then are amplified through the current amplification process. Amplified signals are sent to the antenna via the filter part.

In the case of uplink signals, the frequency of the signals received through the RRH filter part is lowered by Low Noise Amplifier (LNA). The Analog to Digital Conversion (ADC) process converts these signals to baseband signals. The baseband signals are in the 'Digital I/Q and C & M' format, and undergo E/O conversion to be sent to the channel card(MRA-F/MRA-L).

The RRH cannot operate on its own, but operates by being linked to the DU. The RRH is highly flexible in its installation, and helps with setting up a network in a variety of configurations depending on the location and operation method as shown below.

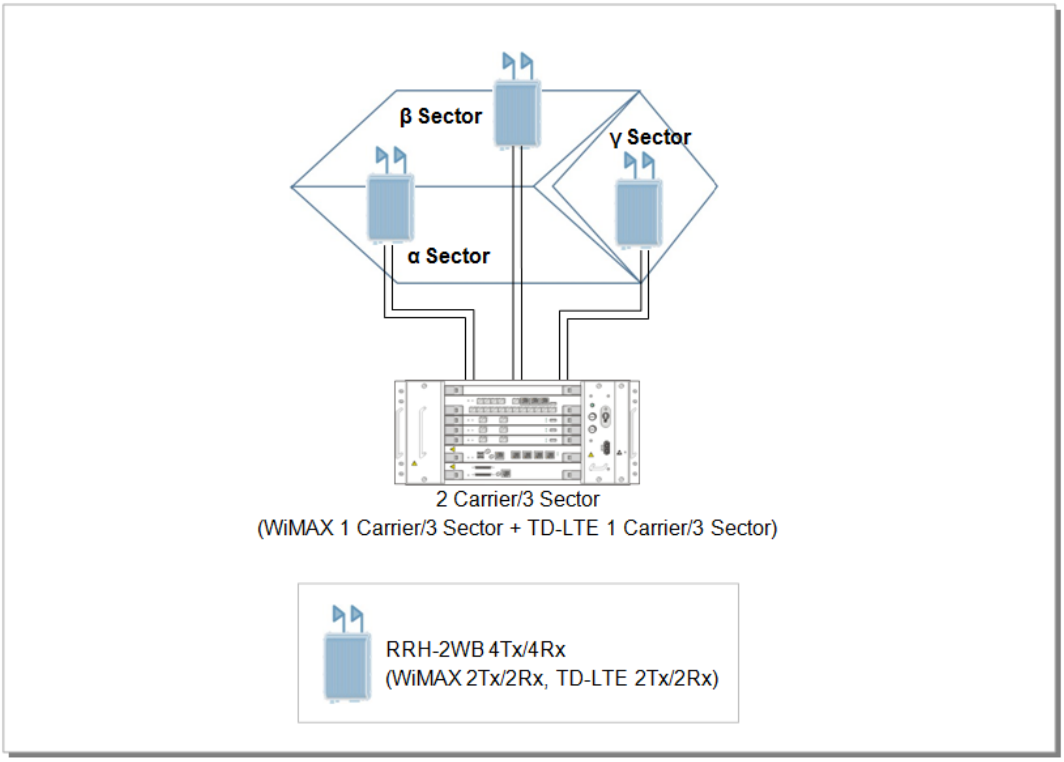


Figure 3.6 Mobile WiMAX + TD-LTE Simultaneous Operation Configuration (2Carrier/3Sector)

3.1.3 DPM-FI

The DPM-FI is mounted to the right of the TD-LTE Flexible system DMB.

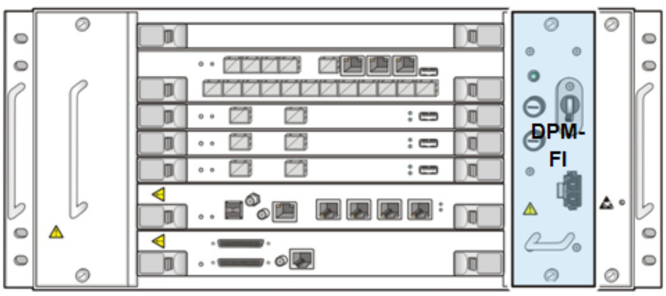


Figure 3.7 DPM-FI Configuration

Board Name	Quantity	Function
DPM-FI	1	DC Power Module-Flexible Indoor Receives DC power through a rectifier and distributes it to every block in the DMB

Every board of the DMB and the fan (FAN-FD48) of the DU in the TD-LTE Flexible system receive power through the MBB-F. Each board of DMB receives -48 VDC and converts it to the required voltage.
The following power diagram shows DU input power that is supplied to DPM-FI and connection points to each board.

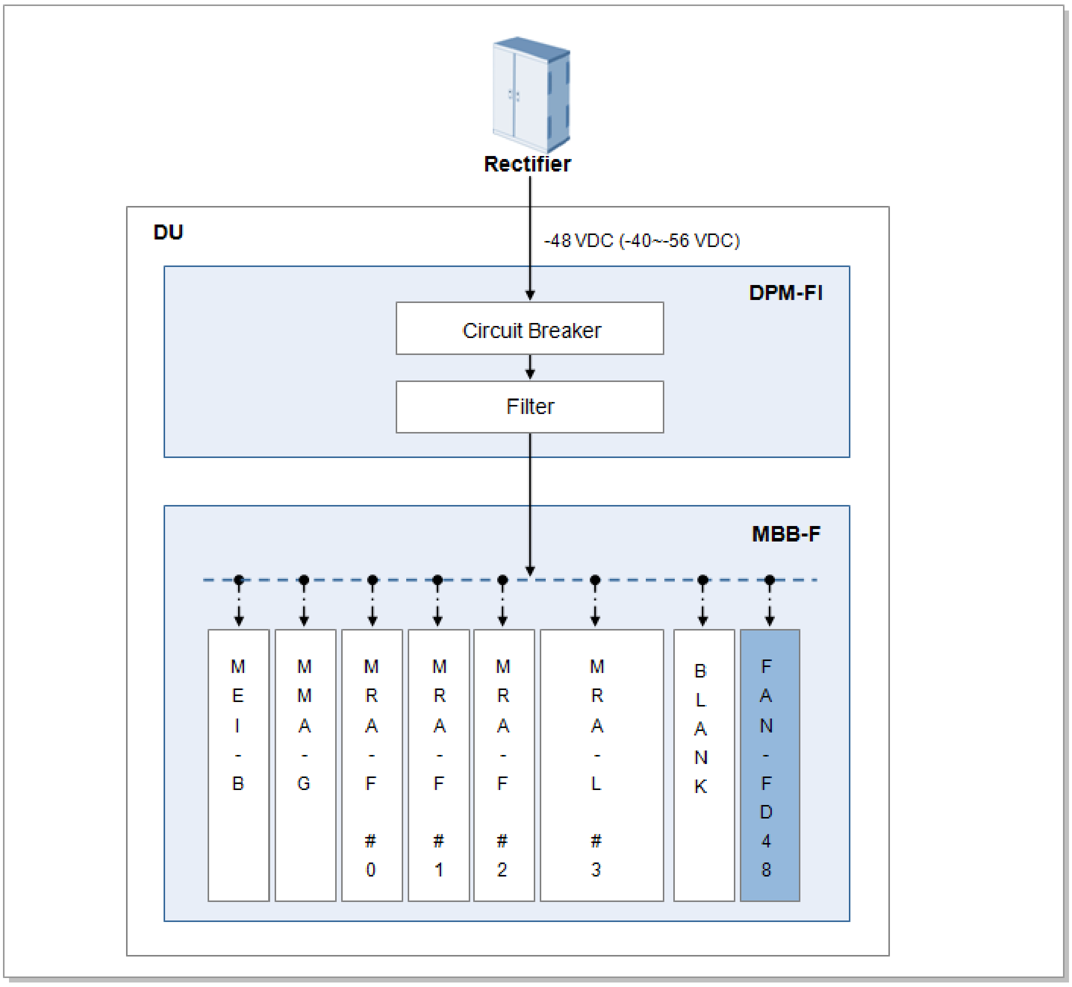


Figure 3.8 Power Structure of TD-Flexible System

> NOTE
>
> **RRH Power Supply**
> If the RRH is distant from the DU, it is supplied with separate power (e.g., rectifier) of -48 VDC (-40~-56 VDC).

3.1.4 Cooling Structure

DU

The DU of the TD-LTE Flexible system maintains the inside temperature of the shelf at an appropriate range using a set of system cooling fans (FAN-FD48), so that the system can operate normally when the outside temperature of the DU shelf changes.

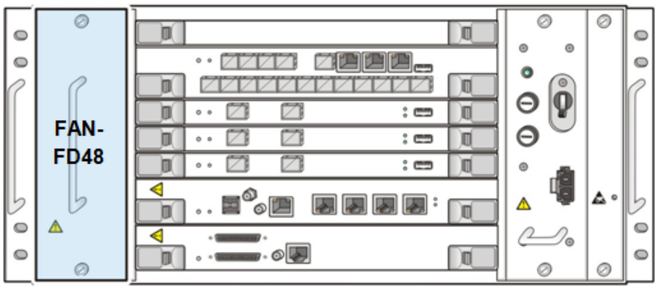


Figure 3.9 Fan Configuration

Board Name	Quantity	Function
FAN-FD48	1	FAN Module-Flexible Digital unit -48 VDC DU cooling fan

The cooling structure of the DU in the TD-LTE Flexible system is as follows.

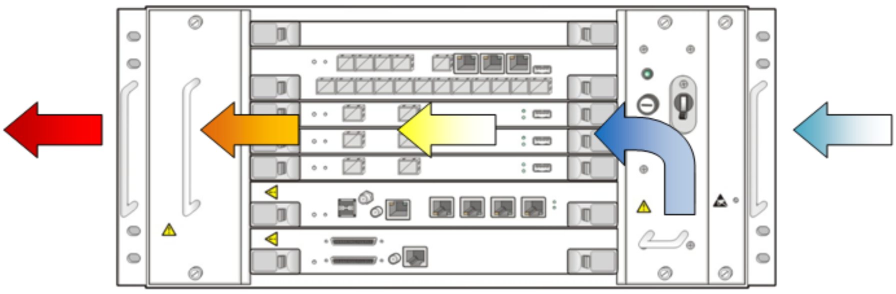


Figure 3.10 Cooling Structure of the DU

The FAN-FD48 has a built-in temperature sensor.

RRH

The RRH of the TD-LTE Flexible system is designed with a natural cooling system that supports an outdoor environment with no additional fan or heater.

3.1.5 External Interface Structure

The layout of TD-LTE Flexible system interfaces is as shown in the figure below:

Support of WiMAX + TD-LTE

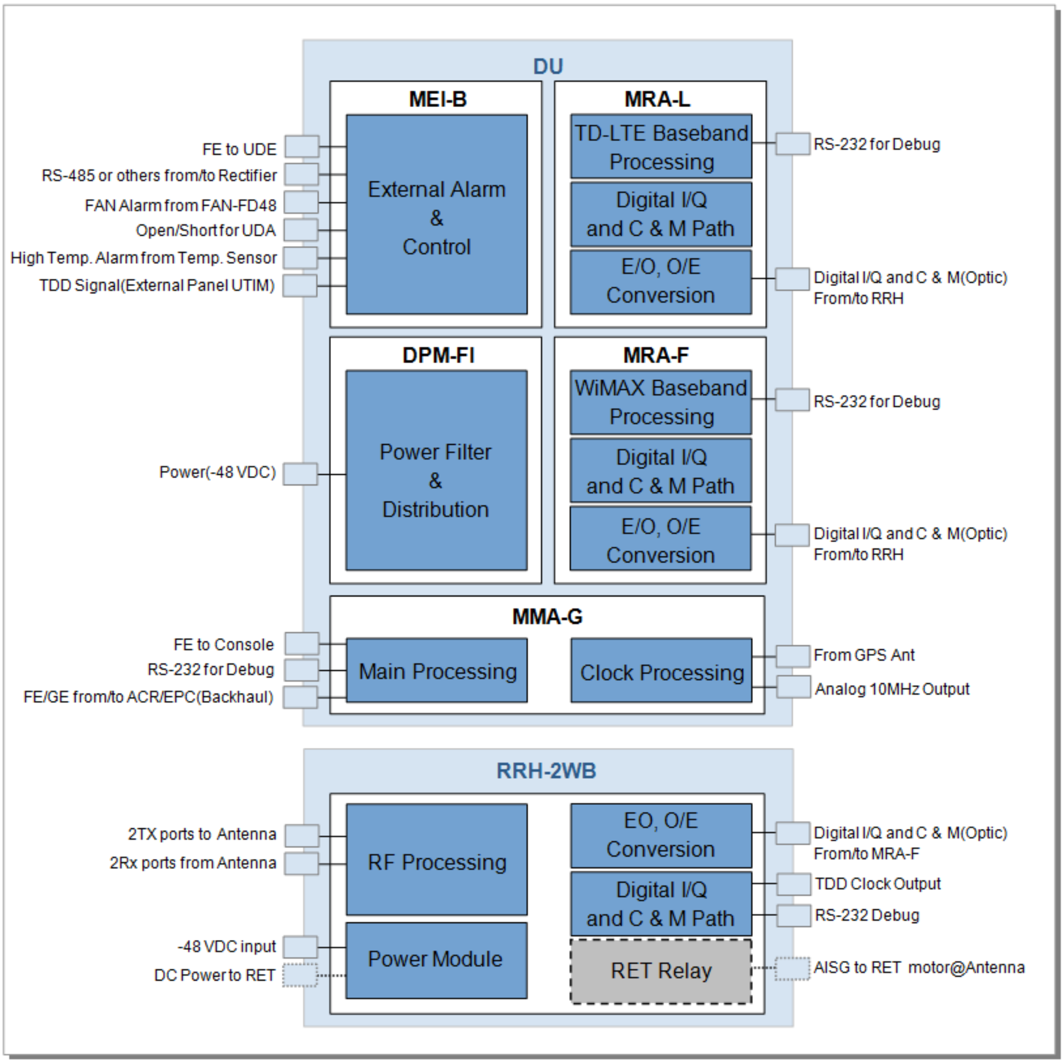


Figure 3.11 External Interfaces of TD-LTE Flexible System

The TD-LTE Flexible system supports MIMO and provides the administrator with the following external interface.

- External Interface of DU

Category	Interface Type	Port No.	Connector Type
UDE	10/100 Base-Tx	1	RJ-45
Rectifier Interface	RS-485	1	RJ-45
UDA	Open/Short	1	68Pin Champ Connector
TDD	TDD Clock(LVTTL)	1	SMA
Power	DC Power(-48VDC)	1	Molex 42816-0212
FE to Console	10/100 Base-TX	1	RJ-45
MMA-G Debug	RS-232	2	USB

Category	Interface Type	Port No.	Connector Type
Backhaul	Simultaneous operation of 1000 Base-X and 100/1000 Base-TX	2	1000 Base-X: SFP(LC)
		2	100/1000 Base-Tx: RJ-45
	100/1000 Base-TX	4	RJ-45
MRA-L Debug	RS-232	2	USB
RRH interface	Digital I/Q and C & M	Max. 12	SFP(Single mode)
MRA-F Debug	RS-232	1	USB
GPS Antenna	Analog RF	1	SMA
Analog 10 MHz	Analog 10 MHz(RF)	1	SMA

- External Interface of RRH–2WB

Category	Interface Type	Port No.	Connector Type
Antenna Interface	Analog RF(Main Traffic)	4	Mini-Din
Power	DC power(-48 VDC)	1	Square Flange Receptacle
RET	AISG 2.1(Power/Control)	1	SU-20SP-8P
DU interface	Digital I/Q and C & M 1.25Gpbs x 4cores	1	SFP(single mode)
Debug	TDD signal output	1	MCX
	Debug	1	USB

3.2 Software Structure

The TD-LTE Flexible system provides a common software platform, and accommodates independent call processing software blocks for WiMAX and TD-LTE channel cards. The OAM block of the TD-LTE Flexible system interworks with the MMA-G and WSM.

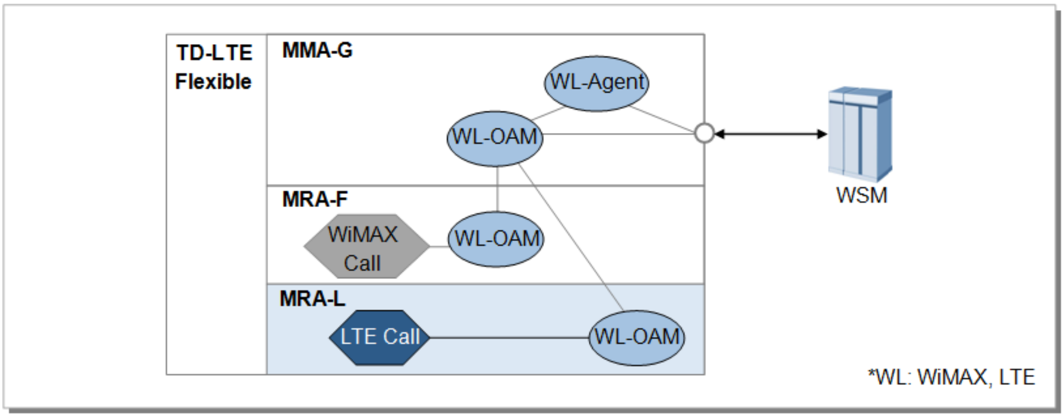


Figure 3.12 Basic Software Architecture of the TD-LTE Flexible System

The components of the system software are shown below: Operating System (OS), Device Driver (DD), Middleware (MW), Network Processor Software (NPS), IP Routing Software (IPRS), and application. The application is divided by Call Control (CC)/Call Processing Software (CPS) block for the call processing and the OAM block for operation and maintenance of the system.

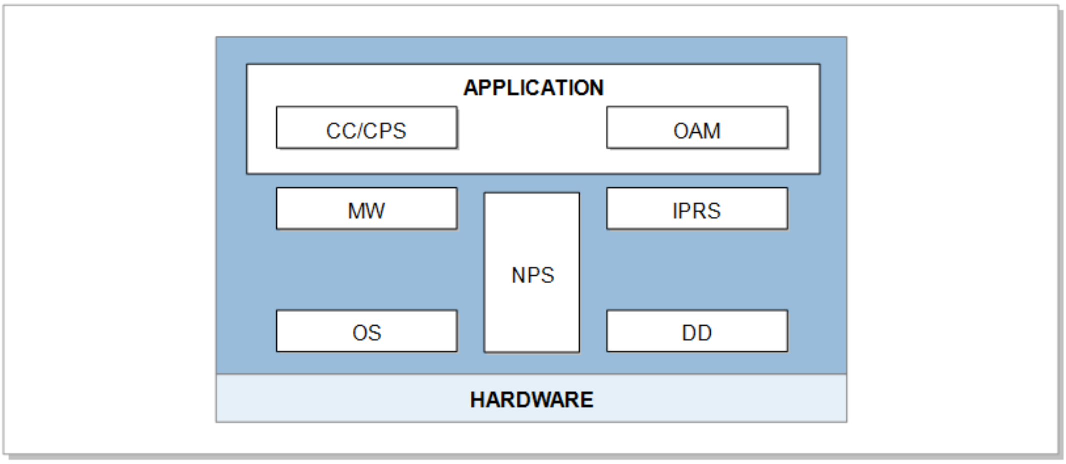


Figure 3.13 Software Structure of System

- Operating System (OS)
  OS initializes and controls the hardware device, and runs the software operation in the hardware. To operate the software, OS uses the embedded Linux OS, and manages the dual software processes. Then, OS provides various functions efficiently with limited resources.
- 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, debugging utility services.

- Device Driver (DD)
  DD provides the API for the user processor to setup/control/detect the hardware device. Also, DD confirms the device configuration by receiving the configuration data from the upper user processor, and also provides the functions of register manipulation for device operation, device diagnosis, statistics and status management.
- Network Processor Software (NPS)
  NPS manages the innate functions of Network Processor (NP) that mainly processes the packets, and it connects the upper processor and NP in Board Processor (BP), and provides the functions of NP message processing, NP statistics data collection and report.
- IP Routing Software (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.
- Call Control (CC)/Call Processing Software (CPS)
  - CC is a software subsystem that processes the calls in the system, and CC interfaces with MS and ACR. CC supports data exchange function to support wireless data service such as the MAC scheduling, air link control, ARQ processing and IEEE 802.16 message processing.
  - CPS is a software subsystem that processes the calls in the system, and CPS interfaces with UD and EPC. CPS supports data exchange function to support wireless data service such as the MAC scheduling, air link control, ARQ processing and S1/X2 message processing.
- Operation And Maintenance (OAM)
  The OAM provides the interface (SNMPv2c/SNMPv3, FTP/SFTP, HTTPs, SSH) of which is standardized to interwork with the upper management system such as the WSM, the Web-EMT and console terminal based on the IMISH. In addition, this performs the functions of initializing and restarting the system, collecting the statistics for processing the call and 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 of the system.

3.2.1 CC Block(Mobile WiMAX)

The Call Control (CC) block caries out the resource management function of the system and the BS function of ASN Profile-C defined in NWG of Mobile WiMAX forum. The CC block consists of RAS Resource Controller (RRC), RAS Service Controller (RSC) and RAS Traffic Controller (RTC) sub-blocks and the functions of each sub-block are as follow:

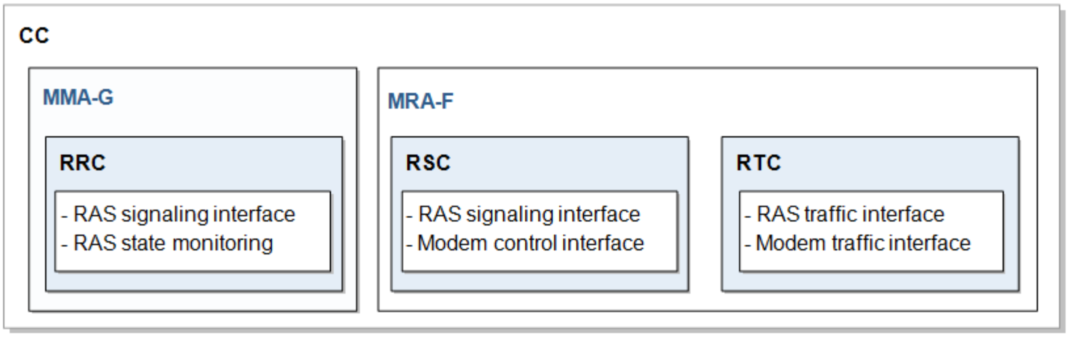


Figure 3.14 CC Block Structure

RRC as the resource manager of the system exchanges the status information with all blocks and assigns appropriate software resources to a service when it receives the necessary service request from RAS/ACR.
RSC processes the MAC signaling via R1 interface and interworks with ACR via R6 interface. RSC performs the Call Admission Control (CAC) in the service creation process and requests the traffic channel setup to RTC. In addition, RSC transfers the information on the internal control message to the modem block in the system.
RTC fragments the user data received from ACR via the R6 interface in MAC PDU format and transfers the data to the modem block or re-assembles the MAC PDU received from an MS via the R1 interface and transmits to ACR. In addition, the RTC interworks with the RSC block controlling the RAS signal and performs the call setup/release procedure.

RRC

RAS Resource Controller (RRC) is in charge of the resource management of the system and is activated on the MMA-G. The RRC interfaces with ACR outside the system and the RSC and OAM blocks inside the system.
Main functions of RRC are as follows:

- ACR Keep Alive
- RSC Keep Alive
- Inter Carrier Load Balancing
- Paging Message Transmission
- System Resource Management

RSC

The RAS Service Controller (RSC) is in charge of the signaling-concentrated service in the system. As for the system outside, the RSC performs the message exchange with ACR via the Mobile WiMAX standard R6 interface. As for the system inside, RSC interworks with the RTC that is in charge of traffic data and transmits the information on the internal control message to the modem block.
The RSC performs the MAC message exchange described in IEEE 802.16 with an MS and carries out the call setup procedure by interworking with the RRC via the system internal message. The RSC is activated on MRA.
Main functions of RSC are as follows:

- CID Creation and Release
- MAC Management Message Processing
- R6 Interface Message Processing
- Handover processing
- Sleep Mode Support for Power Reduction
- Collection of Various Statistics
- Paging Relay Function for MS

RTC

The RAS Traffic Controller (RTC) is the block to process the traffic of the system.
The RTC is the block pertaining to the bearer plane and is located as the kernel module format of the corresponding CPU. The RTC performs the R6 interface under IEEE 802.16 standard and enables to the modem block to perform the R1 interface normally.
The RTC fragments the user data received from ACR via the R6 interface in MAC PDU format and transfers the data to the modem block or re-assembles the MAC PDU received from an MS via the R1 interface and transmits to ACR.
In addition, the RTC interworks with the RTC block controlling the RAS signal and performs the call setup/release procedure. This process is carried out via the memory interface in the RAS card (MRA). The RTC communicates with the modem block via the PCI interface.
The RTC is activated on MRA and its main functions are as follows:

- ARQ function: Receives the ARQ feedback message from an MS and processes the message.
- Analyzes and processes the RSC control message and performs the queue management.
- Performs the traffic interface with the modem block.
- Performs the scheduling function for each QoS class
- Data Traffic Processing Function
  RTC provides the data path between ACR and the system via the R6 data path (GRE tunnel).
- Traffic Control Function for Handover
  In handover, RTC performs the data synchronization function between serving RAS/ACR and target RAS/ACR.

3.2.2 CPS Block(TD-LTE)

The CPS performs call processing in the eNB. It provides interfacing with the EPC, UE and nearby eNBs. The CPS consists of the eNB Control processing Subsystem (ECS) which is responsible for network access and call control functions, and the eNB Data processing Subsystem (EDS) which is responsible for user traffic handling.

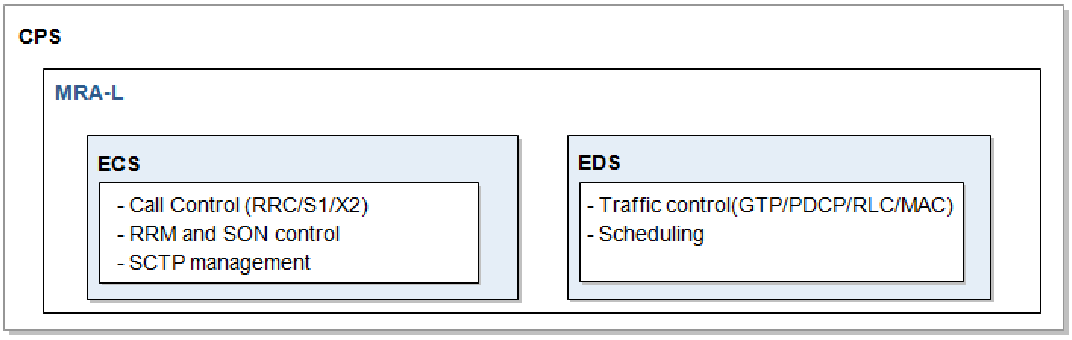


Figure 3.15 TD-LTE CPS Block Structure

ECS

The eNB Control processing Subsystem (ECS) consists of the eNB Common Management Block (ECMB), eNB Call Control Block (ECCB), SCTP Block (SCTB), and CPS SON Agent Block (CSAB) with the following functions.

- ECMB
  - Setting/releasing cell
  - Transmitting system information
  - eNB load control (eNB overload control according to CPU load)
  - Access barring control (control of access barring parameters sent to the SIB2)
  - Resource monitoring management (monitoring control for resources within the eNB such as PRB usage and PDB)
  - Cell load information transmission (acting as the interface for the ICIC function, X2 load information message transmission between eNBs)
- ECCB
  - Radio resource management
  - Idle to Active status transition
  - Enabling/changing/disabling bearers
  - Paging
  - MME selection/load balancing
  - Call admission control
  - Security function
  - Handover control
  - UE measurement control
  - Statistics processing
- SCTB
  - S1-C interfacing
  - X2-C interfacing
- CSAB
  - Mobility Robustness optimization
  - RACH optimization

EDS

The eNB Data processing Subsystem (EDS) consists of the GPRS Tunneling Protocol Block (GTPB), PDCP Control Block (PDCB), Radio Link Control Block (RLCB), and Medium Access Control Block (MACB).

- GTPB
  - GTP tunnel control
  - GTP management
  - GTP data transmission
- PDCB
  - Header compression and decompression: ROHC only
  - User and control plane data transmission
  - PDCP sequence number maintenance
  - Downlink/uplink data retransmission at handover
  - Ciphering and deciphering user data and control data
  - Integrity protection for control data
  - Timer based PDCP SDU discard
- RLCB
  - Transmission for upper layer PDU
  - ARQ function used for AM mode data transmission
  - RLC SDU concatenation, segmentation and reassembly
  - Re-segmentation of RLC data PDUs
  - In sequence delivery
  - Duplicate detection
  - RLC SDU discard
  - RLC re-establishment
  - Protocol error detection and recovery
- MACB
  - RLC SDU concatenation, segmentation and reassembly
  - Multiplexing & de-multiplexing
  - HARQ
  - Transport format selection
  - Priority handling between UEs
  - Priority handling between logical channels of one UE

3.2.3 OAM Block

Operation And Maintenance (OAM) block manages the operation and maintenance of the system, and it is divided as the three shown below:

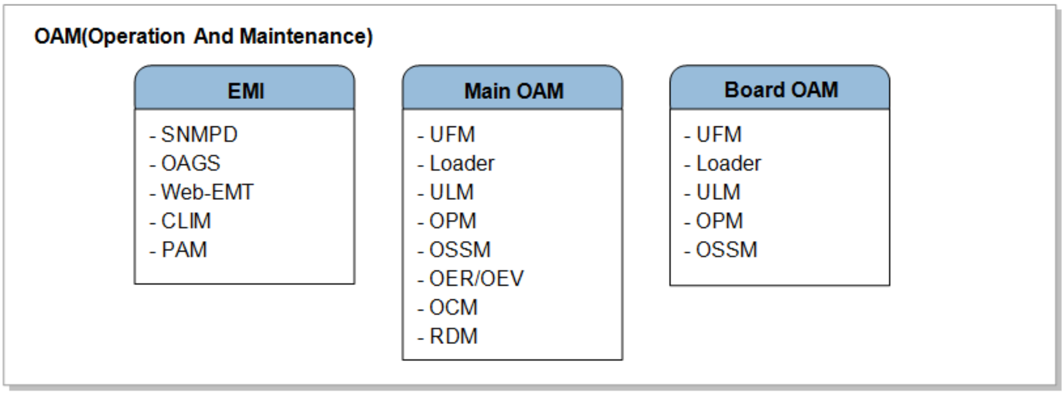


Figure 3.16 OAM Software Structure

The following interface structure diagram shows the communication between OAM blocks. Main OAM and EMI are running on the MMA–G that support master OAM. Board OAM is running on the remaining lower processor board.

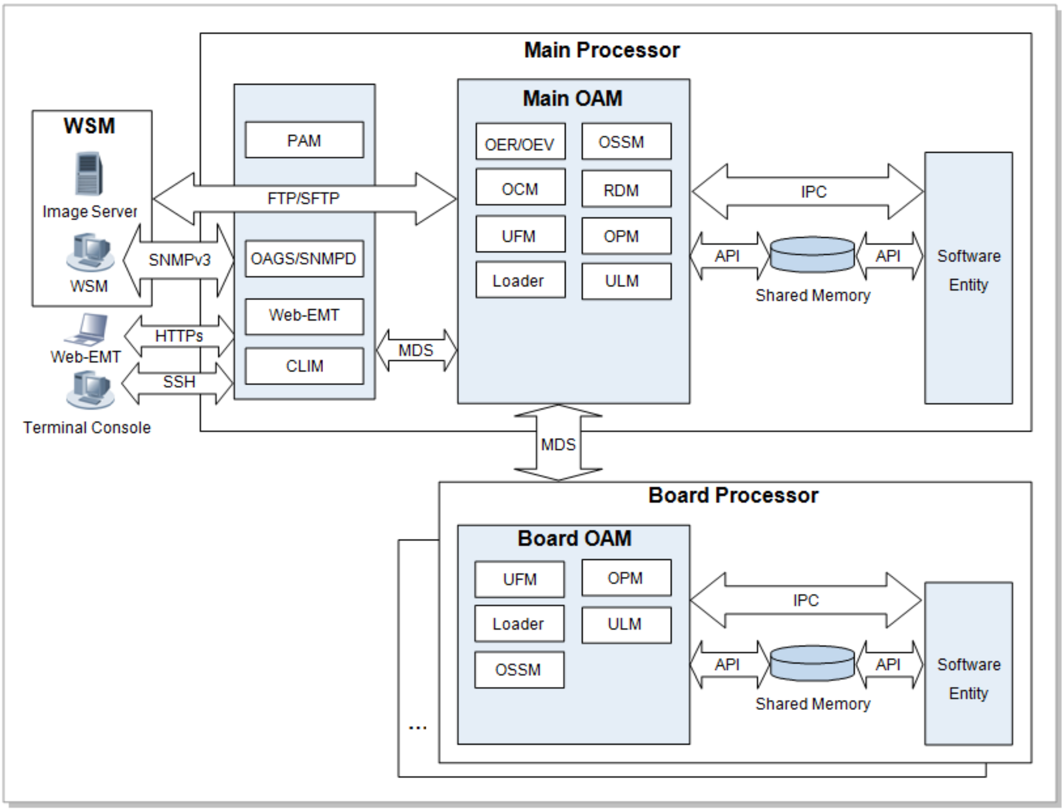


Figure 3.17 Interface between OAM Blocks

The EMI carries out SNMP agent and web server function, and provides the OAM interface between the management system (WSM, Web-EMT and CLI Terminal) and the system by providing the IMISH. Then, to access the system directly via the Web-EMT or the console terminal, the process of the operator authentication and the authority allowance via the WebEMT or Pluggable Authentication Module (PAM) block should be done.

The Main OAM is located in the main processor. The Main OAM communicates with the upper management system by interworking with the EMI block and distributes the Programmable Loading Data (PLD) to the lower processors by managing the system configuration as the format of the PLD. In addition, the Main OAM performs and manages the role of the Image Server (IS) and the Registration Server (RS), collects and saves the statistics data and the failure information, and reports them to the upper management system. The Board OAM is located in the lower processor. The Board OAM collects the failure and the statistics data of each board, reports them to the Main OAM and monitors the software process of each board.
Functional details of each block are as follows.

SNMPD

SNMP Daemon (SNMPD) plays the SNMP agent role to support the standard SNMP (SNMPv2c/SNMPv3) and an interface role for the upper management system (WSM) and interworks with internal subagent. While receiving requests on the standard MIB object from WSM are processed by SNMPD itself, it transmits requests on the private MIB object to subagent in order to be handled properly.
Main Functions are as follows:

- Standard MIB processing
  If the request for the standard MIB object such as MIB-II etc. is received, the SNMPD processes it directly and transmits the response.
- Private MIB processing
  If the request for the Private MIB object is received, it is not processed directly by the SNMPD, but it is transmitted to the corresponding internal subagent, and then the response is transmitted from the subagent and it is transmitted to the manager.

SNMPD is implemented on the MMA-G.

OAGS

Common SNMP Agent Subagent (OAGS) plays the SNMP subagent role to support the standard SNMP(SNMPv2c/SNMPv3).
Also, through master agent (SNMPD) OAGS plays an interface role for the upper management system for the command inquiry and change of ACR to be operated through the get/get-next/get-bulk/set/trap command defined by SNMP.
Main Functions are as follows:

- Providing private MIB
  - Provide private MIB to the management system.
  - Generate the message data file necessary for the interface function between OAM blocks.
- SNMP command processing
  Process the command received from the management system and transmit the corresponding result via the SNMPD.
- Notification function
  Send the SNMP trap to master agent (SNMPD) whenever there are needs to inform the change or the alarm of the system data to the upper management system.

OAGS is implemented on the MMA-G.

WebEMT

The Web-based Element Maintenance Terminal (WebEMT) is the block to interface with the Web client of the console terminal which uses the Web browser, and performs the role of the Web server. Both Web-EMT and the system support the HTTP communications based on the Secure Sockets Layer (SSL).
Main Functions are as follows:

- Web server function
  - HTTP server for the management using Web-EMT
  - Receive html requests and display HTML pages
- OAM block interface
  - Process commands from Web-EMT interoperating with other OAM blocks
  - User management via OAM AAA server

WebEMT is implemented on the MMA-G.

CLIM

The Command Line Interface Management (CLIM) is the block to interface with the IMISH, when it is connected to the console terminal via the Secure Shell (SSH) method. The CLIM processes the received command via the IMISH and displays the corresponding result.
Main Functions are as follows:

- IMISH command processing
  - Setup/change/inquiry of interface and routing functions
  - Setup/change/inquiry of the system operation & maintenance

PAM

The Pluggable Authentication Module (PAM) receives the account and the password of the operator who uses the console terminal (IMISH and Web-EMT) when logging in, thus it perform the operator authentication and the process of allowing the authority.
Main Functions are as follows:

- Operator's account management and authentication
  The function of managing and authenticating the account of the operator who uses the console terminal (IMISH and Web-EMT) is performed.
- Operator's authority management
  The function of allowing the authority for all the commands which the operator can perform is performed.
- Password management
  Management functions such as creating the operator's password, saving and updating the encryption are performed.

PAM is implemented on the MMA-G.

UFM

Universal Fault Management (UFM) manages the ACR faults and the status of software and hardware. UFM informs the detected failures to the upper management system by the filtering function, and applies the severity changes and the threshold to the fault management system. In particular, the UFM receives ToD from a Global Positioning System (GPS) signal receiver, distributes the received ToD to CC software for call processing, and manages faults concerned with the ToD.
The UFM is implemented on MMA–G and all lower boards.
Main Functions are as follows:

- Failure Management
  - Hardware and software failure management by interrupt and polling
  - When the failure is detected, it is reported to the management system and the related block.
- Status Management
  - Status management for the components
  - When the status information of the resource is changed, it is reported to the management system and the related block.
- Failure filtering and inhibition
  - The filtering function is applied to many kinds of the occurred failure, and only the failure of the original reason is reported.
  - Function of inhibiting reporting a specific kind of failure or a specific system according to the operator's request
- Inquiring and changing the failure configuration information
  Inquiring and changing the parameters such as the failure severity and the threshold for the generation
- Failure audit
  Auditing the failure is performed when initializing and restarting the system and when the operator requests to minimize the inconsistency of the failure information between the system and the upper management system.
- Failure history information management and save
- Call fault reporting
  In case of the call fault, the related information (call status, error code, MS information, etc.) is collected and reported to the management system.
- DD Interface
  The interface between DD and applications is provided for statistics and status management of devices.

Loader

Loader manages the entire process from the start of OS to the previous step of ULM running (pre-loading). After that, if ULM is actuated after the initialization script is executed and the registration and loading function is performed, the loader monitors the ULM block. Loader is implemented on MMA-G and all lower boards.
Main Functions are as follows:

- System time setting
  Before NTP-based synchronization, the system time is set by receiving the Time of Date (ToD) from a GPS receiver.
- system registration and loading
  - Registration of the system to the Registration Server (RS)
  - Determination of the loading method
    - Loading as the latest version via the version comparison: Loading via the own non-volatile storage or via the remote IS
    - Loading via the console port (at this time, omitting the registration of the system to the RS)
- Backing up and restoring the software image and the PLD
  Loader saves the software image and the PLD of the latest version in its own nonvolatile storage and restores it as the corresponding information when required.
  (In case of PLD, back-up by operator's command)
- ULM monitoring
  Loader monitors whether the ULM block operates normally and if it is abnormal, this restarts it.

ULM

Universal Loading Management (ULM) downloads and executes the packages that are identified in the file list downloaded by loader during pre-loading process. Also, ULM monitors the executed software and provides the running software information, and supports the restart and the software upgrade by the command. In addition, in the initialization stage, ULM sets the system time by using the Time of Date information obtained from a GPS receiver and periodically performs the synchronization with the NTP server by actuating as an NTP client after the loading is completed.
Main Functions are as follows:

- System initialization and reset
  - System reset by command
  - Act as internal RS & IS of lower board
- Software management
  - Monitor the operation of software block and restart the software block in abnormal state
  - Software restart by command
  - Provide information on software block and the status
- Inventory Management
  - ULM provides the information such as the software version for the components, the PBA ID, the PBA version and the serial number, etc.
  - Function of reporting the inventory information when performing the initialization, adding and extending the components
- Online upgrade and version management for the software
  ULM provides the functions of updating the software and the firmware, upgrading the package and managing the version.
- System time information synchronization

Synchronize system time information with NTP server as a NTP client and transmit the time information to the lower boards

- Time Zone setup
  Setup Time Zone and Daylight Saving Time (DST)
- Mortem time update
  Setup mortem time after system time information synchronization

ULM is implemented on MMA-G and all lower boards.

OPM

Common Performance Management (OPM) collects and provides the performance data for the upper management system operator to know the system performance. The OPM collects the event generated during the system operation and the performance data and transmits them to the management system. The collection cycle of the statistics data of the actual OPM can be set as 15 minutes, 30 minutes, 60 minutes, and if the entire statistics file of the binary format is created every 15 minutes, the management system collects it periodically via the FTP/SFTP.
Main Functions are as follows:

- Record and collect statistics data
  Record statistics data to the memory and generate the statistics file by regularly collecting data per each board
- Save the statistics data
  Save the statistics data of each board in its own nonvolatile storage during up to eight hours
- Inquire and change the statistics configuration information
  Inquire and change the collection cycle (BI) and the threshold of the statistics data
- Threshold Cross Alert (TCA)
  Generate the TCA (Critical, Major, Minor) according to the defined threshold in every collection cycle and report it to the UFM
- Monitor the statistics in real time
  Provide the real-time monitoring function for the specific statistics item designated by the operator

OPM is implemented on MMA-G and all lower boards.

OSSM

Common Subscription Service Management (OSSM) distributes the PLD data necessary for the software blocks, and reports the data changed to the corresponding software block if PLD data are changed. Also, it supports the function to maintain the consistency of PLD data that are scattered in the system.
Main Functions are as follows:

- PLD distribution
  OSSM loads PLD to the shared memory for software block in order to access PLD
- PLD change report
  Report the changes of PLD to the corresponding software block
- PLD audit

Maintain the consistency of PLDs which are distributed in the system (between main board and lower boards)

OSSM is implemented on the MMA-G and all lower boards.

OER/OEV

The Common Event Router (OER)/Common Event Viewer (OEV) manages the event history as the text format. The OER/OEV transmits the information on all the events received from the OAM applications to the related agent (OAGS, WebEMT), and creates and saves the history file of the daily/hourly events, and displays the log contents on the operator window (IMISH) in real time.
Main Functions are as follows:

- Event transmission
  OER/OEV transmits the information on the generated event to the OAGS or the WebEMT block, thus it enables to report it to the management system.
- Creating and saving the event history file
  OER/OEV creates and saves the daily/hourly event history file in its own nonvolatile storage as the 1 Mbyte maximum size.
- Event display
  OER/OEV displays the event generated in the system on the operator window (IMISH) in real time.

OER/OEV is implemented on the MMA-G.

OCM

Common Configuration Management (OCM) manages the system configuration and parameter with PLD, and it provides the data that are necessary for the software blocks. Other software blocks can approach PLD by the internal subscription service (OSSM), and through the command from EMI.
OCM provides the following functions: system configuration grow/degrow, inquiry and change of configuration data and operational parameters.
OCM is implemented on the MMA-G.
Main Functions are as follows:

- System configuration management
  Manage the system configuration with PLD
- PLD inquiry and change
  - Upper management system inquires and changes PLD by command
  - PLD changes are updated in its own nonvolatile storage by operator’s command.
- PLD audit
  For the consistent PLD data with the upper management system
- Grow/degrow of resources
  Link, board, carrier and sector in the system

RDM

The RAS Diagnosis Management (RDM) checks if internal and external connection paths or resources of the system are normal. The connection paths are roughly divided into the external path between the system internal IPC path and another NE and the path between ACR and the system.
In addition, it supports the on-demand test at the request of an operator and the periodical test according to the schedule defined by the operator.
The RDM is implemented on the MMA-G.
Main Functions are as follows:

- Path Test
  - Internal path test: Ping test for the IPC path of the board level in NE
  - External path test: Traceroute test for external hosts
  - Traffic path test: Test for the UDP message-based bearer path between ACR and the system
- Software Block Test
  Ping test for main programs by processors
- RF Exchange Test
  RSSI-based Rx path, Tx power and VSWR diagnosis
- DU-RRH Loopback Test
  Support of loopback function for 'Digital I/Q and C & M' interface
- Backhaul performance monitoring test
  Quality (packet loss, delay and delay variance) measurement for backhaul between ACR and the system
- Periodical online test by the operator setting
- Change of the Diagnosis Schedule
  Schedule setup, such as diagnosis period, start time and end time of periodical online test
- Support of Call Trace Function
  It reports the call trace information (signaling message of a specific MS, RF parameter, and traffic statistics) to the management system via SNMPD.
- Virtual Interface (VIF) generation and removal
  Generate and remove VIF based on physical link configuration in PLD
- VIF state management
  Change the state of physical VIF with link failure
- RF Module Setup and Control
  Transmission of the setup information required for the RF module, and management of failure/status

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CHAPTER 4. Message Flow

4.1 Call Processing Message Flow(WiMAX)

4.1.1 Initial Entry

Below is the procedure that sets up a provisioned Service Flow (SF) in the network-initiated Dynamic Service Add (DSA) mode during the initial network entry procedure.
In the initial entry procedure, the MS periodically receives Downlink Channel Descriptor (DCD), Downlink-MAP (DL-MAP), Uplink Channel Descriptor (UCD), and Uplink-MAP (UL-MAP) messages from the RAS, obtains the downlink channel synchronization and uplink parameters, and sets a provisioned SF connection.

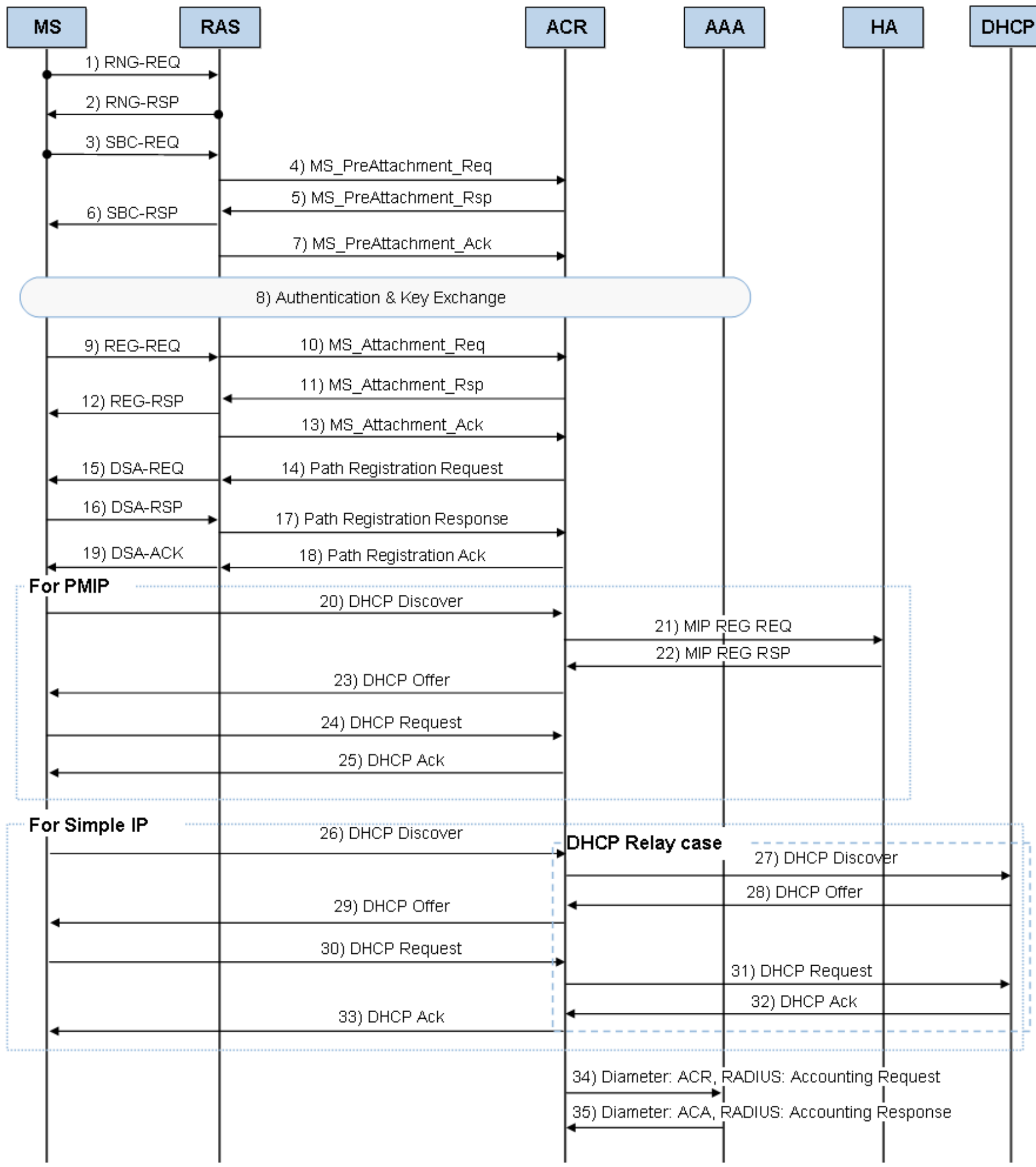

Figure 4.1 Initial Entry Procedure

Category	Description
(1)~(2)	The MS sends the RAS the RNG-REQ message containing the MAC address and Ranging Purpose Indication of the MS. The RAS assigns the Basic & Primary Management CID and sends the RNG-RSP message to the MS.
(3)~(4)	The MS sends the RAS the SBC-REQ message containing the physical parameter and authorization policy information the MS supports. To request the authorization policy, the RAS sends the ACR the MS_PreAttachment_Req message containing the authorization policy support value using the default IP address and UDP port number of the ACR.

Category	Description
(5)~(7)	The ACR sends the RAS the MS_PreAttachment_Rsp message containing the supported authorization policy. The RAS extracts the information received from the ACR and sends the MS the SBC-RSP message containing it. Then the RAS sends the ACR the MS_PreAttachment_Ack message to explicitly provide notification of the start time of the next procedure (EAP transmission).
(8)	The subscriber authentication procedure is performed between the MS and AAA server. When the authentication is successful, the ACR receives provisioned policy information for each subscriber from the AAA server. For more information, see 'Authentication'.
(9)~(13)	The MS sends the RAS the REG-REQ message containing the registration information (MS Capabilities, CS Capabilities, HO Support, etc.). The RAS sends the ACR the MS_Attachment_Req message to inquire about MS Capabilities and CS Capabilities. The ACR sends the RAS a response containing the result for the requested registration information. The RAS sends the MS the REG-RSP message. The RAS sends the ACR the MS_Attachment_Ack message to explicitly provide notification of the start time of the next procedure.
(14)~(19)	To request DSA for Pre-Provisioned SF, the ACR sends the RAS the Path Registration Request message containing the SFID field, Resource Description field (SF/CS parameter), and Data Path ID (= GRE Key) field for setting a data path with the RAS. The RAS receives this message, performs admission control, and then sends the MS the DSA-REQ message. The MS sends the RAS the DSA-RSP message containing the confirmation code as the result of the DSA-REQ message. The RAS sends the ACR the Path Registration Response message containing the data path ID to set a data path with the ACR. The ACR sends the RAS the Path Registration Confirm message. The RAS sends the MS the DSA-ACK message.
(20)~(25)	This procedure is used to assign an IP address to the MS when it uses PMIP. If the MS requests the DHCP procedure to obtain an IP address, the ACR performs the PMIP procedure.
(26)~(33)	This is the procedure for allocating an IP address to the MS that uses the simple IP method. If the MS requests the DHCP procedure to receive an allocated IP address, the ACR allocates the Simple IP address to the MS using the built-in DHCP server functions. As an option, the ACR supports the DHCP Relay Agent function, which interoperates with the external DHCP server.
(34)~(35)	The ACR notifies the AAA server that the session has started using AAA interface protocol.

4.1.2 Authentication

During Initial Entry

The figure below shows the MS authentication procedure during the 'Initial Entry' procedure, as described above.

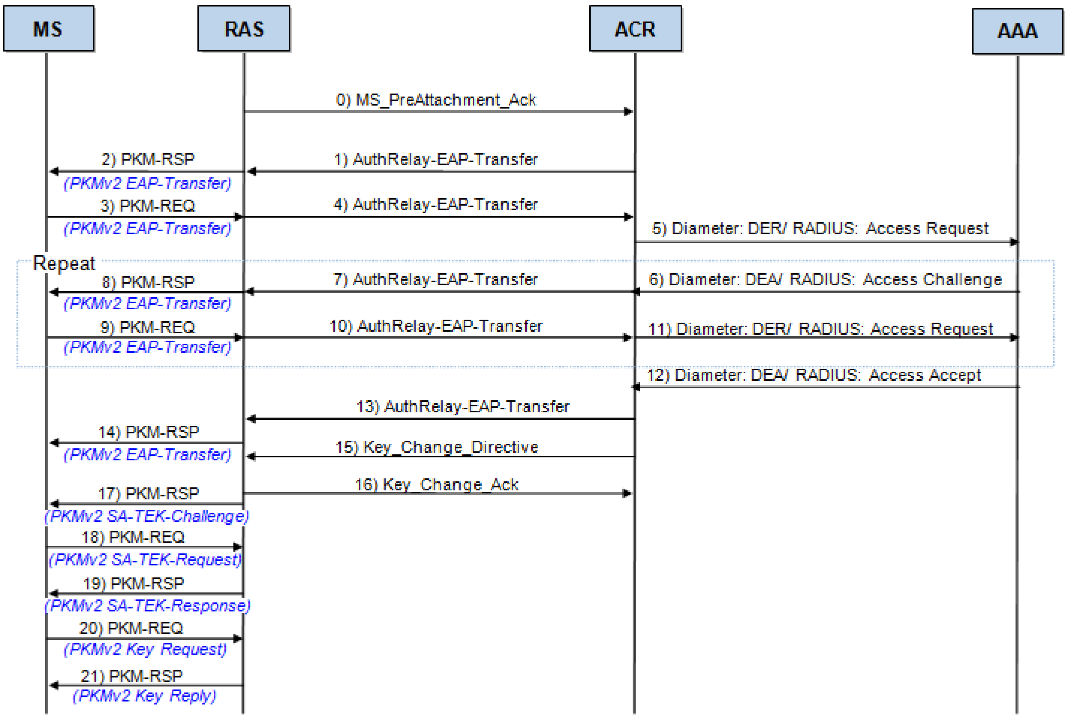

Figure 4.2 Authentication Procedure (During Initial Entry)

Category	Description
(0)~(2)	When receiving the MS_PreAttachment_Ack message from the RAS as a response to the SBC-RSP message, the ACR sends the RAS the AuthRelay-EAP-Transfer message containing the EAP Request/Identity payload to begin EAP authentication. The RAS relays the received EAP payload to the MS using the PKMv2 EAP-Transfer/PKM-RSP message.
(3)~(5)	The MS includes the NAI in the EAP Response/Identity and sends the RAS the PKMv2 EAP-Transfer/PKM-REQ message. The RAS relays the received information to the ACR using the AuthRelay-EAP-Transfer message. ACR exchanges the authentication message including EAP packet using defined AAA interface protocol.
(6)~(11)	In accordance with the EAP method, the subscriber authentication procedure is performed between the MS and AAA server. ACR exchanges the authentication message including EAP packet using defined AAA interface protocol.
(12)~(16)	When the authentication is successfully completed, the ACR receives the Master Session Key (MSK) that is the upper key to provide security and provisioned policy information per subscriber from the AAA server using defined AAA interface protocol. The ACR creates an AK from the MSK and sends the RAS the Key_Change_Directive message containing the created AK Context information and Security Association (SA) information of the MS. Moreover, the RAS communicates EAP Success to the MS using the PKMv2-EAP-Transfer message.

Category	Description
(17)~(19)	After EAP authentication, the RAS sends the MS the SA-TEK-Challenge message to verify the AK key value of the MS and notify the start of SA negotiation. The MS verifies the CMAC of the SA-TEK-Challenge message, verifies the AK key value, and then sends the RAS the SA negotiation information using the SA-TEK-Request. The RAS sends the MS the SA-TEK-Response message containing not only the AKID but also the SA Descriptor, which is the final SA negotiation result.
(20)~(21)	The MS requests a Traffic Encryption Key (TEK) from the RAS using the PKMv2 Key-Request message. The RAS creates a TEK randomly and sends it to the MS using the PKMv2 Key-Reply message. At this time, the TEK is sent encrypted, with a Key Encryption Key (KEK).

NOTE

Types and Uses of Keys

The types and uses of keys are as follows:

- MSK: Used to create an AK
- AK: Used to create a CMAC key
- KEK: Used to encrypt a TEK
- CMAC key: Used to provide integrity for the MAC management message
- TEK: Used to encrypt traffic in the air section

During Authenticator Relocation

When the MS performs CSN-anchored Handover (HO) or the MS in Idle mode moves to another ACR's area and performs location update, the following reauthentication procedure is performed to move the authenticator from the existing serving ACR to the target ACR. When the target ACR triggers the MS to perform the EAP authentication procedure again with the AAA server and notifies the serving ACR of the authentication result, the authenticator relocation procedure finishes.

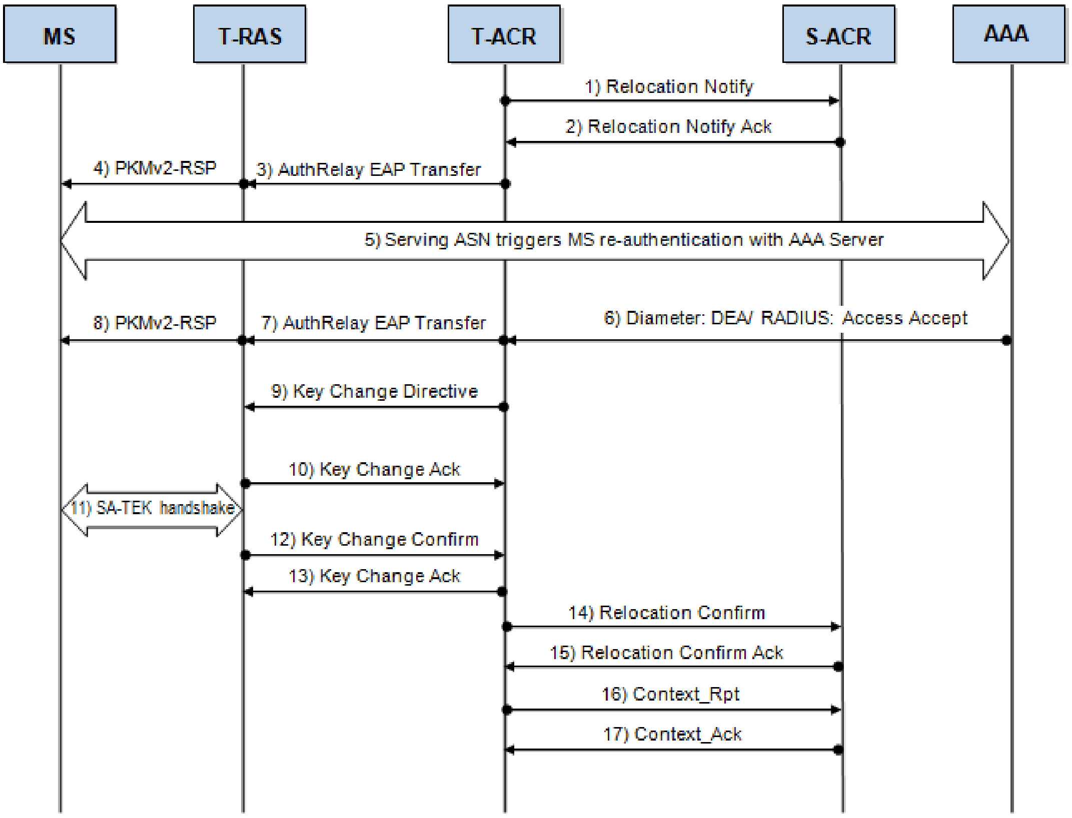

Figure 4.3 Authentication Procedure (During Authenticator Relocation)

Category	Description
(1)~(2)	The T-ACR, which is the new authenticator, exchanges the Relocation Notify/Ack message with the S-ACR, which is the previous authenticator, to relocate the authenticator by performing the reauthentication procedure.
(3)~(11)	The reauthentication procedure is performed in the target area in the same way as the authentication procedure during initial entry.
(12)~(13)	The RAS sends the T-ACR, which is the authenticator, the Key Change Confirm message to indicate that the reauthentication procedure with the MS has finished.
(14)~(15)	The T-ACR exchanges the Relocation Confirm/Ack message with the S-ACR to complete the authenticator relocation procedure.
(16)~(17)	After authenticator relocation, the new authenticator notifies the anchor that the authenticator has changed using the Context Rpt procedure.

4.1.3 State Transition

Awake Mode → Idle Mode (MS-Initiated)

If there is no traffic transmission for a specific period of time, the MS transits from Awake mode to Idle mode.

NOTE

Sleep Mode → Idle Mode Transition
The MS in Sleep mode does not directly transit to Idle mode. This is because, before the MS transits from Sleep mode to Idle mode, it first transits to Awake mode and requests DREG before transiting to Idle mode.

The deregistration procedure for transiting to Idle mode is divided into MS-initiated Idle mode transition and Network-initiated Idle mode transition. The figure below shows the MS-initiated idle mode transition procedure.

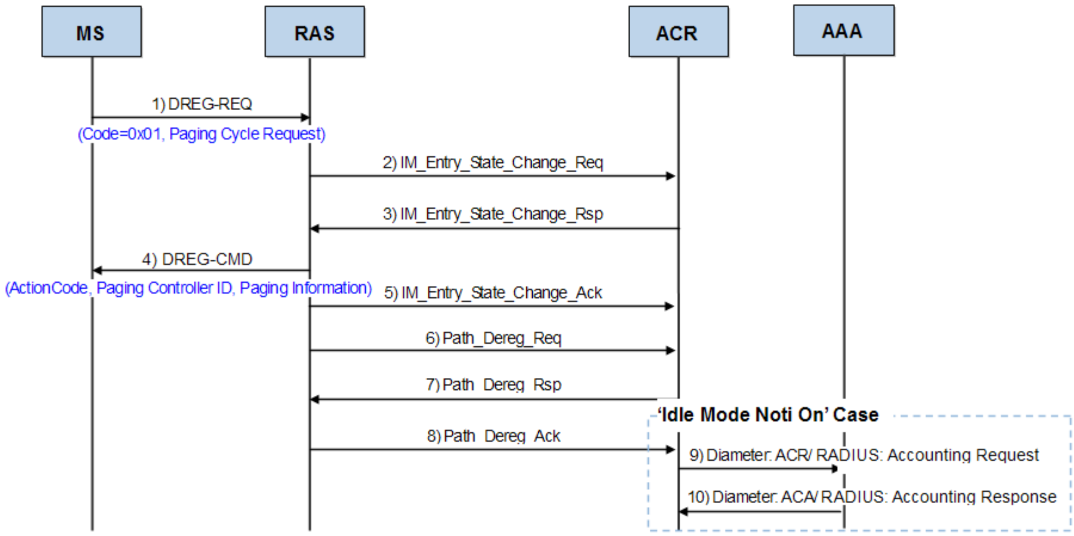

Figure 4.4 Awake Mode → Idle Mode State Transition Procedure (MS-Initiated)

Category	Description
(1)	When the MS transits to Idle mode, it creates the DREG-REQ message and sends it to the RAS. The De-Registration Request Code field value is set to 0x01.
(2)~(5)	The RAS creates the IM_Entry_State_Change_Req message containing the context information of the MS and sends it to the ACR (paging controller). The ACR creates the IM_Entry_State_Change_Rsp message containing Action Code (0 × 05), paging information (PAGING_CYCLE, PAGING_OFFSET), and Idle Mode Retain flag and sends it to the RAS. The RAS sends the MS the DREG-CMD message containing the information received.
(6)~(8)	If no network reentry request is received from the MS until the Idle Resource Retain timer expires, the RAS performs the Data Path (DP) Release procedure with the ACR.
(9)~(10)	When the Idle Mode Notification function is available, If the function is on, the accounting information is updated using the R3 AAA interface accounting message

Awake Mode → Idle Mode (Network-Initiated)

The figure below shows the Network-initiated idle mode transition procedure.

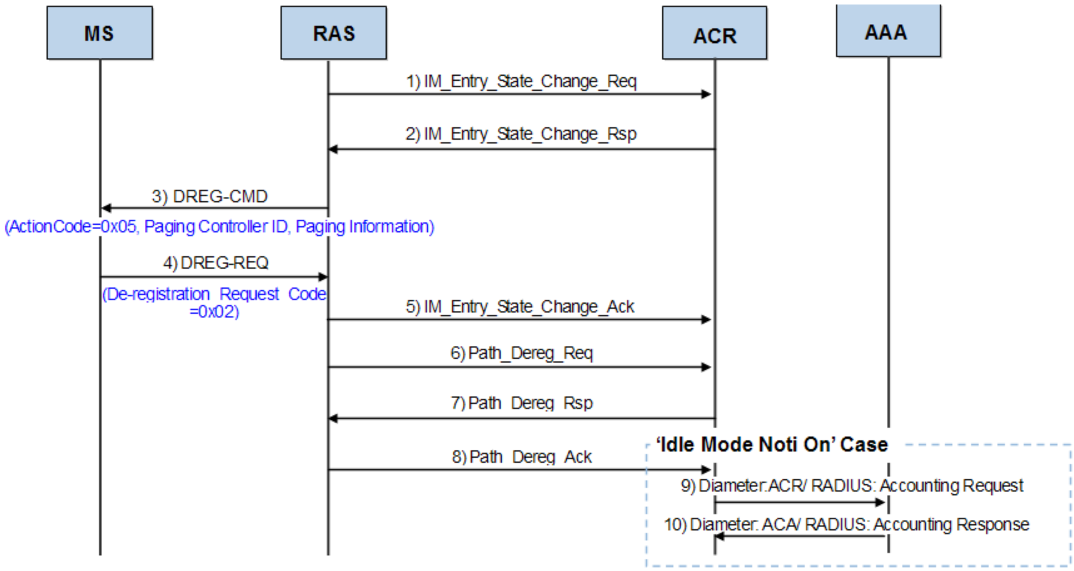

Figure 4.5 Awake Mode → Idle Mode State Transition Procedure (Network-Initiated)

Category	Description
(1)~(3)	If the Dormant timer expires, the RAS creates the IM_Entry_State_Change_Req message containing the context information for the MS and sends it to the ACR (Paging Controller). The ACR creates the IM_Entry_State_Change_Rsp message containing paging information (PAGING_CYCLE, PAGING_OFFSET) and Idle Mode Retain and sends it to the RAS. At this time, the Idle Mode Retain info is set to 0x7F. The RAS sends the MS the DREG-CMD message containing the information received.
(4)	The MS sends the BS the DREG-REQ message and sets the De-Registration_Re-quest_Code field value to 0x02.
(6)~(8)	If no network re-entry request is received from the MS until the Idle Resource Retain timer expires, the RAS performs the Data Path (DP) Release procedure with the ACR.
(9)~(10)	When the Idle Mode Notification function is available, If the function is on, the accounting information is updated using the R3 AAA interface accounting message

Awake Mode → Sleep Mode

Only the RAS can recognize whether the MS is in Awake or Sleep mode. The ACR recognizes both states as Awake mode regardless of which mode the MS is actually in.

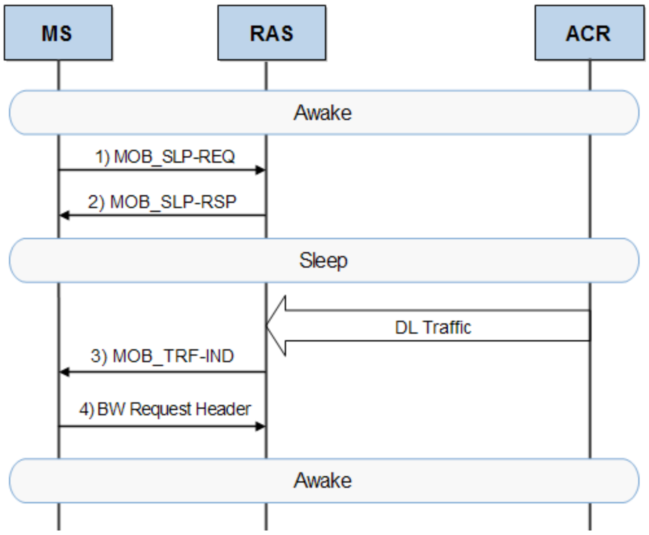

Figure 4.6 Awake Mode → Sleep Mode State Transition Procedure

Category	Description
(1)~(2)	If there is no data transmission for a specific period of time (set by the MS/RAS using a parameter) in the MS, its timer is timed out, and the MS transits from Awake mode to Sleep mode. At this time, the MS sends the MOB_SLP-REQ message to the RAS. The RAS sends the MS the MOB_SLP-RSP message as a response, and then the MS transits to Sleep mode.
(3)~(4)	If incoming traffic occurs for the MS in Sleep mode, the RAS sends the MS the MOB_TRF-IND message at the listening cycle of the MS. When receiving this message, the MS sends the RAS the UL BW Request message in which the BW value is set to 0. When receiving this message, the RAS recognizes that the MS has transited to Awake mode and sends traffic to the MS.

Idle Mode → Awake Mode(QCS)

When the MS in Idle mode responds to a paging caused by incoming traffic or when the MS in Idle mode sends traffic, it transits from Idle mode to Awake mode.
For both cases, the MS has to perform a network re-entry procedure to enter Awake Mode. The Mobile WiMAX system should consider the QCS procedure as a network re-entry method by default.
The figure below shows the procedure (QCS) in which Idle mode is changed to Awake mode during network re-entry.

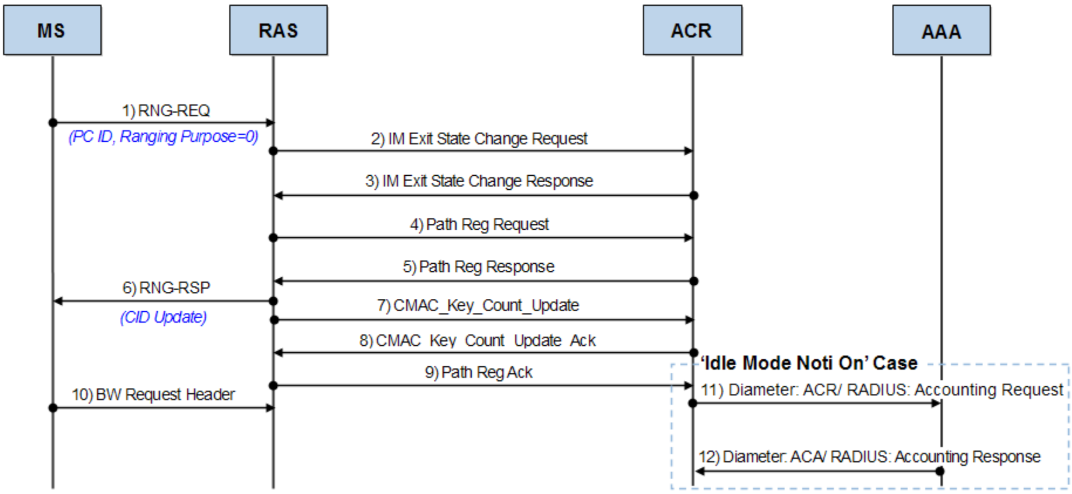

Figure 4.7 Idle Mode → Awake Mode State Transition Procedure (QCS)

Category	Description
(1)	When the MS transits from Idle mode to Awake mode, it creates the RNG-REQ message containing the MAC address and Paging Controller ID and sends it to the RAS. At this time, the Ranging Purpose Indication field value is set to 0x00 (= Network Reentry).
(2)~(3)	The RAS creates the IM Exit State Change Request message containing the parameter value contained in the received RNG-REQ message, and sends it to the ACR. After the ACR checks the Idle mode state information for the MS, to perform the QCS procedure, the ACR sends the RAS the IM Exit State Change Response message containing the Idle Mode Retain information and the AK Context information for CMAC authentication, etc.
(4)~(5)	To set a data path (UL) with the ACR, the RAS sends the ACR the Path Registration Request message containing the data path information, such as the GRE key. As a response (DL) to this message, the ACR sends the RAS the Path Registration Response message containing the data path information, such as the GRE key.
(6)	The RAS responds with the RNG-RSP message containing the HO Optimization flag and the related CID_Update and SA-TEK_Update information for QCS.
(7)~(8)	The RAS notifies the ACR, which is the authenticator, of the new CMAC_KEY_COUNT value updated by the MS.
(9)	The RAS notifies the ACR of the data path setup result using the Path Registration Ack message.
(10)	When receiving the RNG-RSP message, the MS sends the BW Request Header to notify the system that it has transited to Awake mode.
(11)~(12)	When the Idle Mode Notification function is available, If the function is on, the accounting information is updated using the R3 AAA interface accounting message

NOTE

Idle Mode → Awake Mode Transition
For the procedure used when the MS transits from Idle mode to Awake mode because of a paging, refer to 'Paging' section.

4.1.4 Location Update

Inter-RAS Location Update

The figure below shows the location update procedure performed when the MS moves to another paging group in the same ACR.

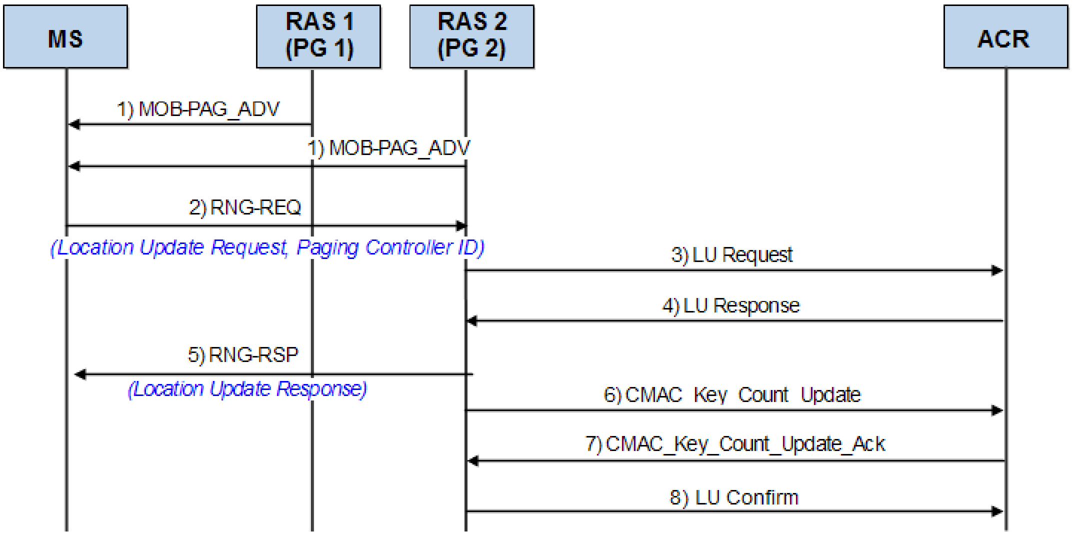

Figure 4.8 Inter-RAS Location Update Procedure

Category	Description
(1)	When the MS in Idle mode moves from paging group 1 to paging group 2, it receives the PAG-ADV message and thus recognizes that its location has changed.
(2)~(3)	To request the location update, the MS sends the new RAS (RAS 2) the RNG-REQ message containing the MAC address, Location Update Request, and Paging Controller ID. Then RAS 2 sends the Location Update Request message to the ACR.
(4)~(5)	The ACR sends RAS 2 the Location Update Response message containing paging information, AK Context information, etc. The RAS 2 checks the validity of the CMAC, and then sends the MS the RNG-RSP message containing the LU Response.
(6)~(7)	The RAS notifies the ACR, which is the authenticator, of the new CMAC_KEY_COUNT value updated by the MS.
(8)	The ACR sends the LU Confirm message to provide notification that the location update procedure has finished.

Inter-ACR Location Update (Anchor Relocation)-PMIP

The figure below shows the location update procedure performed when the MS moves to another ACR's area.

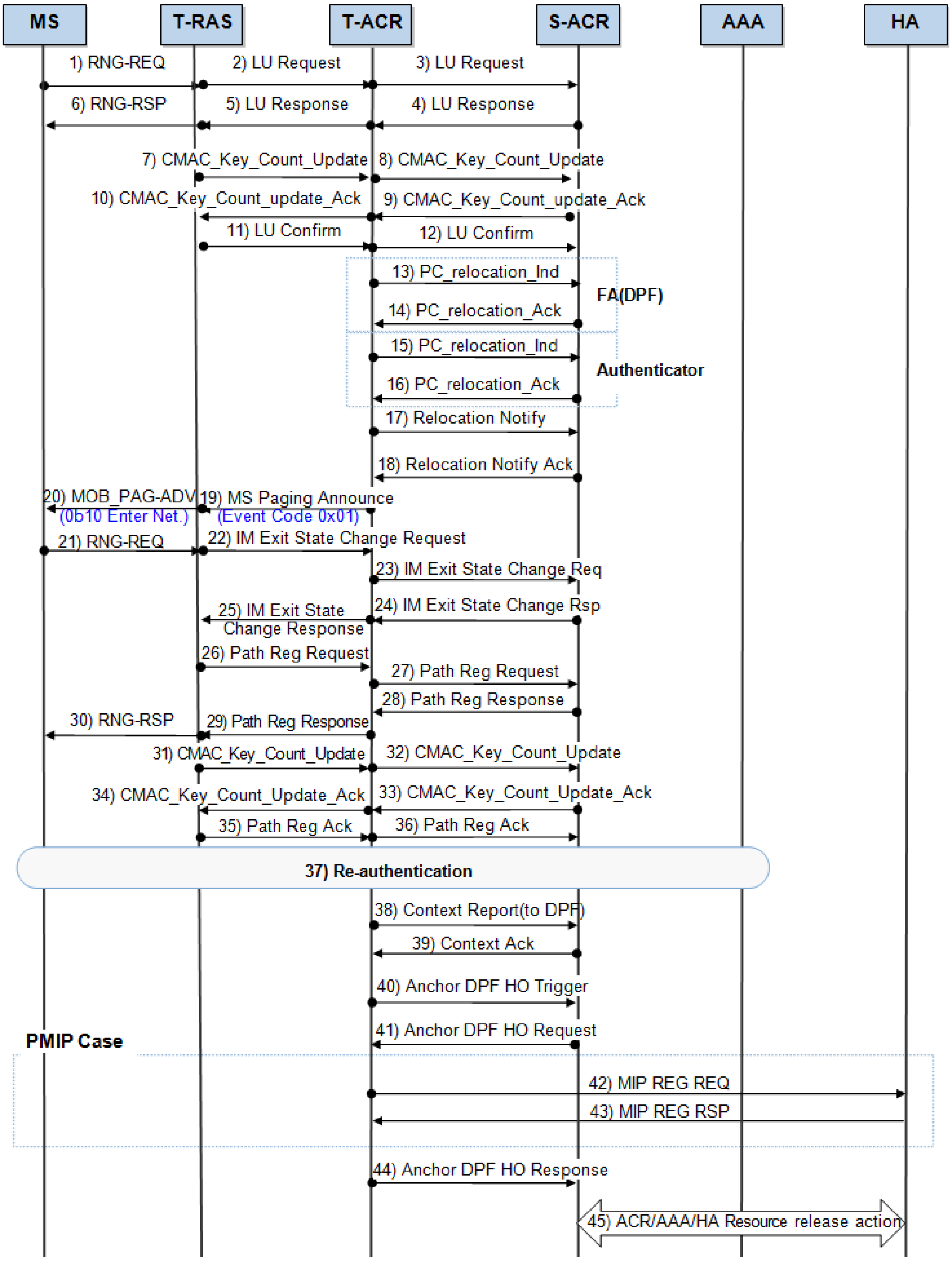

Figure 4.9 Inter-ACR Location Update Procedure (PMIP)

Category	Description
(1)~(2)	When the paging group changes, the MS sends the RNG-REQ message containing the MAC address, location update request, paging controller ID to the new T-RAS (Target RAS) to request a location update. The T-RAS sends its default ACR the Location Update Request message containing the paging controller ID.
(3)~(5)	If the received paging controller ID belongs to the T-ACR (Target ACR), it sends the Location Update Request message to the previous S-ACR (Serving ACR) via the R4 interface to change the paging controller. At this time, the APC Relocation Destination value in the Location Update Request message is set to the paging controller ID of the T-ACR. The S-ACR responds with the Location Update Response that indicates whether to accept the paging controller relocation and the context information for the MS.
(6), (11)~(12)	When receiving the Location Update Response message, the T-RAS sends the MS the RNG-RSP message containing 'LU Response = Success' and sends the LU Confirm message to confirm that the paging controller has changed to the T-ACR.
(7)~(10)	The T-RAS notifies the S-ACR, which is the authenticator, of the new CMAC_KEY_COUNT value updated by the MS.
(13)~(16)	After the location update confirmation, the T-ACR notifies the FA(DPF) and authenticator, which are still located in the S-ACR, that the paging controller has changed.
(17)	The T-ACR sends the S-ACR an authenticator relocation request for the MS.
(18)~(20)	When the S-ACR accepts the authenticator relocation request received from the T-ACR, the T-ACR requests that the MS perform paging to trigger the relocation.
(21)~(36)	When receiving the MOB_PAG-ADV message, the MS performs the QCS procedure, a network reentry procedure, with the network.
(37)~(39)	This is the procedure for relocating the authenticator from the S-ACR to the T-ACR. The T-ACR triggers the MS to perform the EAP authentication procedure again with the AAA server and notifies the S-ACR of the authentication result to complete the authenticator relocation procedure.
(40)~(41)	The T-ACR sends the S-ACR an Anchor DPF relocation request for the MS.
(42)~(43)	When the MS uses PMIP, the T-ACR, in place of the MS, registers MIP to the HA.
(44)~(45)	If the anchor DPF relocation has finished successfully, the S-ACR releases the existing connections to the AAA server and HA.

Inter-ACR Location Update (Anchor Relocation)-Simple IP

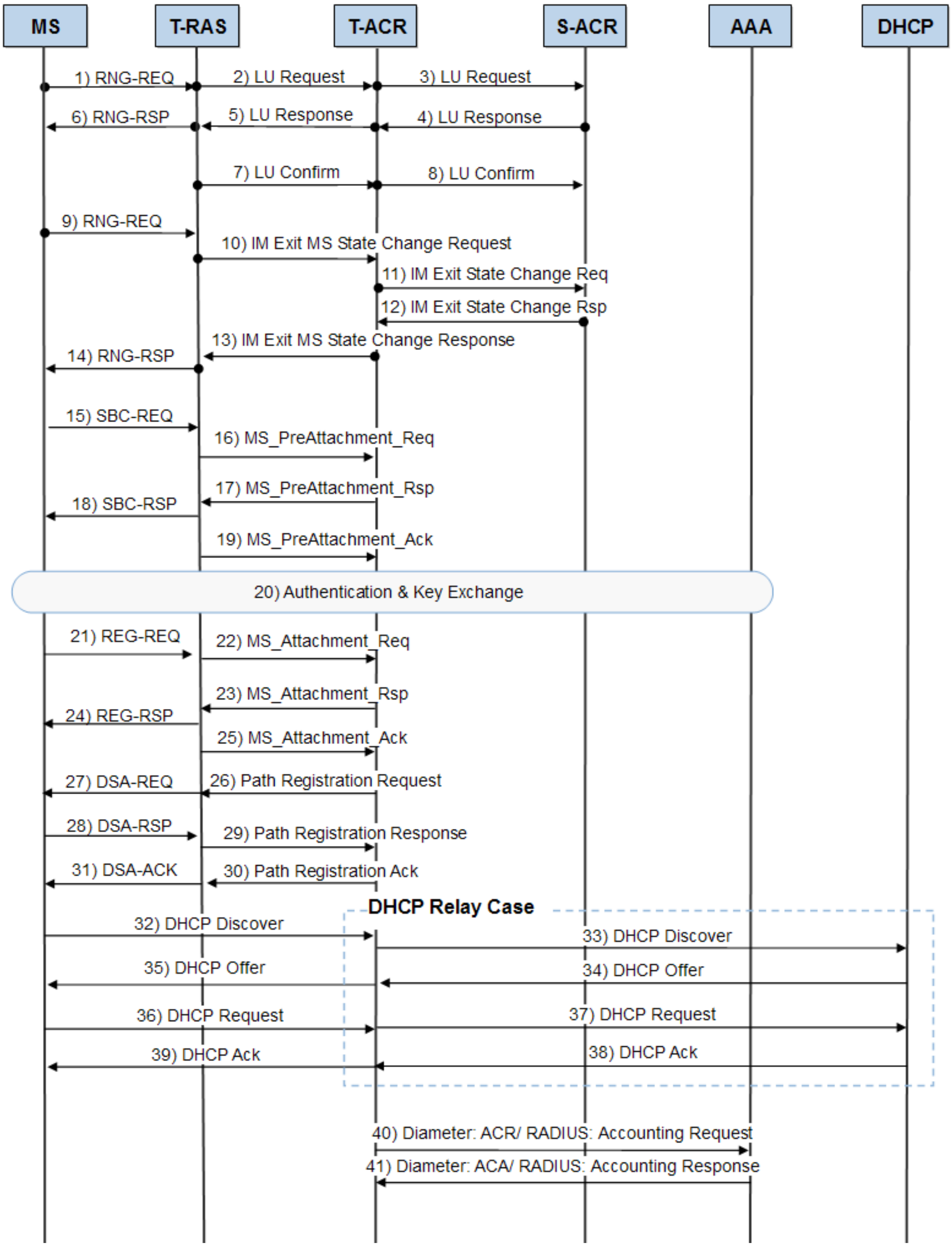

Figure 4.10 Inter-ACR Location Update Procedure (Simple IP)

Category	Description
(1)~(2)	When the paging group changes, the MS sends the RNG-REQ message containing the MAC address, location update request, paging controller ID to the new T-RAS (Target RAS) to request a location update. The T-RAS sends its default ACR the Location Update Request message containing the paging controller ID.
(3)~(5)	If the received paging controller ID belongs to the T-ACR (Target ACR), it sends the Location Update Request message to the previous S-ACR (Serving ACR) via the R4 interface to change the paging controller. At this time, the APC Relocation Destination value in the Location Update Request message is set to the paging controller ID of the T-ACR. The S-ACR responds with the Location Update Response that indicates whether to accept the paging controller relocation and the context information for the MS.
(6)	When the T-RAS receives the Location Update Response message, it sends the MS an RNG-RSP message with 'LU Response' set to 'Fail'.
(7)~(8)	The LU Confirm message is sent to notify that the paging controller is maintained in the S-ACR.
(9)~(14)	The MS performs idle mode exit with the S-ACR, and the S-ACR induces full network re-entry in the MS.
(15)~(31)	The MS performs network re-entry with the T-ACR
(32)~(39)	This is the procedure for allocating an IP address to the MS that uses the simple IP method. If the MS requests the DHCP procedure to receive an allocated IP address, the ACR allocates the Simple IP address to the MS using the built-in DHCP server functions. As an option, the ACR supports the DHCP Relay Agent function, which interoperates with the external DHCP server.
(40)~(41)	The T-ACR notifies the AAA server that the session has started using AAA interface protocol.

Inter-ASN Location Update

The procedure for inter-ASN location update is the same as for inter-ACR location update.

4.1.5 Paging

Paging can be divided into the following two types:

- By periodically broadcasting the MOB_PAG-ADV message, the RAS notifies the MS of the corresponding paging group. Based on the paging information (Paging Cycle, Paging Offset, and PGID) received from the system when the MS transits to Idle mode, the MS checks whether its paging group has changed by periodically checking the MOB_PAG-ADV message.
- When the ACR has traffic to send to the MS in Idle mode, it triggers the MOB_PAG-ADV to the RAS to transit the MS to Awake mode.

The figure below shows the procedure for performing paging to the MS in Idle mode.

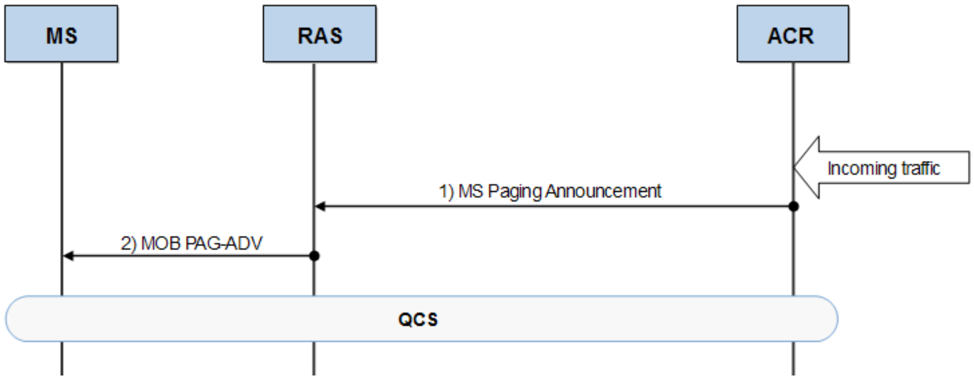

Figure 4.11 Paging Procedure

Category	Description
(1)~(2)	If the MS is in Idle mode when receiving a packet that will be sent to a specific MS, the ACR sends the RAS the MS Paging Announce message containing the MAC address and paging group ID, and Paging Cause(0x02) of the MS to the RAS. The RAS sends the MS the MOB_PAG-ADV message containing the information received from the ACR.

Then, the MS performs the QCS procedure with the network. For more information on the QCS procedure, see to Idle Mode → Awake Mode of 'State Transition.'

4.1.6 Handover

Inter-RAS Handover (HO)

The figure below shows the inter-RAS handover procedure.

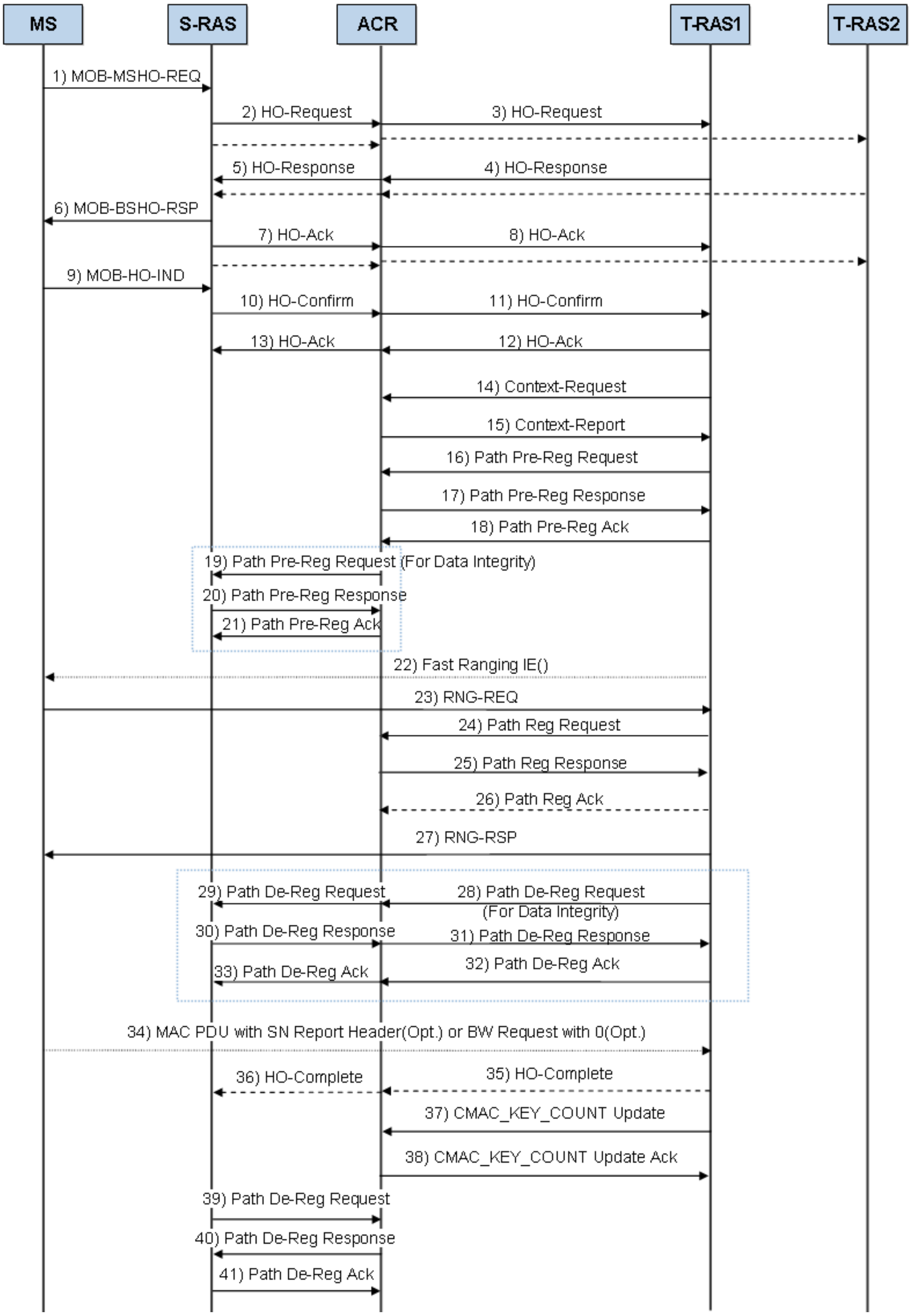

Figure 4.12 Inter-RAS Handover Procedure

Category	Description
(1)~(3)	To request a handover, the MS sends the current S-RAS (Serving RAS) the MOB_MSHO-REQ message containing the neighbor BS (RAS) ID and handover-related parameters. The S-RAS sends the ACR the HO-Request message containing the MOB_MSHO-REQ parameter received and the context information. The ACR forwards the HO-Request message to the T-RAS (Target RAS).
(4)~(8)	The T-RAS sends the ACR the HO-Response message containing the capability information for the T-RAS. The S-RAS sends the MS the MOB_BSHO-RSP message containing the recommended neighbor BS-IDs, HO-ID, and parameter result value.
(9)~(13)	The MS sends the S-RAS the MOB_HO-IND message containing the HO-IND type and target BS-ID to provide notification that the handover will be performed. The S-RAS sends the T-RAS the HO-Confirm message containing the context information and data integrity information (e.g., buffered SDU SN) for the MS.
(14)~(15)	The T-RAS sends the ACR (authenticator) the Context-Request message to request the AK Context information. The ACR responds with the Context-Report message containing the AK context information.
(16)~(21)	The path pre-registration procedure is performed to set up a new data path between the ACR and T-RAS. In addition, a forwarding path is set up so that the S-RAS can send the T-RAS the traffic that it has not yet transmitted to the MS. The traffic is transmitted to the T-RAS.
(22)	When the T-RAS accepts the handover request from the MS, it notifies the MS of the UL_MAP IE so that the MS can send the HO Ranging Request message through the uplink.
(23)	The MS sends the T-RAS the RNG-REQ message containing the MAC address, serving BS-ID, HO indication, etc.
(24)~(26)	The path registration procedure is performed to exchange the SF information that will be mapped to the data path between the ACR and T-RAS, which was created in steps (16) to (18). (26) The procedure is performed if the Path PreReg procedure fails.
(27)	The T-RAS responds with the RNG-RSP message containing the HO Optimization flag, CID_update, and SA-TEK_update.
(28)~(33)	After the S-RAS has sent all traffic to the T-RAS, the forwarding path is released.
(34)	When receiving the RNG-RSP message successfully, the MS sends the RAS the Bandwidth Request (BR) MAC PDU as notification.
(35)~(36)	The T-RAS sends the S-RAS the HO-Complete message to provide notification that the handover has finished.
(37)~(38)	The RAS notifies the ACR, which is the authenticator, of the new CMAC_KEY_COUNT value updated by the MS.
(39)~(41)	When the handover procedure has finished, the old path between the S-RAS and ACR is released.

Inter-ACR Handover (HO)

When performing a handover between ACRs in the same ASN, the path extension through the R6 interface is considered. Therefore, the procedure for inter-ACR handover is the same as inter-RAS handover.

Inter-ASN Handover (HO): ASN-Anchored Mobility

Inter-ASN HO is divided into the ASN-anchored mobility method through the R4 interface and the CSN-anchored mobility method through the R3/R4 interface. The figure below shows the inter-ASN handover procedure in the ASN-anchored mobility method. The S-ACR (Serving ACR) carries out the anchor function.

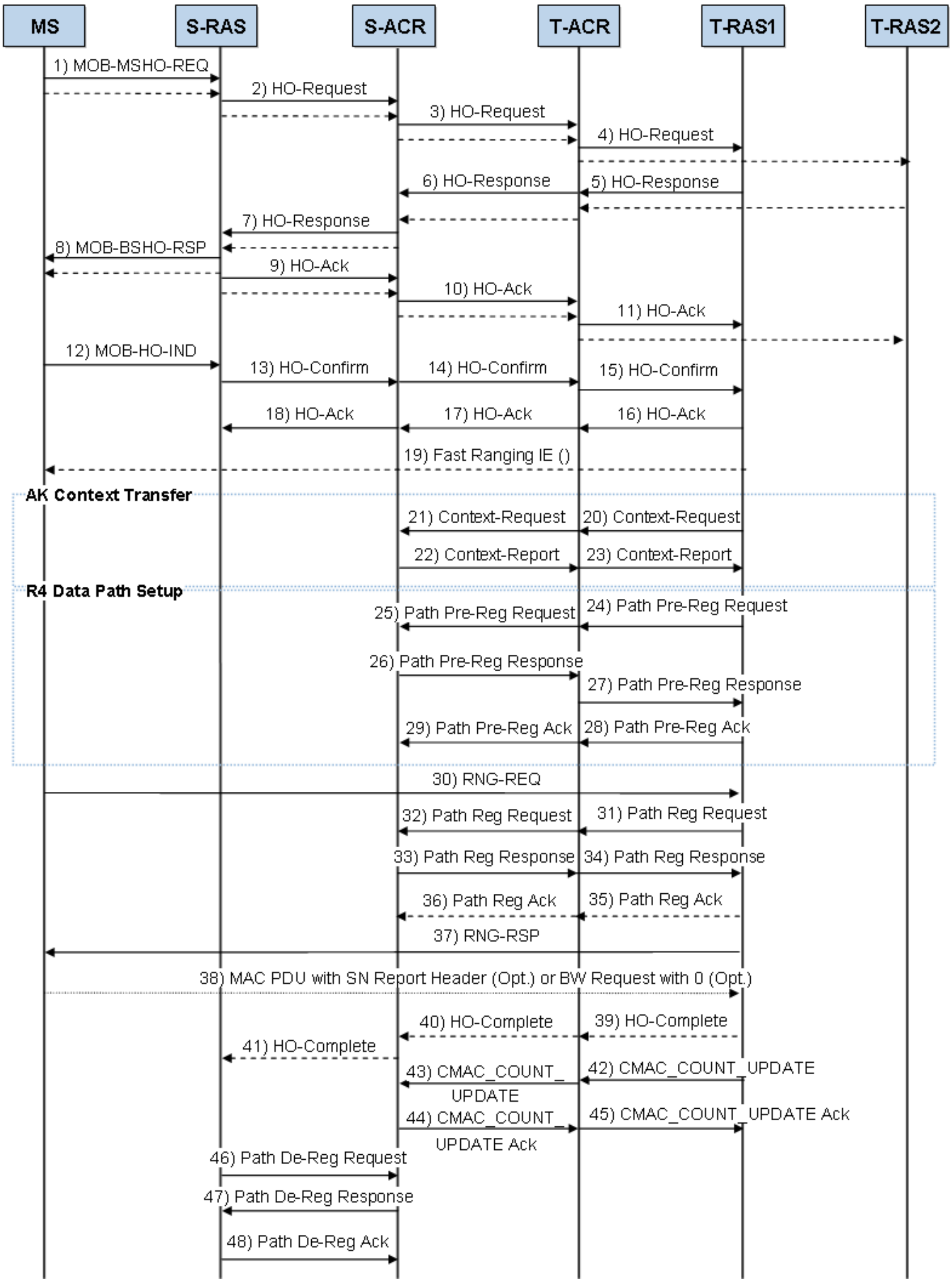

Figure 4.13 Inter-ASN Handover (ASN-Anchored Mobility)

The HO signaling procedure is the same as in inter-RAS HO, but the HO signaling message exchange steps through the R4 interface are added between the S-ACR and T-ACR (Target ACR).

Category	Description
(1)~(4)	To request a handover, the MS sends the current S-RAS (Serving RAS) the MOB_MSHO-REQ message containing the neighbor BS (RAS) ID and handover-related parameters. The S-RAS sends the ACR the HO-Request message containing the MOB_MSHO-REQ parameter received and the context information. The ACR forwards the HO-Request message to the T-RAS (Target RAS).
(5)~(11)	The T-RAS sends the ACR the HO-Response message containing the capability information for the T-RAS. The S-RAS sends the MS the MOB_BSHO-RSP message containing the recommended neighbor BS-IDs, HO-ID, and parameter result value.
(12)~(18)	The MS sends the S-RAS the MOB_HO-IND message containing the HO-IND type and target BS-ID to provide notification that the handover will be performed. The S-RAS sends the T-RAS the HO-Confirm message containing the context information for the MS.
(19)	When the T-RAS accepts the handover request from the MS, it notifies the MS of the UL_MAP IE so that the MS can send the HO Ranging Request message through the uplink.
(20)~(23)	The T-RAS sends the ACR (authenticator) the Context-Request message to request the AK Context information. The ACR responds with the Context-Report 이 message containing the AK context information.
(24)~(29)	The path pre-registration procedure is performed to set up a new data path between the ACR and T-RAS.
(30)	The MS sends the T-RAS the RNG-REQ message containing the MAC address, serving BS-ID, and HO indication.
(31)~(36)	The path registration procedure is performed to exchange the SF (Service Flow) information that will be mapped to the data path between the ACR and T-RAS, which was created in steps (24) to (29). (35)~(36) The procedure is performed if the Path PreReg procedure fails.
(37)	The T-RAS responds by sending the RNG-RSP message containing the HO Optimization flag, CID_update, and SA-TEK_update.
(38)	When receiving the RNG-RSP message successfully, the MS sends the RAS the Bandwidth Request (BR) MAC PDU as notification.
(39)~(41)	The T-RAS sends the S-RAS the HO-Complete message to provide notification that the handover has finished.
(42)~(45)	The RAS notifies the ACR, which is the authenticator, of the new CMAC_KEY_COUNT value updated by the MS.
(46)~(48)	When the handover procedure has finished, the old path between the S-RAS and ACR is released.

Inter-ASN Handover (Inter-ASN HO): CSN-Anchored Mobility

Below is described the inter-ASN HO in the CSN-anchored mobility. The anchor function is relocated from the S-ACR (Serving ACR) to the T-ACR (Target ACR).

The CSN-anchored mobility method consists of the steps through which ASN-anchored mobility Ho is performed and the authenticator and DPF anchor are relocated to the target ACR. For convenience, the triggering of relocation by T-ACR is defined as Pull mode, and the triggering of relocation by S-ACR is defined as Push mode. The Mobile WiMAX system supports both pull mode and push mode.

The CSN-anchored mobility method complies with the MIP standard. The earlier steps of the CSN-anchored HO signaling procedure are the same as in the ASN-anchored mobility HO procedure. The figure below shows the steps after the ASN-anchored HO has been performed.

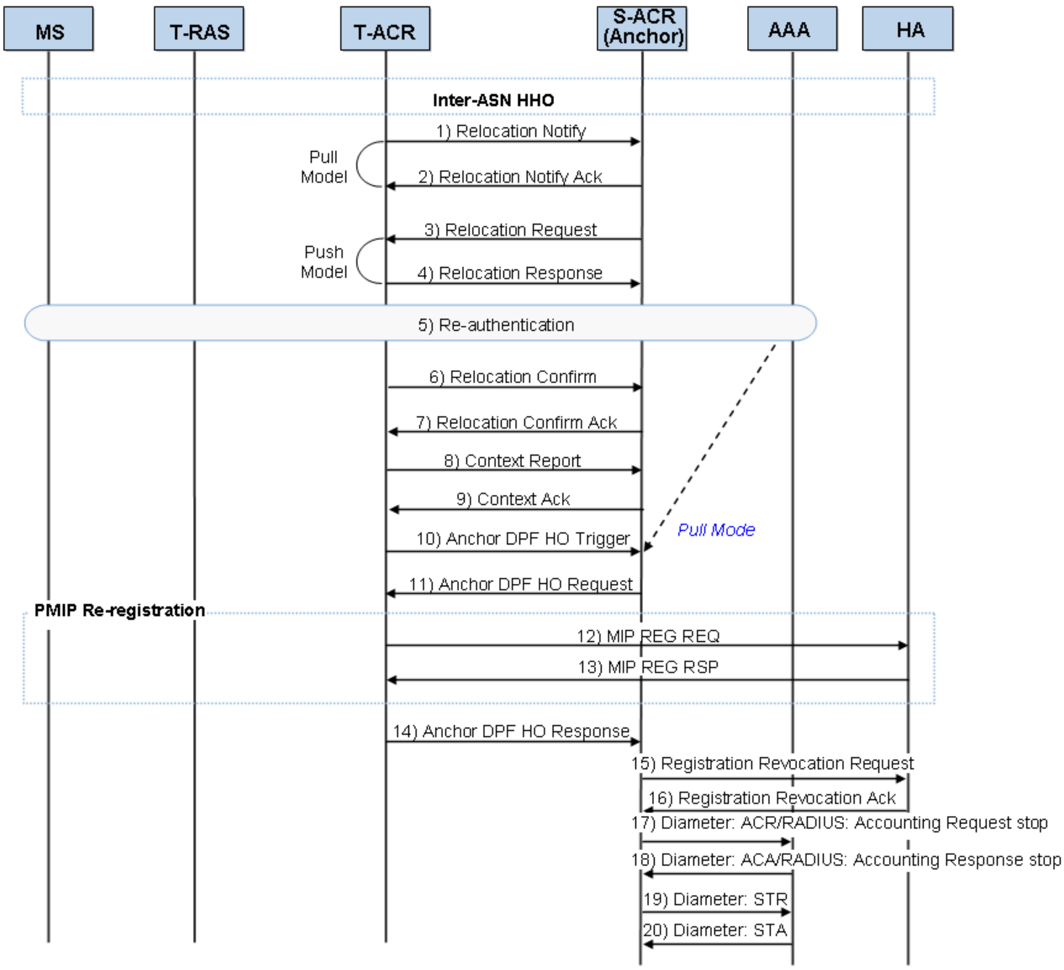

Figure 4.14 Inter-ASN Handover (CSN-Anchored Mobility)

Category	Description
(1)~(7)	This is the procedure for relocating the authenticator from the S-ACR to the T-ACR. The T-ACR triggers the MS to perform the EAP authentication procedure again with the AAA server. The T-ACR notifies the S-RAS of the authentication results to finish the authenticator relocation procedure.
(8)~(9)	The T_ACR transmits the context information for the MS to the S_ACR.
(10)~(14)	The authenticator and FA relocation are triggered and the PMIP registration is processed.

Category	Description
(15)~(16)	The S-ACR cancels MIP registration of the MS in the HA.
(17)~(20)	S-ACR carries out session release procedure with AAA server using defined AAA interface protocol.

4.1.7 Disconnection

Disconnection (Awake Mode)

The figure below shows the procedure with which the MS in Awake mode is disconnected because the power is turned off.

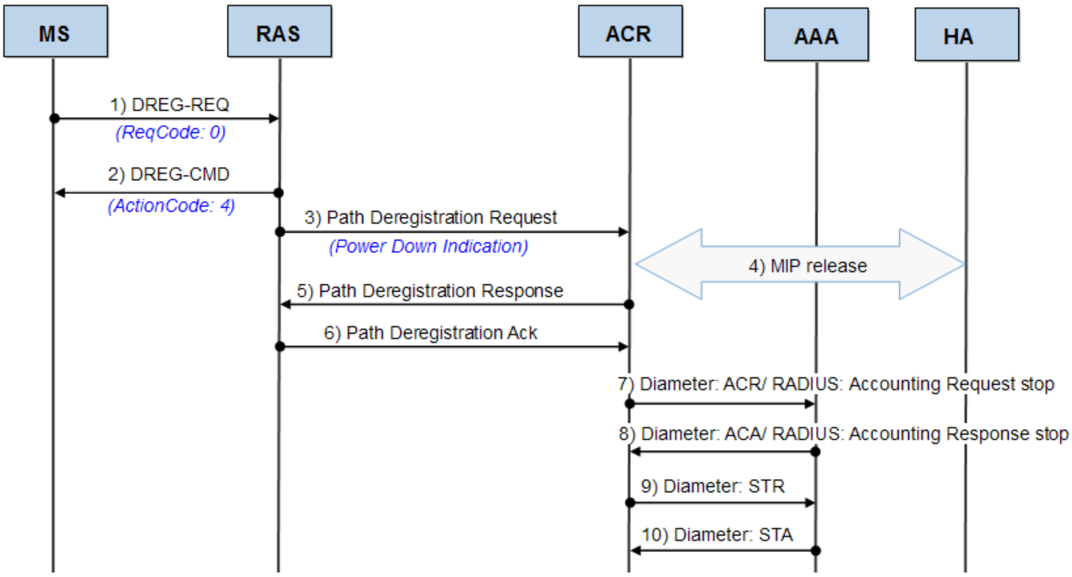

Figure 4.15 Disconnection (Awake Mode)

Category	Description
(1)~(3)	When the MS in Awake mode is turned off, the MS sends the RAS the DREG-REQ message containing 'Deregistration code=0,' and the RAS notifies the ACR of this.
(4)	The ACR performs the procedure for releasing the MIP-related information with the HA.
(5)~(6)	The ACR notifies the RAS of the result for the power down of the MS, and releases the data path.
(7)~(10)	The ACR performs the session release procedure with the AAA server using defined AAA interface protocol.

Disconnection (Idle Mode)

The figure below shows the procedure with which the MS in Idle mode is disconnected because the power is turned off.

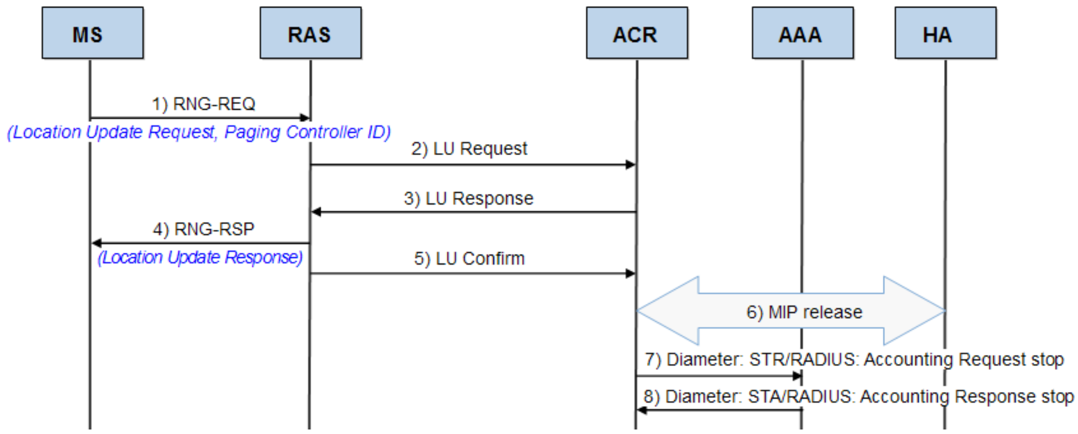

Figure 4.16 Disconnection (Idle Mode)

Category	Description
(1)~(5)	When the MS in Idle mode is turned off, the MS sends the RAS the RNG-REQ message containing the power down indicator, and the RAS notifies the ACR of this. The ACR deletes the information for the MS.
(6)	The ACR performs the procedure for releasing the MIP-related information with the HA.
(7)~(8)	The ACR performs the session release procedure with the AAA server using defined AAA interface protocol.

4.2 Call Processing Message Flow(LTE)

In TD-LTE, the message flows for the attach, service request, detach, and handover procedures are as follows.

4.2.1 Attach

The message flow for attach procedure is illustrated below.

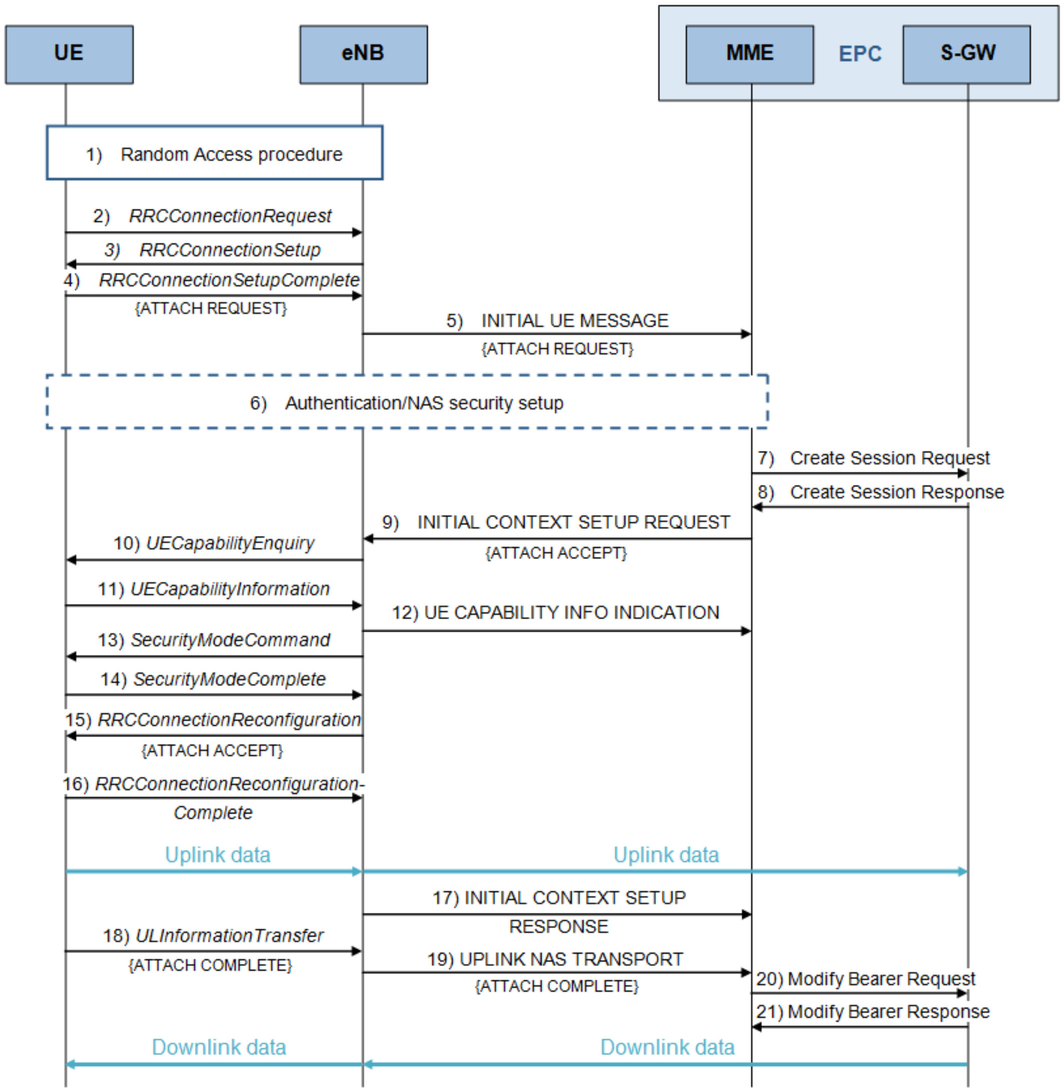

Figure 4.17 Attach Procedure

Step	Description
1)	The UE performs the Random Access procedure (TS 36.321, 5.1) with the eNB.
2)~4)	The UE initializes the RRC Connection Establishment procedure (TS 36.331, 5.3.3). The UE includes the ATTACH REQUEST message, which is an NAS message, in the RRCConnectionSetupComplete message, which is an RRC message, and sends it to the eNB.

Step	Description
5)	The eNB requests the MME from the RRC elements. The eNB includes the ATTACH REQUEST message in the INITIAL UE MESSAGE, which is an S1-MME control message, and sends it to the MME.
6)	If there is no UE context for the UE in the network, integrity is not protected for the ATTACH REQUEST message, or the integrity check fails, authentication and NAS security setup are always performed. The UE performs the EPS Authentication and Key Agreement (AKA) procedure (TS 33.401, 6.1.1) with the MME. The MME sets up an NAS security association with the UE using the NAS Security Mode Command (SMC) procedure (TS 33.401, 7.2.4.4).
7)~8)	The MME selects the P-GW and S-GW. The MME sends the Create Session Request message to the S-GW. From this step to step 17, the S-GW keeps the downlink packet received from the P-GW until the Modify Bearer Request message is received. The S-GW returns the Create Session Request message to the MME.
9)	The MME includes the ATTACH REQUEST message in the INITIAL CONTEXT SETUP REQUEST message, which is an S1-MME control message, and sends it to the eNB. This S1 message also includes the AS security context information for the UE. This information starts the AS SMC procedure at the RRC level.
10)~12)	If the UE Radio Capability IE value is not contained in the INITIAL CONTEXT SETUP REQUEST message, the eNB starts the procedure for obtaining the UE Radio Capability value from the UE and then sends the execution result to the MME.
13)~14)	The eNB sends the SecurityModeCommand message to the UE and then the UE replies with the SecurityModeComplete message. In the eNB, the downlink encryption must be started after the SecurityModeCommand message has been sent, and the uplink decryption must be started after the SecurityModeComplete message has been received. In the UE, the uplink encryption must be started after the SecurityModeComplete message has been sent, and the downlink decryption must be started after the SecurityModeCommand message has been received (TS 33.401, 7.2.4.5).
15)~16)	The eNB includes the ATTACH ACCEPT message in the RRCConnectionReconfiguration message and sends it to the UE. The UE sends the RRCConnectionReconfigurationComplete message to the eNB. After receiving the ATTACH ACCEPT message, the UE can send uplink packets to both of the S-GW and P-GW via the eNB.
17)	The eNB sends the INITIAL CONTEXT SETUP RESPONSE message to the MME.
18)~19)	The UE includes the ATTACH COMPLETE message in the ULInformationTransfer message and sends it to the eNB. The eNB includes the ATTACH COMPLETE message in the UPLINK NAS TRANSPORT message and relays it to the MME.
20)~21)	After receiving both of the INITIAL CONTEXT RESPONSE message at step 17 and the ATTACH COMPLETE message at step 19, the MME sends the Modify Bearer Request message to the S-GW. The S-GW sends the Modify Bearer Response message to the MME. S-GW can send the stored downlink packet.

4.2.2 Service Request

Service Request by the UE

The message flow for service request procedure by UE is illustrated below.

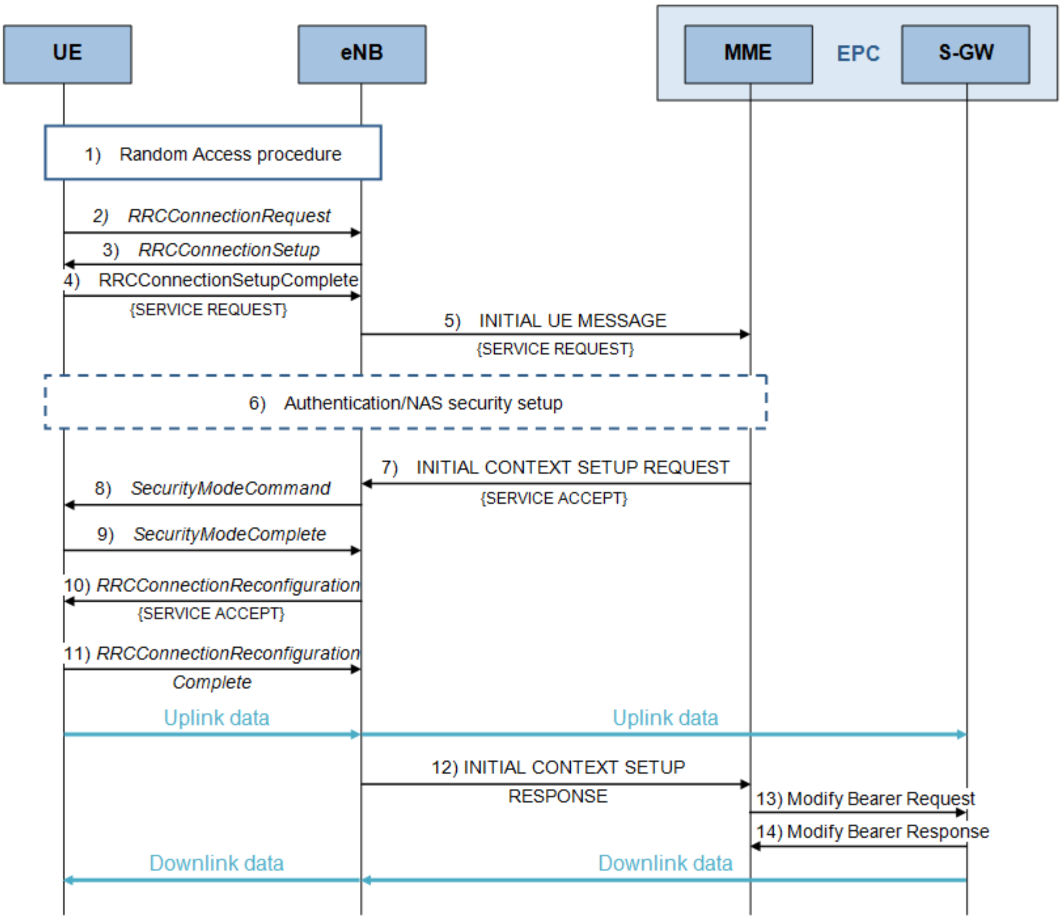

Figure 4.18 Service Request Procedure by UE

Step	Description
1)	The UE performs the Random Access procedure with the eNB.
2)~4)	The UE includes the SERVICE REQUEST message, which is an NAS message, in the RRC message sent to the eNB and sends it to the MME.
5)	The eNB includes the SERVICE REQUEST message in the INITIAL UE MESSAGE, which is an S1-AP message, and sends it to the MME.
6)	If there is no UE context for the UE in the network, integrity is not protected for the ATTACH REQUEST message, or the integrity check fails, authentication and NAS security setup are always performed. The UE performs the EPS Authentication and Key Agreement (AKA) procedure (TS 33.401, 6.1.1) with the MME. The MME sets up an NAS security association with the UE using the NAS Security Mode Command (SMC) procedure (TS 33.401, 7.2.4.4).

Step	Description
7)	The MME sends the INITIAL CONTEXT SETUP REQUEST message, which is an S1-AP message, to the eNB. In this step, radio and S1 bearer are activated for all activated EPS bearers.
8)~11)	The eNB sets up the RRC radio bearers. The user plane security is set up at this step. The uplink data sent by the UE is relayed from the eNB to the S-GW. The eNB sends the uplink data to the S-GW, and then the S-GW relays it to the P-GW.
12)	The eNB sends the INITIAL CONTEXT SETUP RESPONSE message, which is an S1–AP message to the MME.
13)~14)	The MME sends the Modify Bearer Request message for each PDN connection to the S-GW. Now, the S-GW can send the downlink data to the UE. The S-GW sends the Modify Bearer Response message to the MME.

Service Request by Network

The message flow for service request procedure by network is illustrated below.

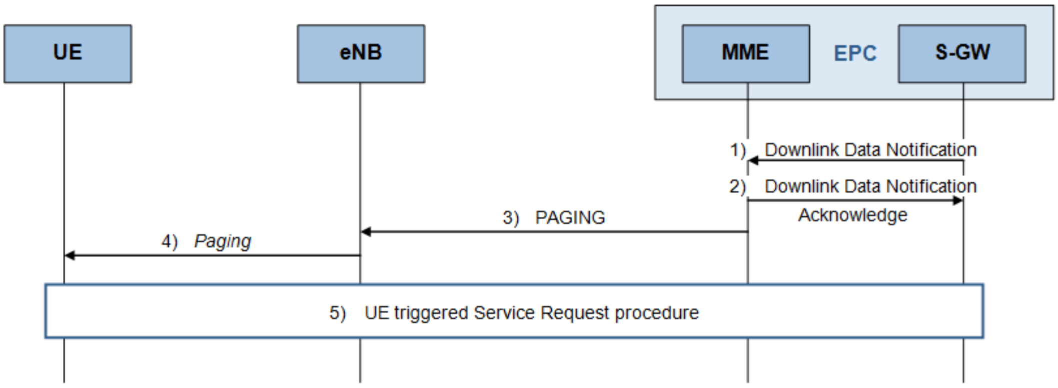

Figure 4.19 Service Request Procedure by Network

Step	Description
1)~2)	When receiving a downlink data packet that should be sent to a UE while the user plane is not connected to that UE, the S-GW sends the Downlink Data Notification message to the MME which has the control plane connection to that UE. The MME issues the Downlink Data Notification Acknowledge message to the S-GW in response. If the S-GW receives additional downlink data packet for the UE, this data packet is stored and no new Downlink Data Notification is sent.
3)~4)	If the UE is registered with the MME, the MME sends the PAGING message to all eNBs which belong to the TA where the UE is registered. If the eNB receives the PAGING message from the MME, it sends the paging message to the UE.
5)	If the UE in idle mode is paged via the E-UTRAN connection, the Service Request procedure is initiated by the UE. The S-GW sends the downlink data to the UE via the RAT which has performed the Service Request procedure.

4.2.3 Detach

Detach by UE

The message flow for Detach procedure by UE is illustrated below.

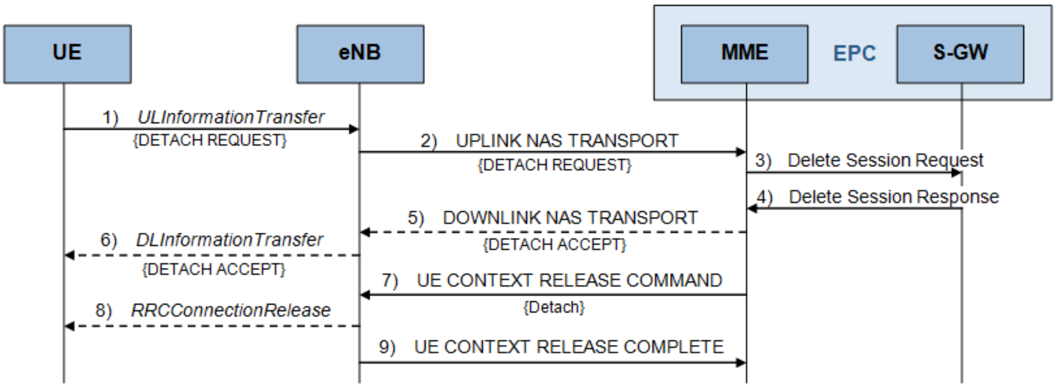

Figure 4.20 Detach Procedure by UE

Step	Description
1)~2)	The UE sends the DETACH REQUEST message, which is an NAS message, to the MME. This NAS message is used to start setting up an S1 connection when the UE is in Idle mode.
3)	The active EPS bearers and their context information for the UE and MME which are in the S-GW are deactivated when the MME sends the Delete Session Request message for each PDN connection to the S-GW.
4)	When receiving the Delete Session Request message from the MME, the S-GW releases the related EPS bearer context information and replies with the Delete Session Response message.
5)~6)	If the detachment procedure has been triggered by reasons other than disconnection of power, the MME sends the DETACH ACCEPT message to the UE.
7)	The MME sets the Cause IE value of the UE CONTEXT RELEASE COMMAND message to 'Detach' and sends this message to the eNB to release the S1-MME signal connection for the UE.
8)	If the RRC connection has not yet been released, the eNB sends the RRCConnectionRelease message to the UE in requested reply mode. Once a reply to this message is received from the UE, the eNB removes the UE context.
9)	The eNB returns the UE CONTEXT RELEASE COMPLETE message to the MME and confirms that S1 is released. By doing this, the signal connection between the MME and eNB for the UE is released. This step must be performed immediately after step 7.

Detach by the MME

The message flow for Detach procedure by MME is illustrated below.

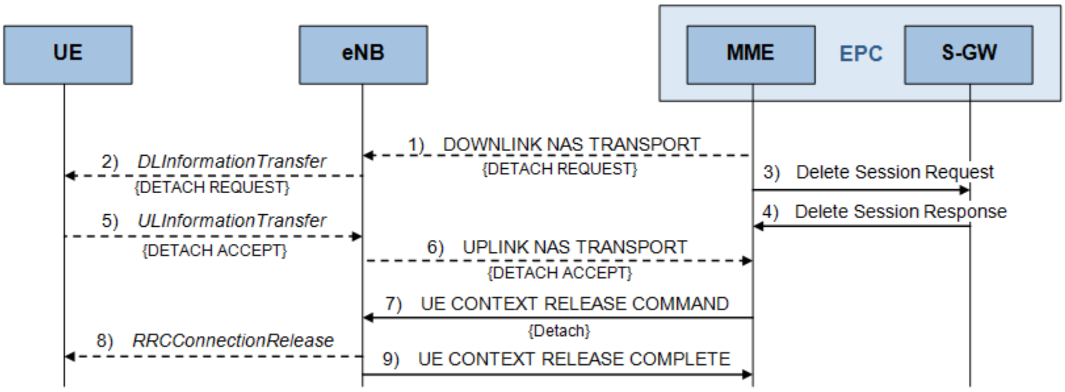

Figure 4.21 Detach Procedure by MME

Step	Description
1)~2)	The MME detaches the UE implicitly if there is no communication between them for a long time. In case of the implicit detach, the MME does not send the DETACH REQUEST message to the UE. If the UE is in the connected state, the MME sends the DETACH REQUEST message to the UE to detach it explicitly.
3)	The active EPS bearers and their context information for the UE and MME which are in the S-GW are deactivated when the MME sends the Delete Session Request message for each PDN connection to the S-GW.
4)	When receiving the Delete Session Request message from the MME, the S-GW releases the related EPS bearer context information and replies with the Delete Session Response message.
5)~6)	If the UE has received the DETACH REQUEST message from the MME in step 2, it sends the DETACH ACCEPT message to the MME. The eNB forwards this NAS message to the MME.
7)	After receiving both of the DETACH ACCEPT message and the Delete Session Response message, the MME sets the Cause IE value of the UE CONTEXT RELEASE COMMAND message to 'Detach' and sends this message to the eNB to release the S1 connection for the UE.
8)	If the RRC connection has not yet been released, the eNB sends the RRCConnectionRelease message to the UE in Requested Reply mode. Once a reply to this message is received from the UE, the eNB removes the UE context.
9)	The eNB returns the UE CONTEXT RELEASE COMPLETE message to the MME and confirms that S1 is released. Through this, the signaling connection between the MME and eNB for the UE is released. This step must be performed immediately after step 7.

4.2.4 Handover

X2-based Handover

The message flow for X2 based handover procedure is illustrated below.

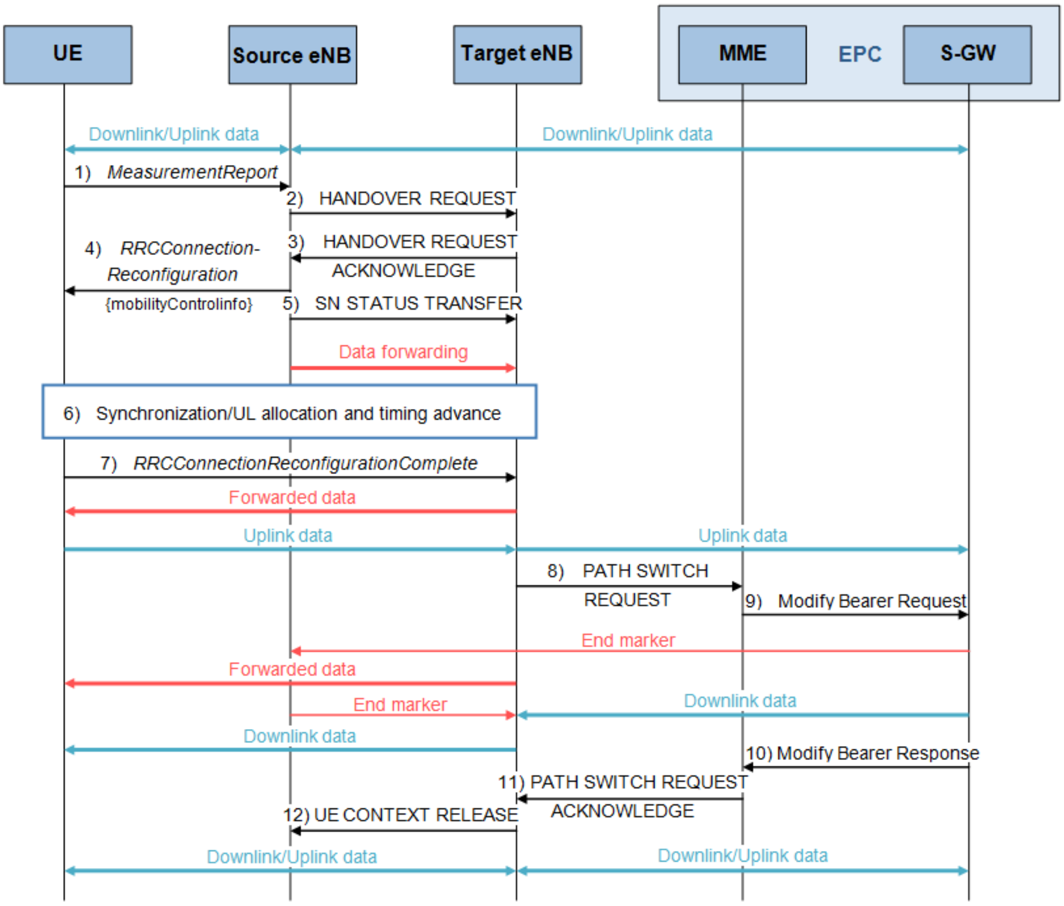

Figure 4.22 X2 Based Handover Procedure

Step	Description
1)	The UE sends the MeasurementReport message according to the system information, standards and rules. The source eNB determines whether to perform the UE handover based on the MeasurementReport message and the radio resource management information.
2)	The source eNB sends the HANDOVER REQUEST message and the information required for handover to the target eNB. The target eNB can perform management control in accordance with the E-RAB QoS information received.
3)~4)	The target eNB creates the RRCConnectionReconfiguration message which contains the mobileControlInfo IE for preparing and executing the handover. The target eNB includes the RRCConnectionReconfiguration message in the HANDOVER REQUEST ACKNOWLEDGE message and sends it to the source eNB. The source eNB sends the RRCConnectionReconfiguration message and the necessary parameters to the UE to command it to perform the handover.
5)	To relay the uplink PDCP SN receiver status and the downlink PDCP SN transmitter status of the E-RABs of which the PDCP status must be preserved, the source eNB sends the SN STATUS TRANSFER message to the target eNB.

Step	Description
6)	After receiving the RRCConnectionReconfiguration message containing mobileControlInfo IE, the UE performs synchronization with the target eNB and connects to the target cell via a Random Access Channel (RACH). The target eNB replies with UL allocation and a timing advance value.
7)	After successfully connecting to the target cell, the UE uses the RRCConnection-ReconfigurationComplete message to notify the target eNB that the handover procedure is complete.
8)	After successfully connecting to the target cell, the UE uses the RRCConnection-ReconfigurationComplete message to notify the target eNB that the handover procedure is complete.
9)~10)	The MME sends the Modify Bearer Request message to the S-GW. The S-GW changes the downlink data path into the target eNB. The S-GW sends at least one 'end marker' to the source eNB through the previous path, and releases the user plane resources for the source eNB. The S-GW sends the Modify Bearer Response message to the MME.
11)	The MME acknowledges the PATH SWITCH REQUEST message by issuing the PATH SWITCH REQUEST ACKNOWLEDGE message.
12)	The target eNB sends the UE CONTEXT RELEASE message to the source eNB to notify that the handover has successful and to make the source eNB release its resources. If the source eNB receives the UE CONTEXT RELEASE message, it releases the radio resources and the control plane resources related to the UE context.

S1-based Handover

The message flow for S1 based handover procedure is illustrated below.

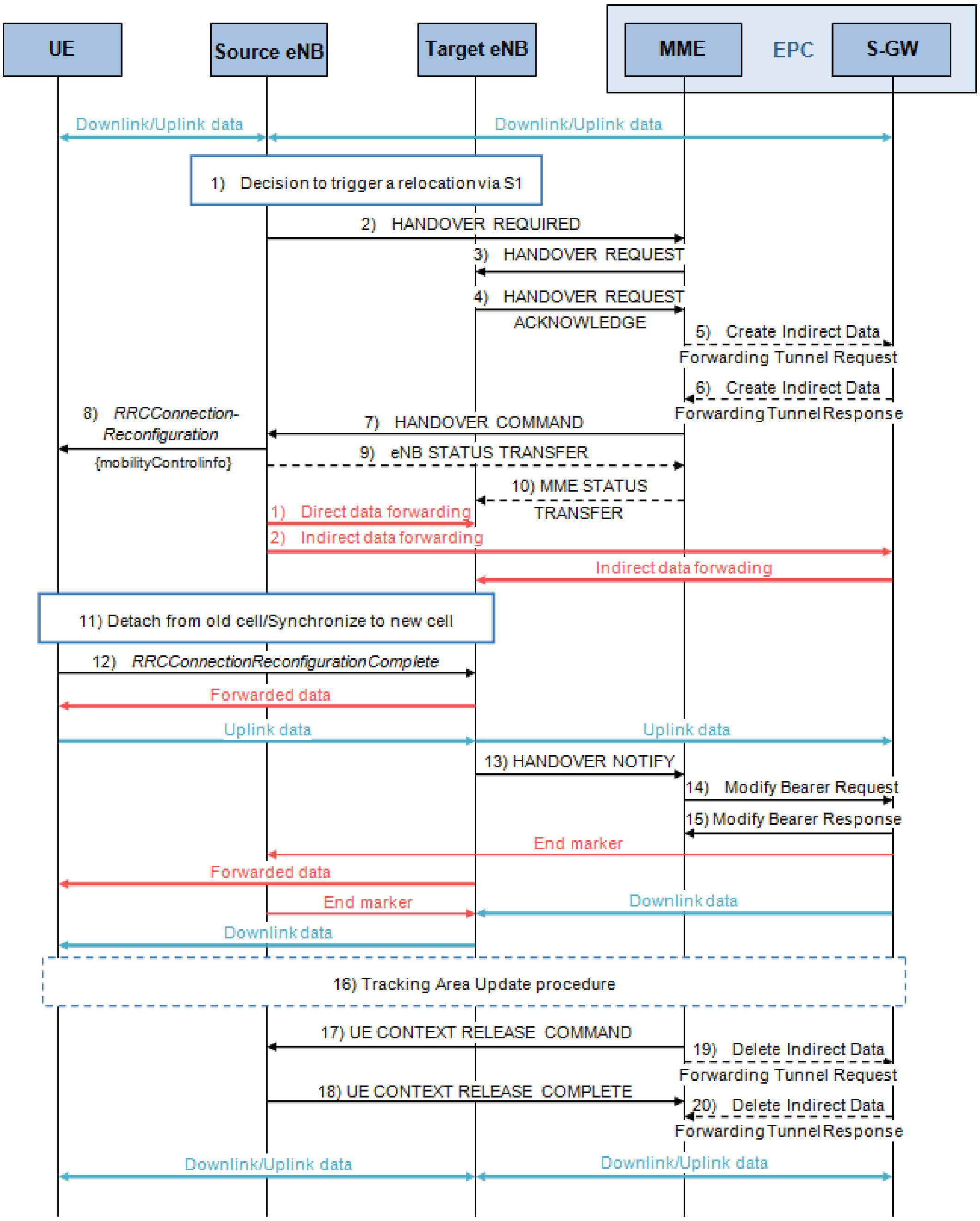

Figure 4.23 S1-based Handover Procedure

Step	Description
1)	The source eNB determines whether to perform S1-based handover to the target eNB. The source eNB can make this decision if there is no X2 connection to the target eNB or if an error is notified by the target eNB after an X2-based handover has failed, or if the source eNB dynamically receives the related information.
2)	The source eNB sends the HANDOVER REQUIRED message to the MME. The source eNB notifies the target eNB which bearer is used for data forwarding and whether direct forwarding from the source eNB to the target eNB is possible.

Step	Description
3)~4)	The MME sends the HANDOVER REQUEST message to the target eNB. This message makes the target eNB create a UE context containing the bearer-related information and the security context. The target eNB sends the HANDOVER REQUEST ACKNOWLEDGE message to the MME.
5)~6)	If indirect forwarding is used, the MME sends the Create Indirect Data Forwarding Tunnel Request message to the S-GW. The S-GW replies the MME with the Create Indirect Data Forwarding Tunnel Response message.
7)~8)	The MME sends the HANDOVER COMMAND message to the source eNB. The source eNB creates the RRCConnectionReconfiguration message using the Target to Source Transparent Container IE value contained in the HANDOVER COMMAND message and then sends it to the UE.
9)~10)	To relay the PDCP and HFN status of the E-RABs of which the PDCP status must be preserved, the source eNB sends the eNB/MME STATUS TRANSFER message to the target eNB via the MME. The source eNB must start forwarding the downlink data to the target eNB through the bearer which was determined to be used for data forwarding. This can be either direct or indirect forwarding.
11)	The UE performs synchronization with the target eNB and connects to the target cell via the RACH. The target eNB replies with UL allocation and a timing advance value.
12)	After successfully synchronizing with the target cell, the UE uses the RRCConnectionReconfigurationComplete message to notify the target eNB that the handover procedure is complete. The downlink packets forwarded by the source eNB can be sent to the UE. The uplink packets can also be sent from the UE to the S-GW via the target eNB.
13)	The target eNB sends the HANDOVER NOTIFY message to the MME. The MME starts the timer which tells when the source eNB resources and the temporary resources used for indirect forwarding at S-GW will be released.
14)	The MME sends the Modify Bearer Request message for each PDN connection to the S-GW. Downlink packets are sent immediately from the S-GW to the target eNB.
15)	The S-GW sends the Modify Bearer Response message to the MME. If the target eNB changes the path for assisting packet resorting, the S-GW immediately sends at least one ‘end marker’ packet to the previous path.
16)	If any of the conditions listed in section 5.3.3.0 of TS 23.401 (6) is met, the UE starts the Tracking Area Update procedure.
17)~18)	When the timer started at step 13 expires, the MME sends the UE CONTEXT RELEASE COMMAND message to the source eNB. The source eNB releases the resources related to the UE and replies with the UE CONTEXT RELEASE COMPLETE message.
19)~20)	If indirect forwarding is used and when the timer started by the MME at step 13 expires, the MME sends the Delete Indirect Data Forwarding Tunnel Request message to the S-GW. This message makes the S-GW release the temporary resources allocated for indirect forwarding at step 5. The S-GW replies the MME with the Delete Indirect Data Forwarding Tunnel Response message.

Inter-RAT Handover_LTE to HRPD PS Handover

Inter-RAT Handover_ LTE to HRPD PS Handover

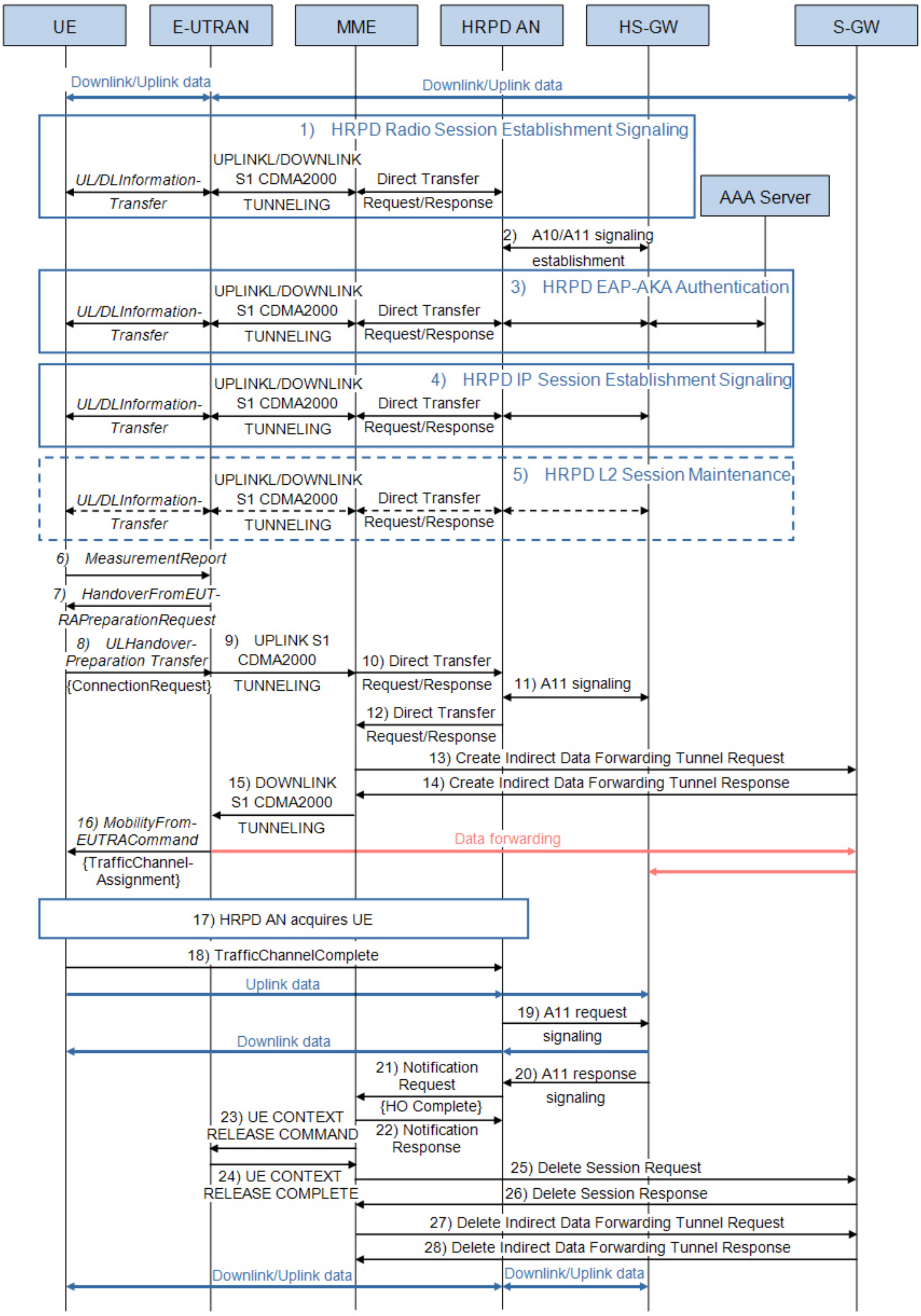

Figure 4.24 PS Handover Procedure from E-UTRAN to HRPD

Step	Description
1)	The UE determines to start pre-registration process to a potential target HRPD network. When the pre-registration procedure is performed, the UE can configure and maintain a dormant session to the target HRPD network while it is attached to the E-UTRAN/MME.
2)	The HRPD AN creates a signal relationship with the UE through the A10/A11 interface of HS-GW and HRPD network.
3)	The UE, HS-GW, and 3GPP AAA servers authenticate the UE in the HRPD system by exchanging EAP-AKA signal.
4)	The UE and HS-GW configures a context to support bearer traffic environment used in the E-UTRAN by exchanging signals.
5)	If session management is required even before handover decision, the UE or HRPD AN can perform session management by tunneling a HRPD session management message on S101.
6)	The E-UTRAN determines handover by receiving MeasurementReport from the UE.
7)	The handover decision is sent to the UE through the HandoverFromEUTRAPreparationRequest message.
8)	The UE sends the ULHandoverPreparationTransfer message to the E-UTRAN. The HRPD ConnectionRequest message is sent to the HRPD AN to acquire information required to connect to the HRPD transmission channel.
9)	The E-UTRAN includes the HRPD ConnectionRequest message in the UPLINK S1 CDMA2000 TUNNELING message and sends it to the MME. The E-UTRAN includes CDMA2000 HO Required Indication IE, which notifies MME to prepare for handover, in the UPLINK S1 CDMA2000 TUNNELING message.
10)	The MME determines the HRPD AN address and includes HRPD ConnectionRequest message in the Direct Transfer Request message and sends it to the HRPD AN.
11)	The HRPD AN allocates a requested radio connection resource and asks for a forwarding address to the HS-GW. The HS-GW replies back with HS-GW address and GRE key(s) which are intended for forwarding traffic on the S103.
12)	The HRPD AN includes the HRPD TrafficChannelAssignment message in the Direct Transfer Request message and sends it to the MME. It sends both HS-GW address and GRE key(s) if data forwarding is applicable.
13)~14)	If the Direct Transfer Request message includes HS-GW address and GRE key(s), the MME determines S1-U bearer to be forwarded to the HRPD, and it sends Create Indirect Data Forwarding Tunnel Request message to the S-GW to set a resource for indirect forwarding. The S-GW secures data forwarding resource for the S103 and allocates a forwarding address for S1 to the Create Indirect Data Forwarding Tunnel Response message.
15)	The MME includes the HRPD TrafficChannel- Assignment message in the DOWNLINK S1 CDMA2000 TUNNELING message and sends it to the E-UTRAN.

Step	Description
16)	The E-UTRAN includes the HRPD TrafficChannelAssignment message in the MobilityFromEUTRACommand message and sends it to the UE. The UE recognizes this message as a handover command message. The E-UTRAN starts to send downlink data packets to the S-GW and the S-GW sends these packets to the HS-GW through the S103 tunnel.
17)	The UE tunes a radio signal to the HRPD AN and acquires a transmission channel.
18)	The UE sends the HRPD TrafficChannelComplete message to the HRPD AN.
19)~20)	The HRPD AN sends A11 request signal to the HS-GW to make it start to set up a user plane connection between the HRPD AN and the HS-GW. The P-GW switches the flow from S-GW to HS-GW. The HS-GW sends A11 reply signal to the HRPD AN.
21)~22)	The HRPD AN includes the 'HO Complete' in the Notification Request message and sends it to the MME. The MME replies to the HRPD AN by using the Notification Response message. The MME starts the timer which will notify the S-GW when it will release the EPS bearer resource and a resource which was used for indirect forwarding.
23)~24)	The MME releases UE context at the E-UTRAN.
25)~28)	If any one of the timers which were started in Step 22 is expired, the MME sends the Delete Session Request message to the S-GW to release the S-GW resource. The S-GW notifies resource release by using the Delete Session Response message. The MME sends the Delete Indirect Data Forwarding Tunnel Request message to the S-GW to make it release a temporary resource which was used for indirect forwarding. The S-GW replies the MME with the Delete Indirect Data Forwarding Tunnel Response message.

4.3 Network Synchronization Message Flow

The TD-LTE Flexible system uses GPS for the system synchronization. The UCCM of the MMA-G, which is the GPS reception module, creates the clock with the clock information received from a GPS and then distributes the clock to each hardware module in the TD-LTE Flexible system.

Clock information required by the RRH is sent from the MRA-F through 'Digital I/Q and C & M', and the RRH recovers clock information from the signals to create necessary clocks.

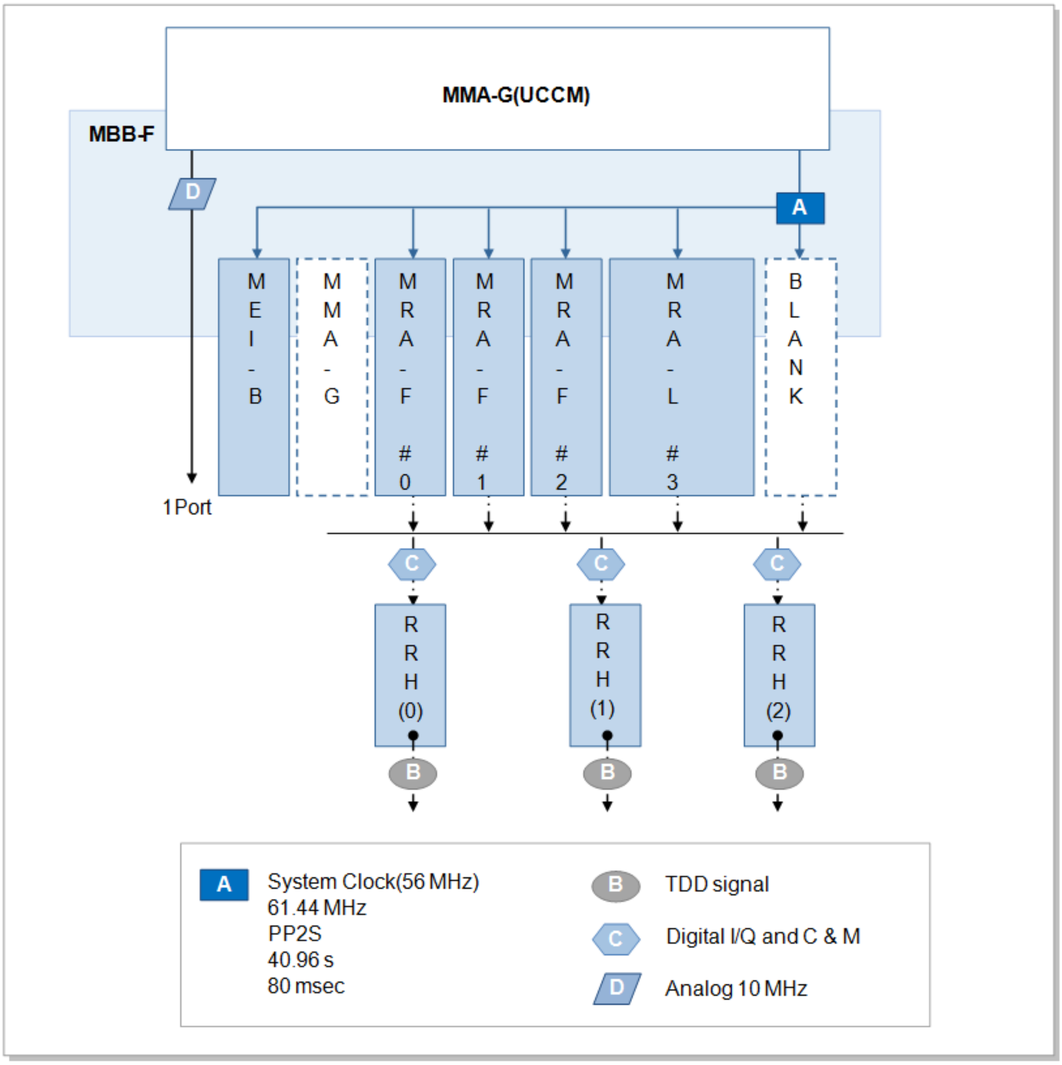

Figure 4.25 Network Synchronization Flow of TD-LTE Flexible system

4.4 Alarm Signal Flow

The detection of failures in the TD-LTE Flexible system can be implemented by hardware interrupt or software polling method. The failures generated in the TD-LTE Flexible system are reported to the management system via the SNMP trap message.

Failure Alarm Types

- System Failure Alarms
  Time Sync Fail, Fan Fail, Temperature High, etc.
- Board Failure Alarms
  - Hardware Failure Alarms: FUNCTION FAIL, BOARD DELETION, etc.
  - Software Failure Alarms: COMMUNICATION FAIL, PORT DOWN, CPU OVERLOAD, etc.
- RRH Failure Alarms
  LOW GAIN, OVER POWER, VSWR FAIL, PLL UNLOCK, RRH INTERFACE FAIL, etc.
- UDA
  Support of 24 UDA

Failure Report Message Flow

The main OAM (UFM) collects the failures detected from each board and UDA interface of the TD-LTE Flexible system and notifies them to the management system. At this time, it only reports the upper failure information by using the failure filtering function. If it receives the command to inhibit the report for a specific failure or all system failures from the management system, it does not report the failure report.
The flows for the failure detection and the report message are as shown in the figures below:

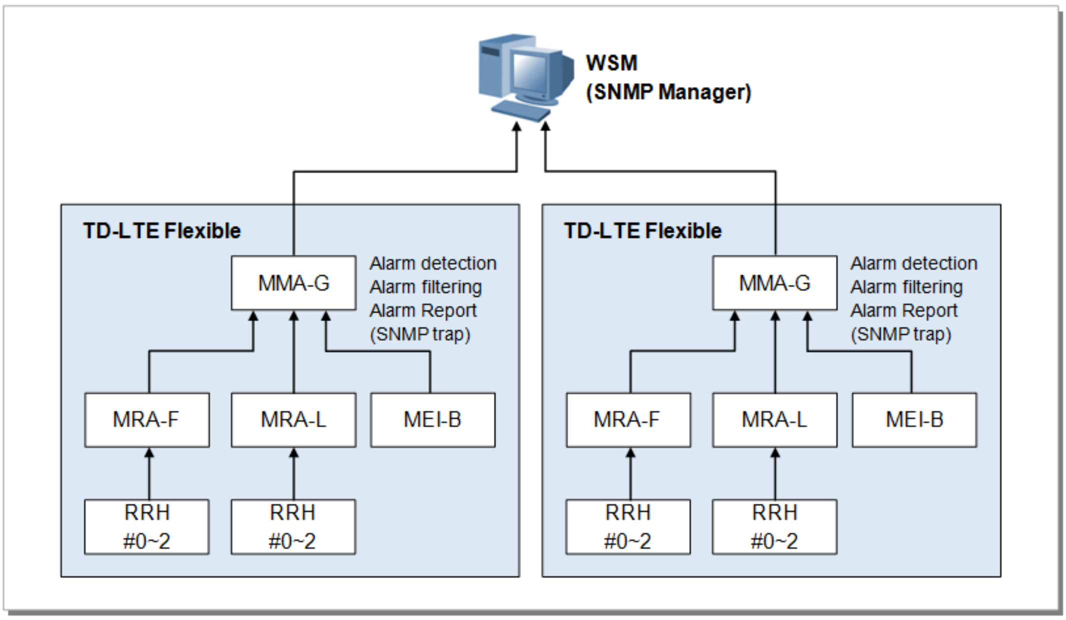

Figure 4.26 Alarm Signal Flow of TD-LTE Flexible system

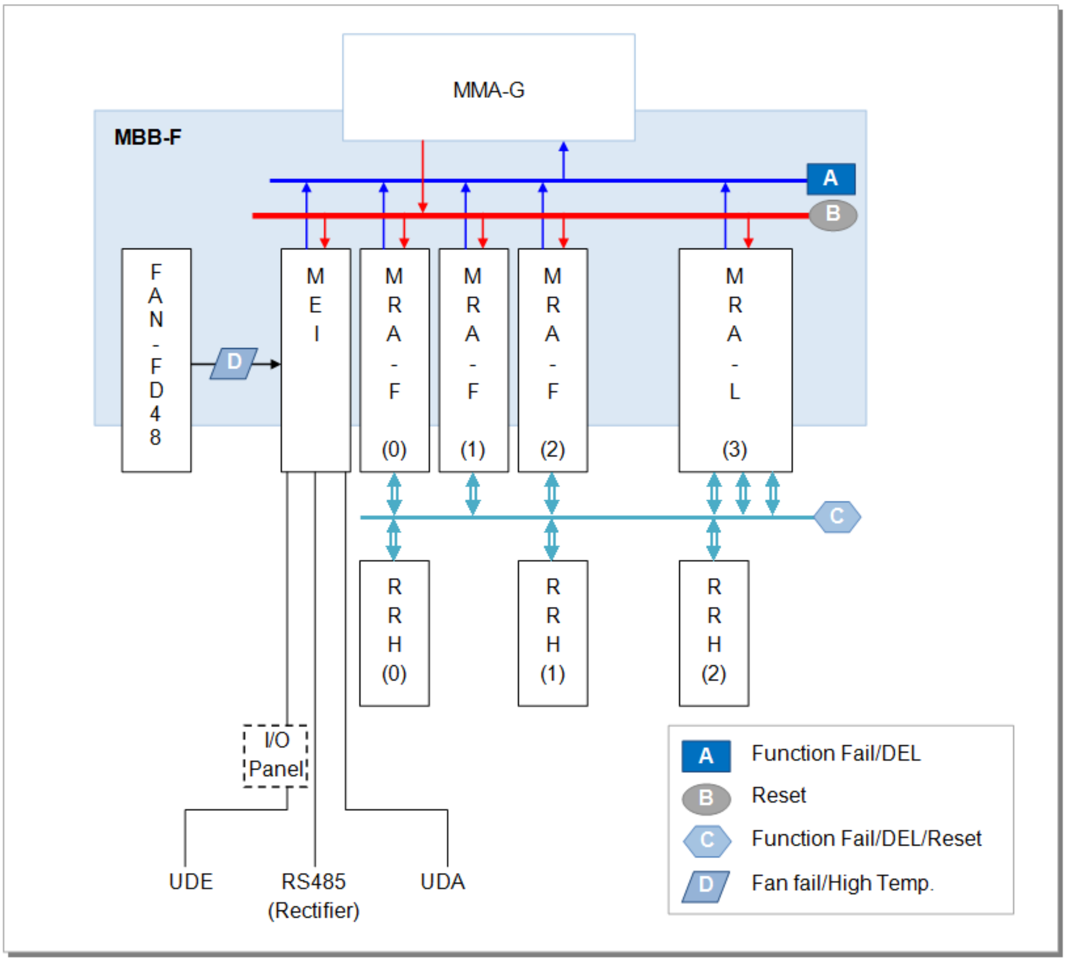

Figure 4.27 Alarm and Control Structure of TD-LTE Flexible system

4.5 Loading Message Flow

Loading is the procedure to download the software execution files and the data from the IS, which are required to perform each function of each processor and each device of the TD-LTE Flexible system. Loading the TD-LTE Flexible system is performed in the procedure of initializing the system.
In addition, if a specific board is mounted on the system or the hardware is reset, or if the operator of the upper management system reboots a specific board, loading is performed.
Loading is classified into two types, one is loading by using its own non-volatile storage and the other is loading by using the remote IS. When the system is initialized for the first time, the TD-LTE Flexible system receives the loading by using the remote IS, and after this, saves the corresponding information in the internal storage, and backs up the recent information periodically, and then it is available to avoid unnecessary loading. After the first initialization, if the information saved in its own storage is the recent information by comparing the version, the TD-LTE Flexible system does not receive the remote loading.
The loaded information includes the software image which is configured with the execution file and the script file, the configuration information, the PLD related to the operation parameter and various configuration files. Among them, all the information required for the static routing function of the TD-LTE Flexible system is saved in its own storage as the startup configure file format, and provides the information required at the time of the initialization.

Loading Procedure

To perform the loading procedure when initializing the TD-LTE Flexible system, the loader performs the followings first. (Pre-loading)

- Boot-up
  The booter of the Flash ROM loads the kernel and the Root File System (RFS) from the flash ROM to the RAM Disk, and performs the kernel.
- IP configuration
  The IP address information is acquired from the flash ROM and is set to communicate with the first upper management system. When auto initialization, TD-LTE Flexible system acquires automatically L3 information such as IP address, subnet mask and gateway IP address for communication by using DHCP. TD-LTE Flexible system acquires IP address of additional information server, and then receives the NE ID and IP address of RS from the additional information server.
- Registration
  The NE is registered to the RS, and the IP address of the IS is acquired during the registration.
- Version Comparison
  The version of the software image and the version of the PLD saved in the remote IS and in the internal storage are compared, and the location where to perform loading is determined from that.
- File List Download
  The list of the files to be loaded is downloaded for each board.

Loading Message Flow

After performing the pre-loading procedure, if the method of loading is determined, the Main OAM (ULM) of the MMA-G which performs the operation and the maintenance of the entire TD-LTE Flexible system performs loading by using the FTP/SFTP to the corresponding IS (remote ID or its own storage). Then, the Main OAM (ULM) becomes the internal image server for the lower board and performs the loading procedure.
The information on the software loaded in the TD-LTE Flexible system can be checked in the upper management system.
The loading message flow is as the following figure:

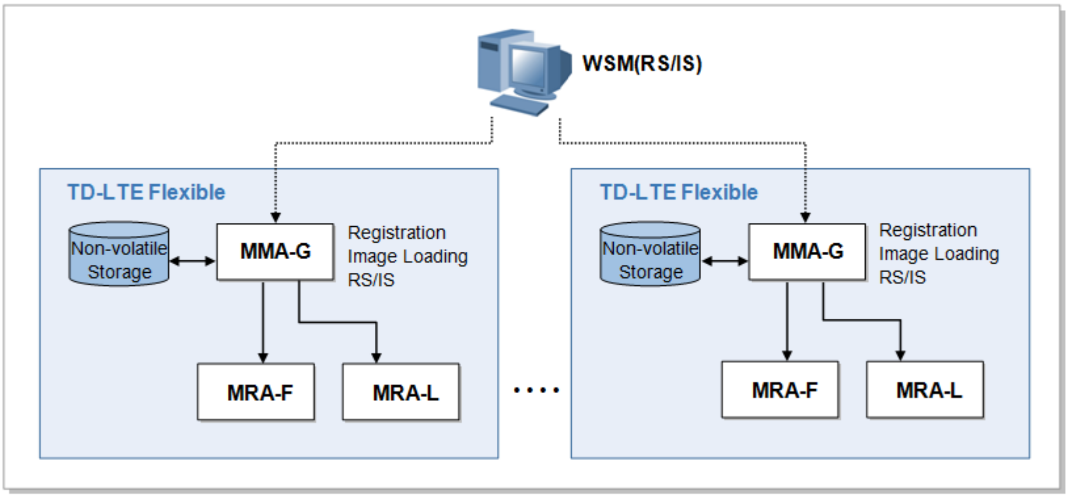

Figure 4.28 Loading Message Flow

4.6 Operation and Maintenance Message Flow

An operator can check and change the status of the TD-LTE Flexible system by means of the management system. To this end, the TD-LTE Flexible system provides the SNMP agent function. The function enables the WSM operator to perform the operation and maintenance function of the TD-LTE Flexible system at remote site by using the SNMP.
In addition, the operator can perform Web-EMT based maintenance function by using a Web browser in a console terminal or IMISH based maintenance function by using the SSH connection. However, grow/degrow, paging information change and neighbor list change functions are only available on WSM.
The statistical information provided by the TD-LTE Flexible system are provided to the operator according to collection period and the real-time monitoring function for a specific statistical item specified by the operator is, also, provided.

Operation and Maintenance Message Flow

The operation and maintenance of the TD-LTE Flexible system is carried out via the SNMP get/get_next/get_bulk/set/trap message between the SNMP agent on the main OAM and the SNMP manager of the WSM. The TD-LTE Flexible system deals with various operation and maintenance messages received from the SNMP manager of the management system, transfers the results and reports the events, such as failure generation or status change, in real time as applicable.
The statistical information is provided as statistical file format in unit of BI and the collection period can be specified as one of 15, 30 and 60 minutes.
The OAM signal flow is as shown in the figure below:

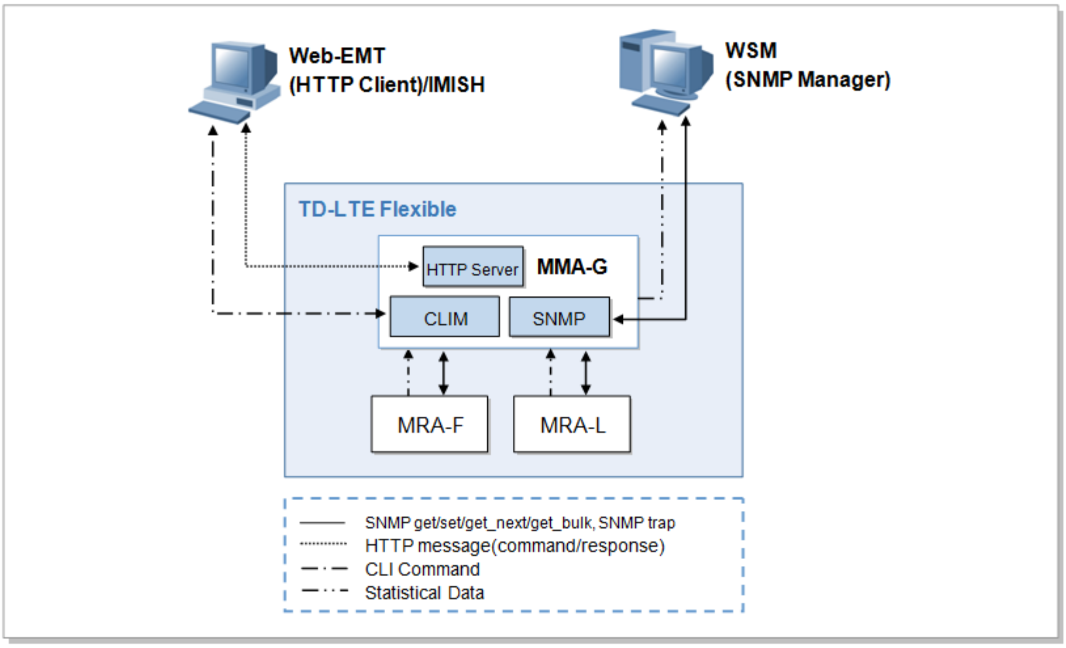

Figure 4.29 Operation and Maintenance Signal Flow

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CHAPTER 5. Additional Function and Tool

5.1 Web-EMT

The Web-EMT is a type of GUI-based consol terminals and the tool to access the TD-LTE Flexible system directly, monitor the device status and perform operation and maintenance. An operator can execute the Web-EMT only with Internet Explorer and the installation of additional software is not necessary. In addition, GUI is provided in HTTPs protocol type internally.

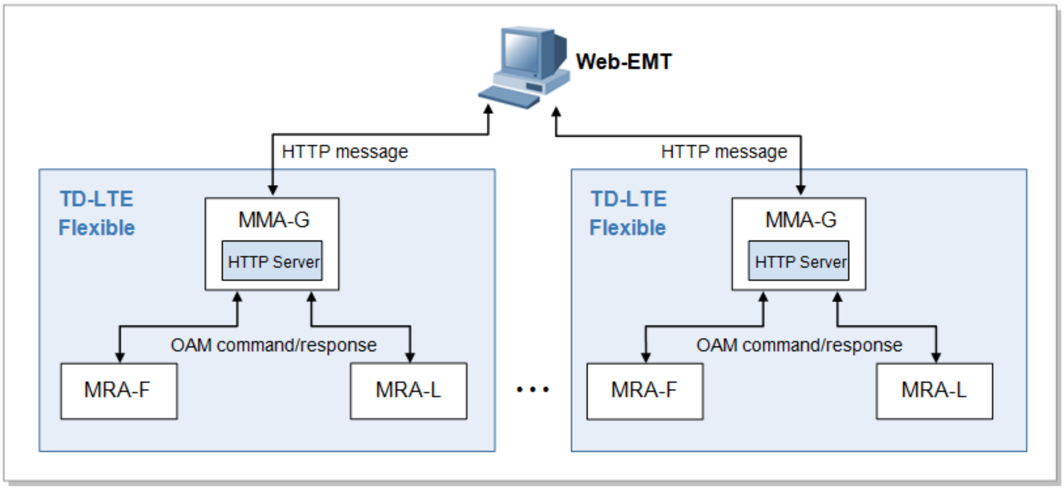

Figure 5.1 Web-EMT Interface

The Web-EMT enables the operator to restart the TD-LTE Flexible system or internal boards, inquire/set configuration and operation parameters, carry out status and failure monitoring and perform the diagnosis function. However, the functions for resource grow/degrow or the changes of the operation information concerned with neighbor list are only available on the WSM managing the entire network and the loading image.

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ABBREVIATION

A

AAA	Authentication, Authorization, and Accounting
ACR	Access Control Router
ADC	Analog to Digital Conversion
AGC	Automatic Gain Control
AISG	Antenna Interface Standards Group
AM	Acknowledged Mode
AMBR	Aggregated Maximum Bit Rate
AMC	Adaptive Modulation and Coding
API	Application Programming Interface
ARQ	Automatic Repeat request
AS	Access Stratum
ASN	Access Service Network

B

BI	Bucket Interval
BP	Board Processor

C

C & M	Control & Management
CAC	Call Admission Control
CC	Call Control
CC	Chase Combining
CID	Connection Identifier
CLEI	Common Language Equipment Identifier
CLIM	Command Line Interface Management
CLLI	Common Language Location Identifier
CMIP	Client Mobile IP
CoS	Class of Service
CPS	Call Processing Software
CSAB	CPS SON Agent Block
CSN	Connectivity Service Network
CTC	Convolutional Turbo Code

D

DAM	Diameter AAA Management
DCD	Downlink Channel Descriptor
DD	Device Driver
DFT	Discrete Fourier Transform
DHCP	Dynamic Host Configuration Protocol
DL	Downlink
DL-MAP	Downlink-MAP
DMB	Digital Main Block
DPM-FI	DC Power Module -Flexible Indoor
DST	Daylight Saving Time

E

E/O	Electrical to Optic
EAP	Extensible Authentication Protocol
ECCB	eNB Call Control Block
ECMB	eNB Common Management Block
ECS	eNB Control processing Subsystem
EDS	eNB Data processing Subsystem
EMI	Electro-Magnetic Interference
EMI	EMS Interface
EMS	Element Management System
EPC	Evolved Packet Core
E-UTRAN	Evolved-UTRAN

F

FA	Foreign Agent
FA	Frequency Allocation
FAN-FD48	FAN-Flexible Digital unit -48 VDC
FE	Fast Ethernet
FEC	Forward Error Correction
FFT	Fast Fourier Transform
FRP	Frequency Reuse Pattern

G

GBIC	Gigabit Interface Converter
GBR	Guaranteed Bit Rate
GE	Gigabit Ethernet
GERAN	GSM/EDGE Radio Access Network
GPS	Global Positioning System
GPSR	GPS Receiver
GRE	Generic Routing Encryption
GTPB	GPRS Tunneling Protocol Block

GUI	Graphical User Interface

H

HA	Home Agent
H-ARQ	Hybrid-Automatic Repeat request
HO	Handover
HTTPs	Hypertext Transfer Protocol over SSL

I

ICIC	Inter-Cell Interference Coordination
IDFT	Inverse Discrete Fourier Transform
IEEE	Institute of Electrical and Electronics Engineers
IMISH	Integrated Management Interface Shell
IP	Internet Protocol
IPRS	IP Routing Software
IR	Incremental Redundancy
IS	Image Server

L

LSM-C	LTE System Manager-Core
LTE	Long Term Evolution

M

MAC	Medium Access Control
MACB	Medium Access Control Block
MBB-F	Mobile WiMAX base station Backplane Board-Flexible
MBR	Maximum Bit Rate
MCS	Modulation and Coding Scheme
MEI-B	Mobile WiMAX base station External Interface board assembly-Basic
MIB	Master Information Block
MIMO	Multiple Input Multiple Output
MIP	Mobile IP
MLPPP	Multi Link Point to Point Protocol
MMA-G	Mobile WiMAX base station Main control board Assembly-General
MME	Mobility Management Entity
MRA-F	Mobile WiMAX base station RAS board Assembly-Flexible
MRA-L	Mobile WiMAX base station RAS board Assembly-LTE
MS	Mobile Station
MU	Multi-User
MW	Middleware

N

NAS	Non-Access Stratum
NE	Network Element
NP	Network Processor
NPS	Network Processor Software
NWG	Network Working Group

O

O/E	Optic to Electrical
OAGS	Common SNMP Agent Subagent
OAM	Operation And Maintenance
OCM	Common Configuration Management
OER	Common Event Router
OFDMA	Orthogonal Frequency Division Multiple Access
OPM	Common Performance Management
OS	Operating System
OSSM	Common Subscription Service Management

P

PAPR	Peak to Average Power Ratio
PBA	Panel Board Assembly
PCB	Printed Circuit Board
PCEF	Policy and Charging Enforcement Function
PCRF	Policy & Charging Rules Function
PDCB	PDCP Control Block
PDCP	Packet Data Convergence Protocol
PDU	Protocol Data Unit
PF	Proportional Fair
PGID	Paging Cycle, Paging Offset
PHY	Physical Layer
PLD	Programmable Loading Data
PLER	Packet Loss Error Rate
PMI	Precoding Matrix Indicator
PMIP	Proxy Mobile IP
PP2S	Pulse Per 2 Seconds
PPP	Point to Point Protocol
PRB	Physical Resource Block

Q

QAM	Quadrature Amplifier Modulation
QCI	QoS Class Identifier
QCS	Quick Connection Setup
QoS	Quality of Service

R

RAS	Radio Access Station
RB	Radio Bearer
RDM	RAS Diagnosis Management
RFS	Root File System
RLCB	Radio Link Control Block
ROHC	Robust Header Compression
RRC	RAS Resource Controller
RRH	Remote Radio Head
RS	Registration Server
RSC	RAS Service Controller
RSSI	Received Signal Strength Indicator
RTC	RAS Traffic Controller

S

SAE	System Architecture Evolution
SBC	Subscriber Station Basic Capacity
SC	Single Carrier
SCTB	SCTP Block
SDU	Service Data Unit
SFBC	Space Frequency Block Coding
SFF	Small Form Factor Fixed
SFP	Small Form Factor Pluggable
SFTP	Secure File Transfer Protocol
S-GW	Serving Gateway
SIBs	System Information Blocks
SMFS	Samsung Mobile WiMAX U-RAS Flexible Shelf assembly
SNMP	Simple Network Management Protocol
SNMPD	SNMP Daemon
SSH	Secure Shell
SSL	Secure Sockets Layer
STBC	Space Time Block Coding
SU	Single User

T

TA	Tracking Area
TCA	Threshold Cross Alert
TDD	Time Division Duplex

U

UCCM	Universal Core Clock Module
UCD	Uplink Channel Descriptor
UDA	User Defined Alarm

UDE	User Define Ethernet
UDP	User Datagram Protocol
UE	User Equipment
UFM	Common Fault Management
UL	Uplink
ULM	Universal Loading Management
UL-MAP	Uplink-MAP

V

VIF	Virtual Interface
VLAN	Virtual Local Area Network

W

Web-EMT	Web-based Element Maintenance Terminal
WLAN	Wireless Local Area Network
WSM	Mobile WiMAX System Manager

Z

ZCS	Zero Code Suppression

Mobile WiMAX/TD-LTE BS TD-LTE Flexible

System Description

SAMSUNG ELECTRONICS

	Warning: rf exposure is subject to routine evaluation at time of licensing.