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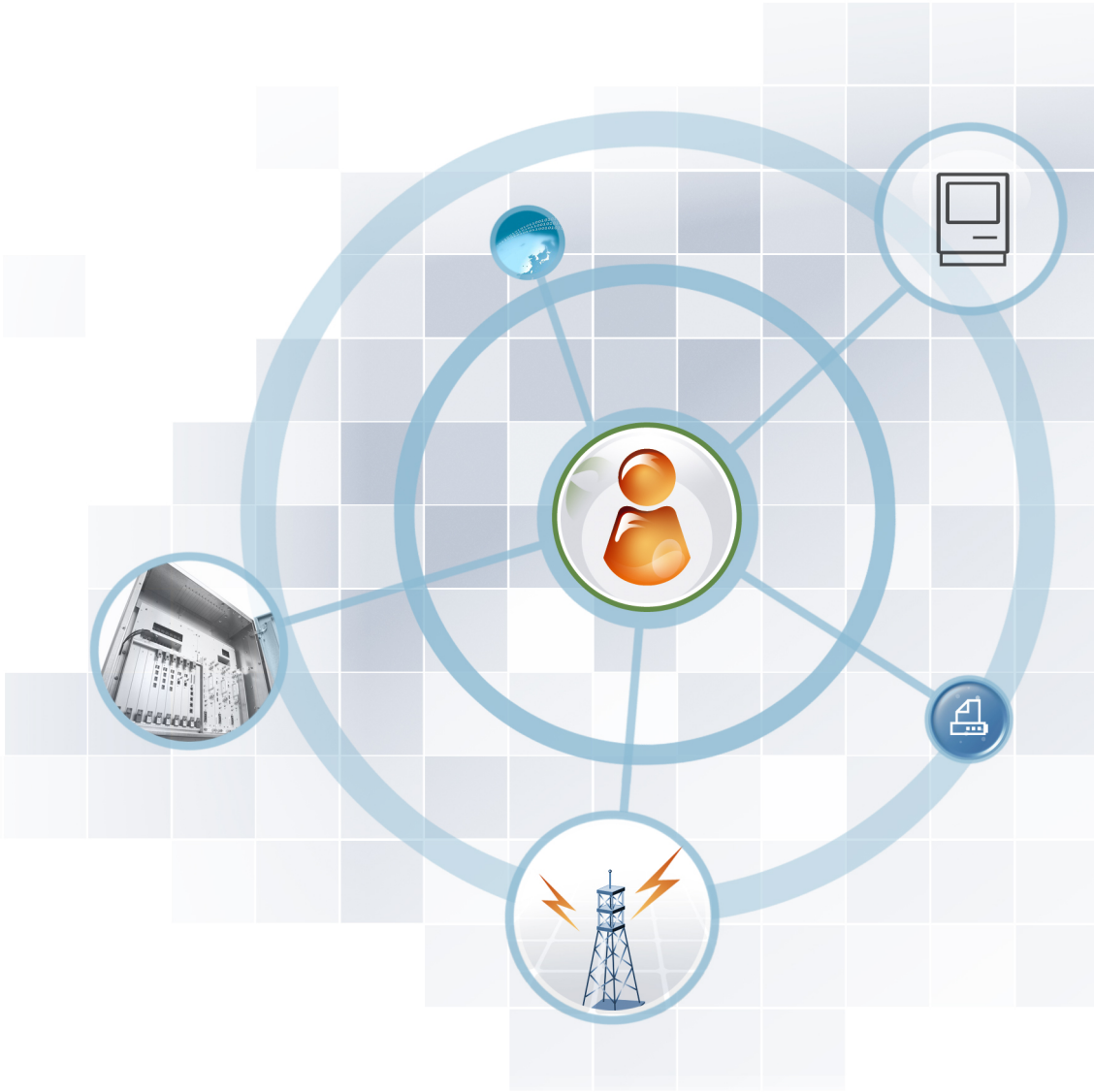
Ver. 1.0

Mobile WiMAX RAS U-RAS Flexible V2

System Description



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INTRODUCTION

Purpose

This description describes the characteristics, functions and structures of the U-RAS Flexible V2, which is the RAS of Mobile WiMAX.

Document Content and Organization

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

CHAPTER 1. Overview of Samsung Mobile WiMAX System

- Samsung Mobile WiMAX System Introduction
- Components of Samsung Mobile WiMAX 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

- RET
- 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

Indicates additional information as a reference.

Revision History

VERSION	DATE OF ISSUE	REMARKS
1.0	06. 2012.	First Version

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CHAPTER 1. Samsung Mobile WiMAX Network

1.1 Introduction to Samsung Mobile WiMAX

The Mobile 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/Cor/D3 defining the technologies supporting mobility, which include handover, paging.

Samsung Mobile WiMAX Standard
In this description, the entire Samsung Mobile WiMAX standard is expressed IEEE 802.16.

The wireless LAN (WLAN, Wireless Local Area Network) can provide high speed data services, but its radio wave is short and covers only small areas, and also gives limited user mobility. It is difficult for WLAN to ensure Quality of Service (QoS) for data service.
On the contrary, the present mobile communication networks support the mobility of the users, but the service charge and the cost of system operations are high due to the limited wireless resources. To provide faster service in the existing mobile communication networks, it requires a separate wireless communication technology such as High Speed Downlink Packet Access (HSDPA) for the data services.
Samsung Mobile WiMAX can, therefore, overcome the limitations of the WLAN and present mobile communication networks, and accommodate only the advantages of the system.
Samsung Mobile WiMAX can ultimately provide the high speed wireless internet services with low cost at any time and in anyplace.
In addition, the IEEE 802 working group is in the process of amending the IEEE 802.16e to develop the more advanced technology standard, 802.16m. The 802.16m technology standard will be a major step from the actual Mobile WiMAX, and will be reflected in the IMT-Advanced standard of the ITU-R.
The 802.16m standard, which can substitute the current 802.16e standard, will provide a faster download (above 150 Mbps at 20 MHz basis), a faster upload (above 50 Mbps at 20 MHz basis) and a consistent service under 350 km/h speed movement, while ensuring mutual compatibility with 802.16e.
The WiMAX forum plans to promote the WiMAX Release 2.0 specification based on the 802.16m standard.

Characteristics of the Samsung Mobile WiMAX System

The major characteristics of Samsung Mobile WiMAX system are listed below.

- High Compatibility and Cross-Interworking
  The Samsung Mobile WiMAX system is based on IEEE 802.16-2005 standard and complies with Wave 2 Profile and ASN Profile C of the Mobile WiMAX Forum. Therefore, the Samsung Mobile WiMAX system provides high compatibility and excellent cross-interworking.
- High Performance Module Structure
  The Samsung Mobile WiMAX system has high performance by using high-performance processor and provides the module structure that it is easy to upgrade hardware and software.
- High System Stability
  The Samsung Mobile WiMAX system provides the redundancy structure for main modules to ensure higher stability.
- Advance RF and Antenna Solution Support
  The Samsung Mobile WiMAX system applies the power amplifier to support wideband operation bandwidth and supports Multiple Input Multiple Output (MIMO) in default.
- Evolution Possibility into Next Generation Networking
  The Samsung Mobile WiMAX system complies with the structure of the Mobile WiMAX ASN Profile C network and the ASN Profile C network composition is similar to the network structure considered in 3GPP Long Term Evolution (LTE)/Service Architecture Evolution (SAE). Therefore, the Samsung Mobile WiMAX system can easily evolve into the next generation network.
- Maintenance Function with Strengthened Security
  The Samsung Mobile WiMAX system can provides the security function (SSH and HTTPs) to all channels for operation and maintenance. The Samsung Mobile WiMAX system provides the operator Authentication, Authorization and Accounting (AAA) function to authenticate the operator and assign the right for system access and stores the operation history in a log.

Samsung Mobile WiMAX System(ACR and RAS) Functions

Samsung Mobile WiMAX System provides high speed data services using the transmission technology of Orthogonal Frequency Division Multiple Access (OFDMA) by the Time Division Duplex (TDD), and can give wider coverage compared to the existing WLAN. The system performance and the capacity have been expanded by the high performance hardware, and thus, it can easily give various functions and services to the users.


NOTE

System Support Standards

Network Working Group (NWG) of Mobile WiMAX Forum defines the Mobile WiMAX network as Access Service Network (ASN) and Connectivity Service Network (CSN). RAS of Samsung is Base Station (BS) and ACR is ASN-GW (Gateway) of ASN, respectively.

RAS and ACR are based on ASN Profile C and Wave 2 Profile defined in the Mobile WiMAX Forum and the Wave 2 Profile contains Wave 1 Profile.

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

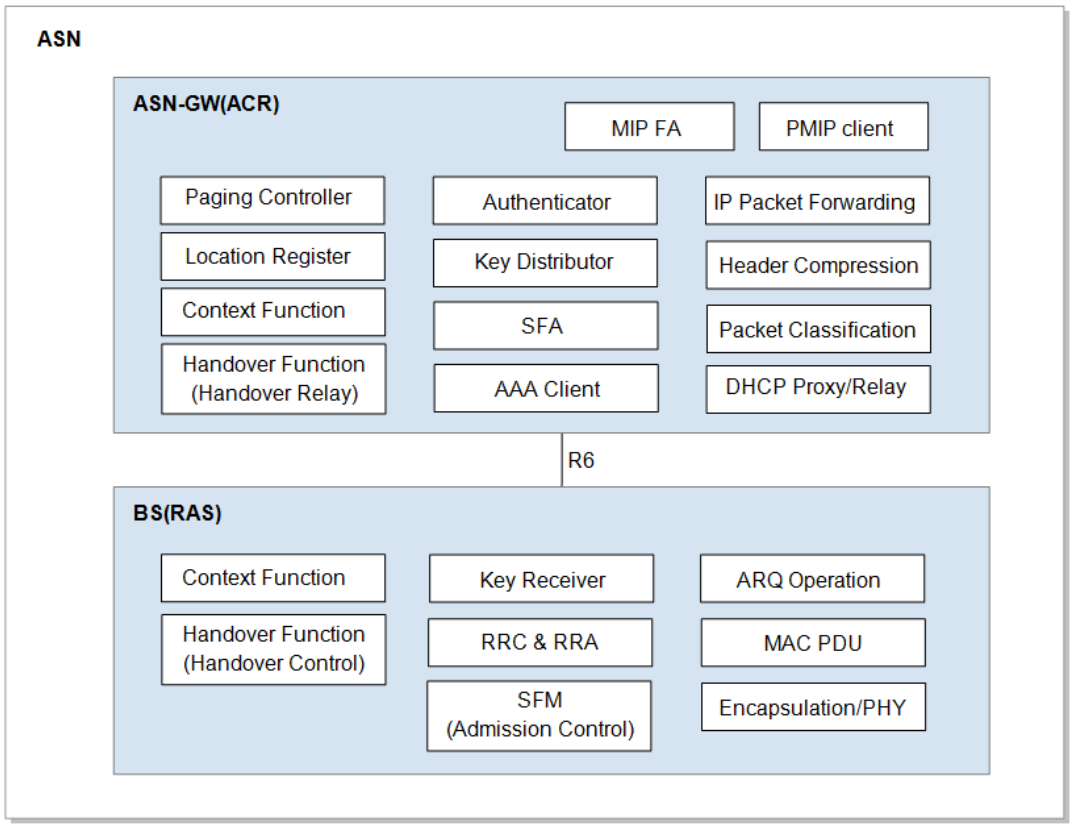


Figure 1.1 Configuration of Mobile WiMAX System Functions (Based on Profile C)

The 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 an 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 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 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.


NOTE

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

1.2 Samsung Mobile WiMAX Network Configuration

Samsung Mobile WiMAX network is composed of ASN, CSN, and WSM. WSM is the Network Element (NE) to manage ACR and RAS. ASN is connected with CSN by router and switch.

The following diagram shows the composition of Samsung Mobile WiMAX network.

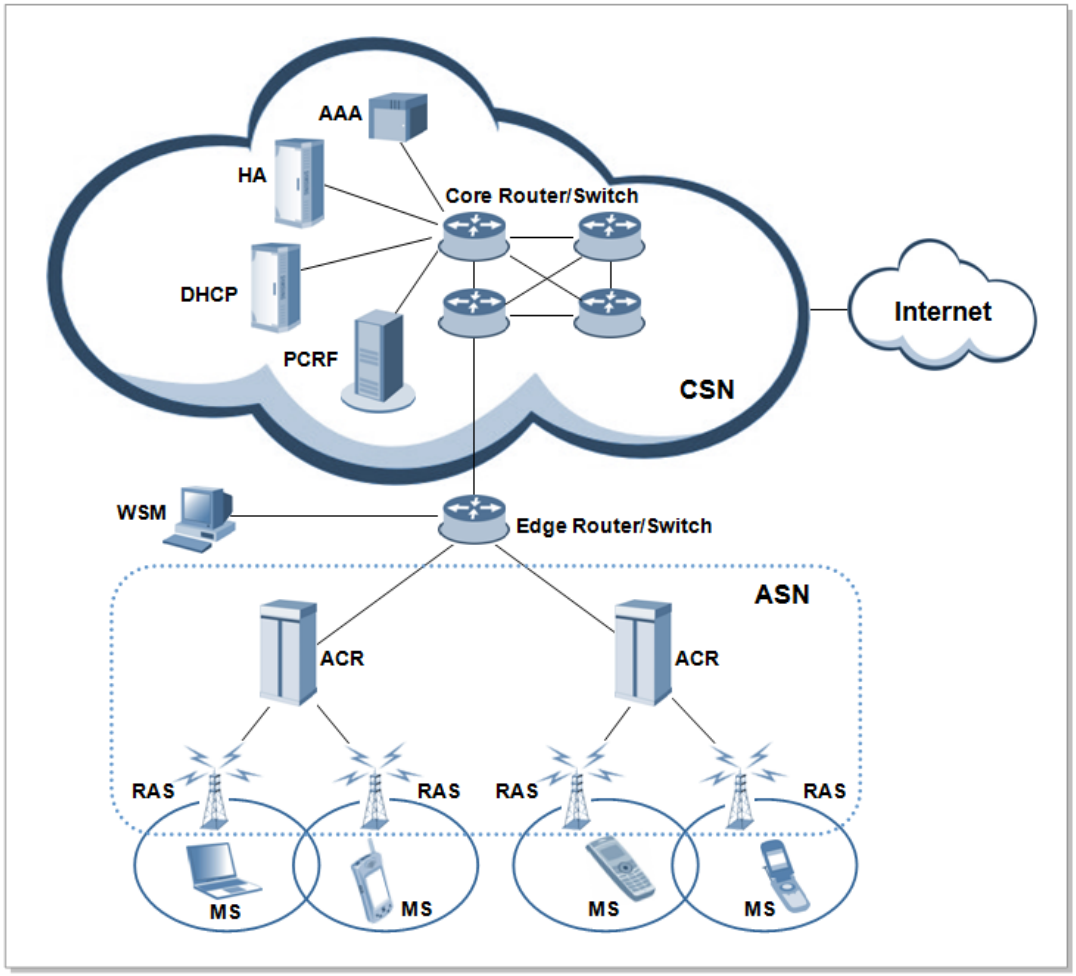


Figure 1.2 Samsung Mobile WiMAX Network Configuration

Radio Access Station (RAS)

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.

Access Control Router (ACR)

ACR, which is the system between CSN and RAS, enables several RASs 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.

Samsung Mobile WiMAX System Manager (WSM)

WSM provides the management environment for the operator to operate and maintain ACR and RAS.

Home Agent (HA)

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 to exchange PMIPv4 signalling and bearer traffic.

Authorization, Authentication and Accounting (AAA) Server

AAA server interfaces with ACR and carries out subscriber authentication and accounting functions. The AAA server interfaces with ACR via Diameter/RADIUS protocol and provides Extensible Authentication Protocol (EAP) certification.

Dynamic Host Configuration Protocol (DHCP) Server

The DHCP server allocates IP addresses to simple IP users. When an MS requests an IP address allocation, the DHCP server allocates an IP address in interoperation with the ACR that functions as the DHCP relay agent and sends it to the ACR.

Policy & Charging Rules Function (PCRF) Server

The PCRF server is the server that manages the service policy and interfaces with ACR via Diameter protocol. The PCRF server sends QoS setting information for each user session and accounting rule information to ACR.

CHAPTER 2. Overview of System

2.1 System Introduction

The U-RAS Flexible V2, RAS of Mobile WiMAX, is controlled by ACR and connects Mobile WiMAX calls to MS.
The U-RAS Flexible V2 interfaces with MS via a wireless channel observing the Mobile WiMAX standard (IEEE 802.16) and provides high-speed data service and multimedia service in wireless broadband.
To this end, the U-RAS Flexible V2 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 U-RAS Flexible V2 and set/hold/disconnect the packet call connection, handover control and ACR interface function and system operation management function.
Physically, the U-RAS Flexible V2 consists of a Digital Unit (DU) and a Mobile WiMAX base station Remote Radio Head (RRH).
The RRH is located remotely from the DU. The DU is a digital unit of 19 in. shelf form and can be installed in an indoor or outdoor 19 in. rack. It supports a capacity up to 2Carrier/3Sector. The DU is operated in omni or sector mode depending on the features of the installation location.
An RRH is a standalone RF unit. It is installed on an outdoor wall or pole.
U-RAS Flexible V2 supports 2Carrier/3Sector (6 subcell).

Application of the OFDMA Method

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.

Separate DU and RRH Structure

As the U-RAS Flexible V2 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 DUs and RRHs receives -48 VDC of power for its operation.

- Versatile Network Operation
  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.
- 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 or pole.
  Moreover, as the distance between the RRH and antenna is minimized, the loss of RF signals due to the antenna feeder line can be reduced so that more enhanced RF receiving performance than the existing rack-type RAS 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 U-RAS Flexible V2 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 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.

Support of MIMO

The U-RAS Flexible V2 supports MIMO through the 2Tx/2Rx RF path of the RRH. The following methods are available in MIMO:

- 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 U-RAS Flexible V2 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.

Support of Smooth Migration

DU of U-RAS Flexible V2 can be migrated to TD-LTE by add the channel card and upgrading the software. RRH of U-RAS Flexible V2 can be migrated to TD-LTE in same RF band by only software upgrade, and RRH can support 802.16e and TD-LTE at the same time.

System Feature Availability

For the availability of a specific feature described in this system description, please see a relevant document provided separately.

2.2 Main Functions

The main functions of the U-RAS Flexible V2 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

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 U-RAS Flexible V2 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 U-RAS Flexible V2 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 U-RAS Flexible V2 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 U-RAS Flexible V2 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 U-RAS Flexible V2 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 U-RAS Flexible V2 performs the subchannelization to mitigate the interference between cells.
The U-RAS Flexible V2 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

U-RAS Flexible V2 transmits the column of the QAM symbol structure to the MS via the sub-carriers pertained to each subchannel.

DL/UL MAP Construction

The U-RAS Flexible V2 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 U-RAS Flexible V2 and includes various control information for the MS.

Power Control

The U-RAS Flexible V2 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 U-RAS Flexible V2 transmits the power correction command to each MS and then makes the MS power intensity be the level required in the U-RAS Flexible V2 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 U-RAS Flexible V2 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 wireless channel environment or the change in the interference signal level.

MIMO

The U-RAS Flexible V2 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 U-RAS Flexible V2 as two MSs with each individual antenna send data simultaneously by using the same channel.

The U-RAS Flexible V2 provides the adaptive MIMO switching function, which dynamically selects the SM or STC method for the downlink MIMO function. The U-RAS Flexible V2 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 Call Processing Function

Cell Initialization Function

The U-RAS Flexible V2 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 U-RAS Flexible V2 enables an MS to enter to or exit from the network. When an MS enters to or exit from the network, the U-RAS Flexible V2 transmits/receives the signaling message required for call processing via R1 interface with the MS or R6 interface with ACR. The U-RAS Flexible V2 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 U-RAS Flexible V2 collects and release the allocated CID.

Handover

The U-RAS Flexible V2 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 U-RAS Flexible V2 performs the data switching function. In handover, the U-RAS Flexible V2 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 U-RAS Flexible V2 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 U-RAS Flexible V2 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 U-RAS Flexible V2 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 U-RAS Flexible V2 checks if the air resources of the requested subcell exceed the threshold and determines the creation of the service

MAC ARQ Function

The U-RAS Flexible V2 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 U-RAS Flexible V2 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 U-RAS Flexible V2 is delivered to the modem in the U-RAS Flexible V2. At this time, the U-RAS Flexible V2 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 U-RAS Flexible V2 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.

2.2.3 IP Processing Functions

IP QoS Function

Since the U-RAS Flexible V2 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 U-RAS Flexible V2 supports the mapping between Differentiated Services Code Point (DSCP) and 802.3 Ethernet MAC service class.

Simultaneous Support of IPv4/IPv6

ACR communicates with the U-RAS Flexible V2 through the GRE tunnel and the backhaul IP version between the U-RAS Flexible V2 and ACR is managed independently from the service IP version for the MS.
Even if, therefore, IPv4 is used in backhaul between the U-RAS Flexible V2 and ACR, all of IPv4, IPv6 and IPv4/IPv6 dual stack services can be supported for the MS.

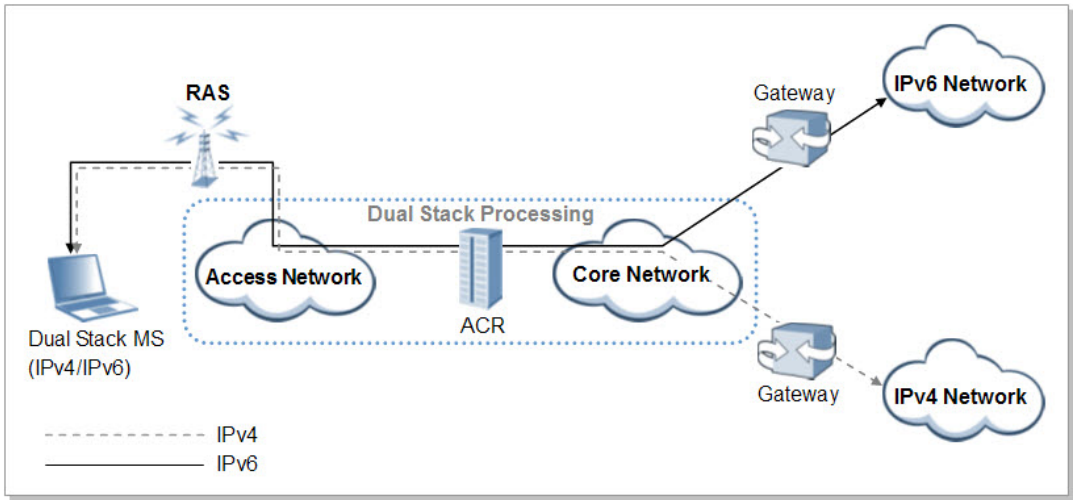


Figure 2.1 IPv4/IPv6 Dual Stack Operation

IP Routing Function

Since the U-RAS Flexible V2 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 U-RAS Flexible V2 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 U-RAS Flexible V2 supports the static routing configuration only and not the router function for the traffic received from the outside. When the U-RAS Flexible V2 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 U-RAS Flexible V2 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 U-RAS Flexible V2 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.

2.2.4 Auxiliary Device Interface Function

The U-RAS Flexible V2 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 U-RAS Flexible V2 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 U-RAS Flexible V2 carries out the NAT function to change the address into a public IP address (i.e., the IP address of the U-RAS Flexible V2) for the communication with an external monitoring server.

2.2.5 Maintenance Function

The U-RAS Flexible V2 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.

Carrier Expansion (6 Subcell) Function

The U-RAS Flexible V2 can supports six subcells by mounting the six channel cards. Operator can set the operating sector and operating frequency for each subcell. (However, RRH-B3 supports up to four subcells.)

Graphic and Text-based Console Interface

WSM manages the entire Mobile WiMAX system by using Database Management System (DBMS) and U-RAS Flexible V2 interworks with this WSM. In addition, ACR 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 U-RAS Flexible V2 provides the authentication and the permission management functions for the operator who manages the Mobile WiMAX system. The operator accesses the U-RAS Flexible V2 by using the operator's ID and password via Web-EMT or IMISH and the U-RAS Flexible V2 assigns the operation right in accordance with the operator's level.
The U-RAS Flexible V2 carries out the logging function for successful access, access failure and login history.

Maintenance Function with Enhanced Security Function

For the security, the U-RAS Flexible V2 supports Hyper Text Transfer Protocol over SSL (HTTPs) and Secure Shell (SSH) in the communication with console terminals.

On-line Software Upgrade

When a software package is upgraded, the U-RAS Flexible V2 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 U-RAS Flexible V2 updates the package stored in a non-volatile storage.
In addition, the U-RAS Flexible V2 can re-perform the 'Change to New package' stage to roll back into the previous package before upgrade.

Call Trace Function

The U-RAS Flexible V2 supports the call trace function for a specific MS. The U-RAS Flexible V2 can carry out the call trace function up to 2 MSs per carrier/sector, and up to 10 MSs per system. If a call occurs in the MS that an operator previously specified via ACR, the signaling message and statistical traffic data are transmitted to WSM. Besides, the U-RAS Flexible V2, also, sends the RF environment information, such as Carrier to Interference and Noise Ratio (CINR) for MS, Modulation and Coding Schemes (MCS) level and Burst Error Rate (BER).

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

The Mobile WiMAX system of Samsung 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 Mobile WiMAX 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 U-RAS Flexible V2 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 U-RAS Flexible V2, and the U-RAS Flexible V2 creates and stores a file for each period.

Threshold Cross Alert (TCA) Control

The U-RAS Flexible V2 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 U-RAS Flexible V2 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 U-RAS Flexible V2 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.

Integrity Check

The U-RAS Flexible V2 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.

OAM Traffic Throttling

The U-RAS Flexible V2 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.

Throughput Test

The U-RAS Flexible V2 provides a throughput test for the backhaul to the ACR. The U-RAS Flexible V2 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 U-RAS Flexible V2 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 U-RAS Flexible V2 is running may affect the system performance.

Disabling Zero Code Suppression (ZCS)

The U-RAS Flexible V2 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.

Line loopback test between the DU and RRH

The U-RAS Flexible V2 provides the loopback test function to check whether communication is normal on the baseband I/Q and C & M interface line between the DU and RRH.

2.3 Specifications

Capacity

The capacity of the U-RAS Flexible V2 is as follows:

Category	System Capacity
Channel Bandwidth	10 MHz
RF Band	RRH-B4 : 2,496~2,690 MHz (194 MHz)
Maximum Number of Carriers/Sectors	2 Carrier/3 Sector (6sucell)
Interface between ACR and U-RAS Flexible V2	Select one of Fast Ethernet and Gigabit Ethernet
FFT size/Carrier/Sector	1,024
Channel Card Capacity	1Carrier/1Sector
Output	Antenna Port-based – 5 W+5W/Carrier @ 10 MHz – 10 W+10W/Carrier @ 10 MHz , Power Boosting

Input Power

The table below lists the power standard for the U-RAS Flexible V2.

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 U-RAS Flexible V2.

Category		Standard
Size [mm (in.)]	DU (W × D × H)	432×396×200 (17×15.59×7.87)
	RRH-B4 (W × D × H)	350×207.5×550 (13.78×8.17×21.65)
Weight [kg (lb.)]	DU	20(44.09) or less
	RRH-B4	About 23(50.71)

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)]	5~90% (Non-condensing), The absolute humidity per 1m³of air should not exceed 30g.
Altitude	-60~1,800 m(-197~6,000 ft)
Vibration	GR-63-CORE Sec.4.4 – Earthquake – Office Vibration – Transportation Vibration
Sound Pressure Level	Less than 65 dBA measured at points 1.5 m (5 ft) above the floor and 0.6 m (2 ft) all around.
EMI	FCC Title47 Part 15 Class A EN 301 389 GR1089-CORE(Issue4)
a) The standards of temperature/humidity conditions are based on the value on the position where is 400 mm (1.3 ft) away from the front of the DU and in the height of 1.5 m (5 ft) on the bottom.	

- RRH

Category	Range
Temperature Condition[a)]	-40~50℃(-40~122℉)
Humidity Condition [a)]	5~100% (Condensing), The absolute humidity per 1m³of air should not exceed 30g.
Altitude	-60~1,800 m(-197~6,000 ft)
Vibration	GR-487-CORE Sec.3.39 – Transportation shock – Transportation vibration – Installation shock – Environmentally induced vibration – Earthquake resistance
Sound Pressure Level	Less than 65 dBA measured at 1.5 m (5 ft) from the RRH in all horizontal directions at a height of 1 m (3 ft)
EMI	FCC Title47 Part 15 Class B EN 301 389 G1089-CORE(Issue4)
RF Regulation	FCC Title47 Part27
a) The standards of temperature/humidity conditions are based on the value on the position where is 400 mm (1.3 ft) away from the front of the RRH and in the height of 1.5 m (5 ft) on the bottom.	

Environmental Alarm

The table below lists the environmental alarm provided in the U-RAS Flexible V2 in default.

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

GPSR Specification

The table below lists the GPS Receiver (GPSR) characteristics of U-RAS Flexible V2.

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 U-RAS Flexible V2.

Category	Description
Tx Output Power	– 10W @avg power per carrier/sector – 20W @avg power per carrier/sector, power boosting
Tx Constellation error	In accordance with the 802.16e standard
RX Sensitivity	In accordance with the 802.16e standard

2.4 Interface between Systems

Interface Structure

The U-RAS Flexible V2 interfaces with another RAS and ACR as shown in the figure below:

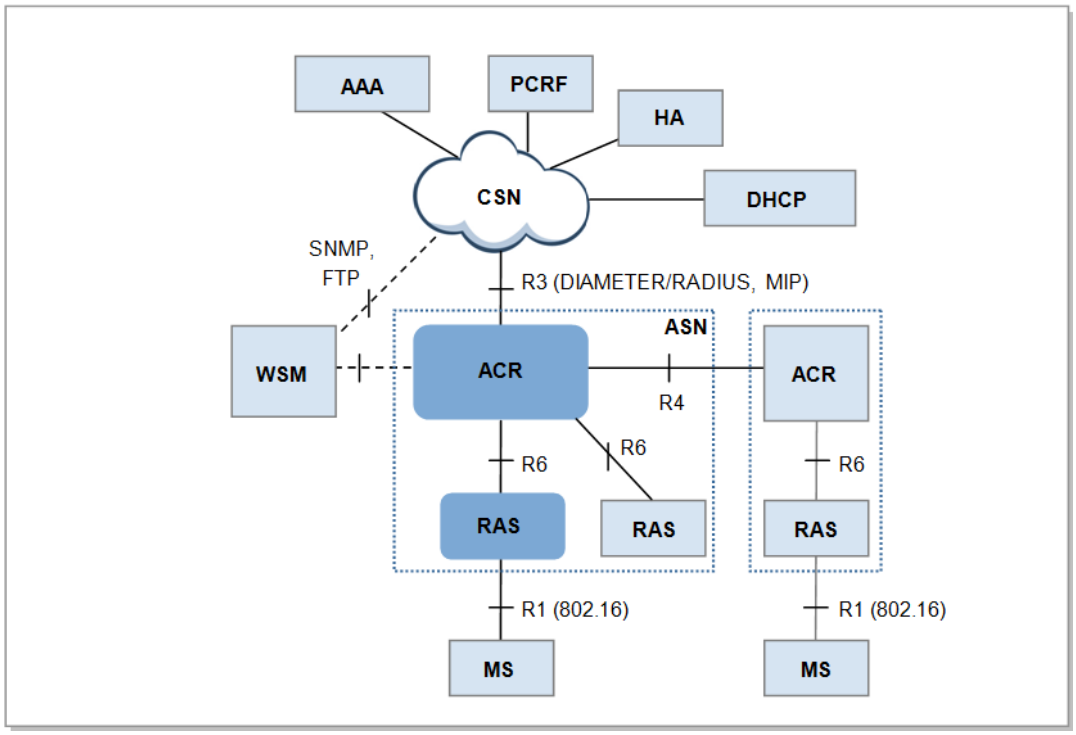


Figure 2.2 Structure of U-RAS Flexible V2 Interface

- Interface between U-RAS Flexible V2 and MS
  The U-RAS Flexible V2 interfaces with an MS according to the IEEE 802.16 radio access standard to exchange the control signal and the subscriber traffic.
- Interface between U-RAS Flexible V2 and ACR
  The interface between an ACR and the U-RAS Flexible V2 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 U-RAS Flexible V2 and WSM
  The interface between the U-RAS Flexible V2 and the WSM complies with SNMPv2c of IETF standard, FTP and proprietary standard of Samsung and its physical access method is GE/FE.

Protocol Stack

- Protocol Stack between NEs
  The figure below shows the protocol stack between NEs.

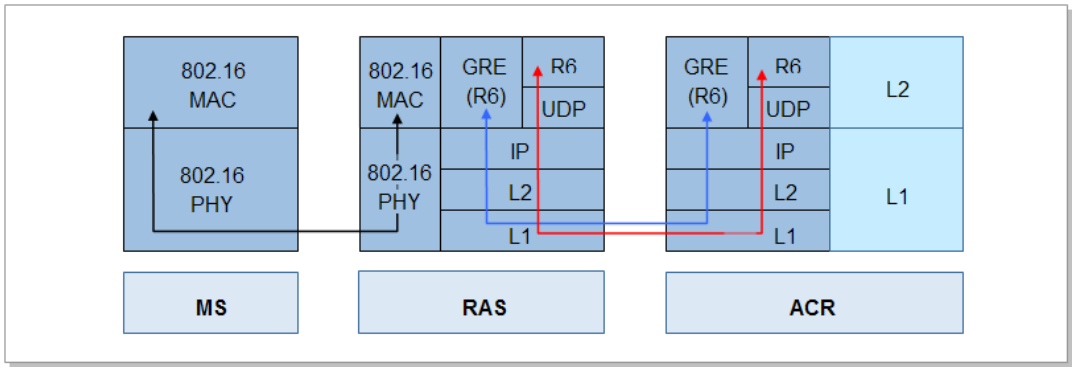


Figure 2.3 Protocol Stack between NEs

The U-RAS Flexible V2 interworks with MSs via R1 interface according to IEEE 802.16 standard and the interface between the U-RAS Flexible V2 and ACR is R6 interface. The R6 signaling interface is executed on UDP/IP and the R6 traffic interface uses the GRE tunnel.

- Protocol Stack for Operation and Maintenance

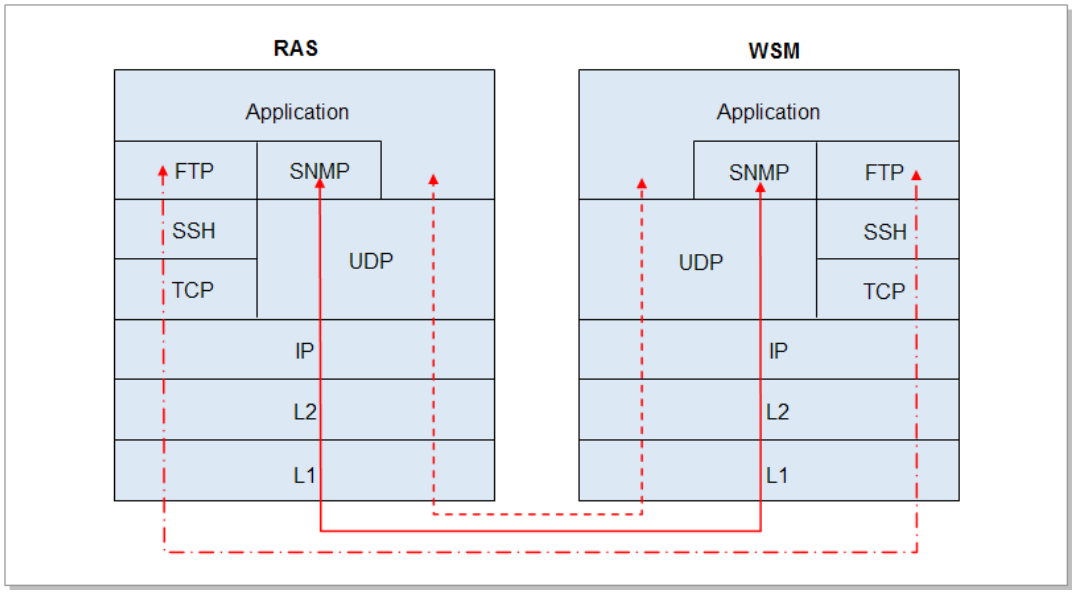


Figure 2.4 Protocol Stack between U-RAS Flexible V2 and WSM

The U-RAS Flexible V2 interworks with WSM in UDP/IP-based SNMP method to carry out the operation and maintenance functions. In particular, the U-RAS Flexible V2 interworks with WSM in TCP/IP-based FTP method to collect the statistical data periodically, initialize & restart the system and download software.

Physical Interface Operation Method

The U-RAS Flexible V2 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 U-RAS Flexible V2. 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.

CHAPTER 3. System Structure

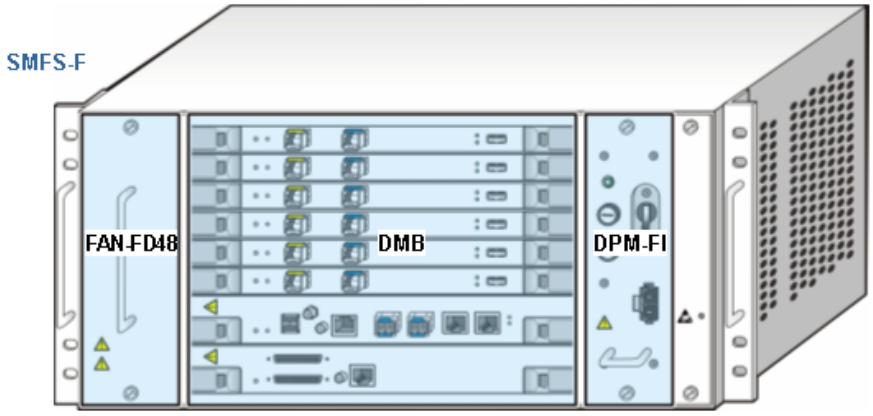
3.1 Hardware Structure

The U-RAS Flexible V2 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 (6subcell) 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 U-RAS Flexible V2
  - 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 U-RAS Flexible V2, enables the U-RAS Flexible V2 to interface with ACR 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 U-RAS Flexible V2 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-B4

The RRH-B4 is a single unit that can be installed on a wall or pole without an additional shelf or rack.
The RRH-B4 is a unified RF module interfacing remotely with the DU through an optical cable. It is located at the front end of the antenna.

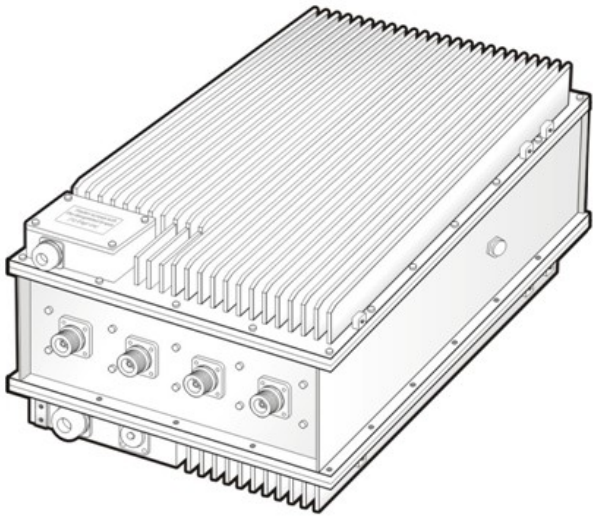


Figure 3.2 RRH-B4 Configuration

On a downlink, it converts the data traffic in the form of ‘Digital I/Q and C & M’ received from the MRA-F of the DU into RF signals and then sends them through an external antenna. Conversely, on an uplink, the RRH-B4 converts the RF signals received through the antenna into ‘Digital I/Q and C & M’ data traffic, and then sends them to the MRA-F of the DU. The RRH-B4 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 U-RAS Flexible V2.

- 2Carrier/3Sector MIMO

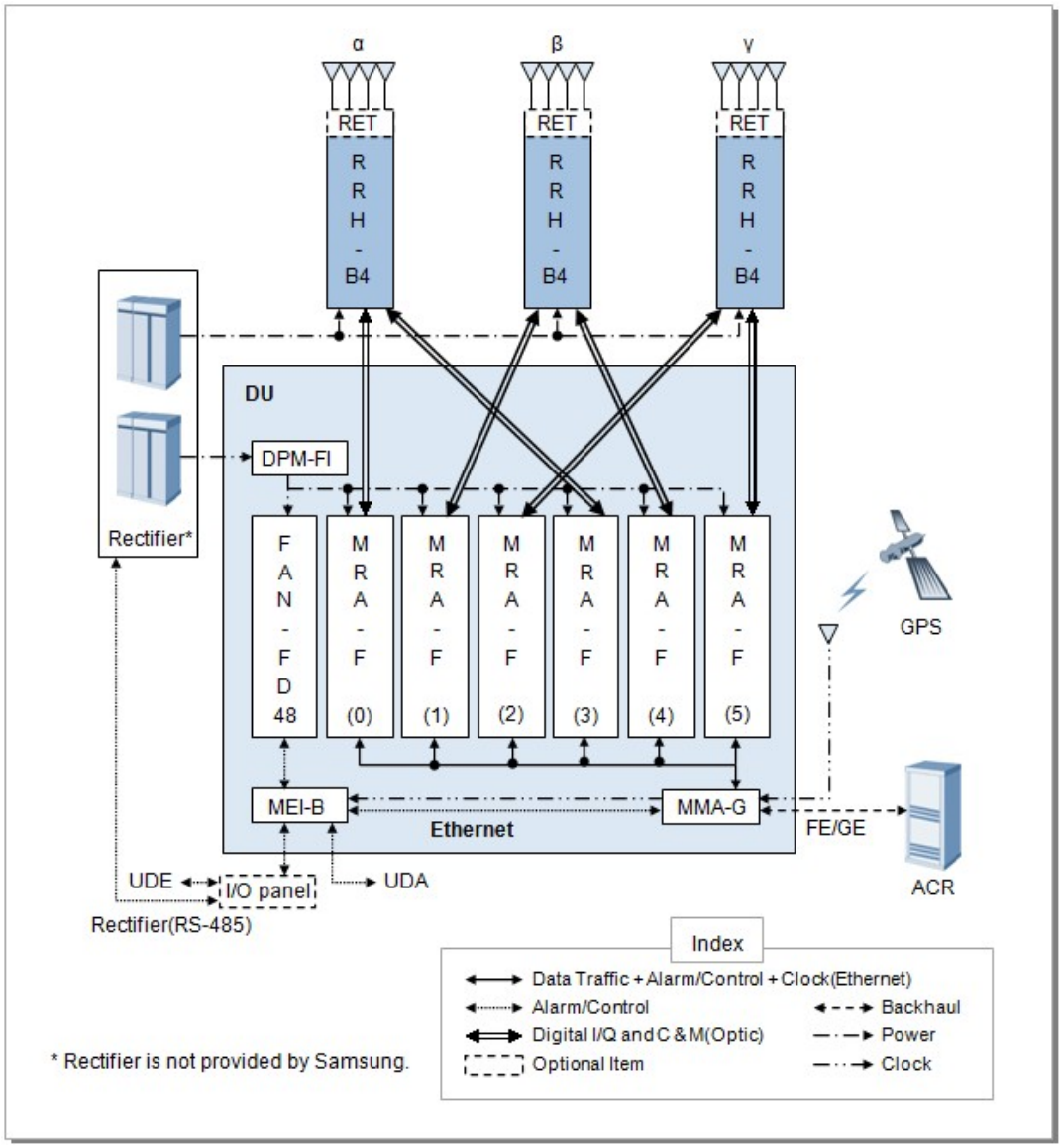


Figure 3.3 Internal Configuration of System (MIMO, 2Carrier/3Sector)

- 6 Subcell MIMO (Carrier Expansion Function)

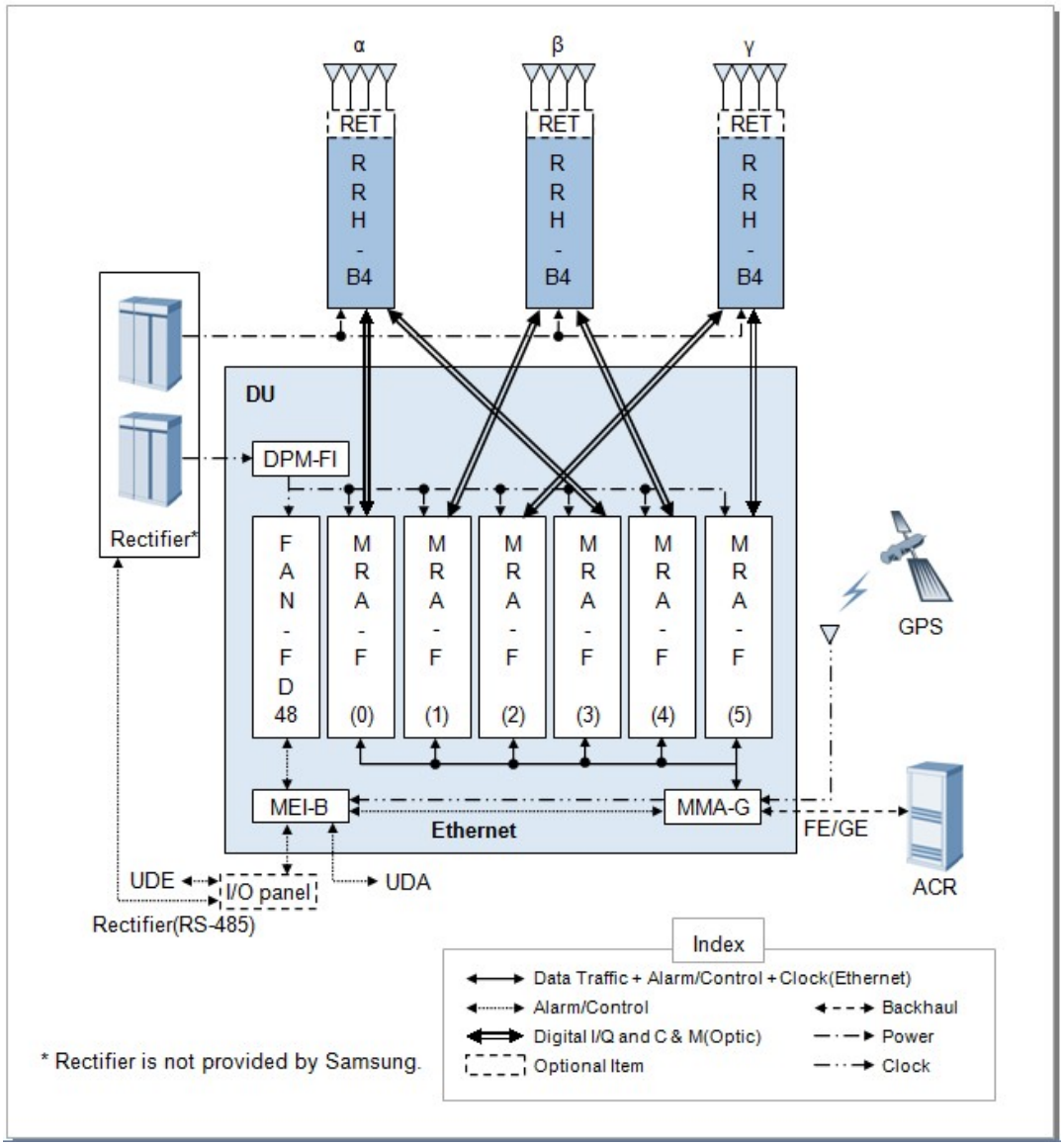


Figure 3.4 Internal Configuration of System (Example of MIMO and 6 Subcell)

NOTE

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 U-RAS Flexible V2 and rectifier, the rectifier must meet the interface protocol specified by Samsung. For other operations, the U-RAS Flexible V2 can communicate with the rectifier using User Defined Alarms (UDA).

3.1.1 DMB

The Digital Main Block (DMB) supports the operation and maintenance of the U-RAS Flexible V2, interfacing between the U-RAS Flexible V2 and ACR, 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 U-RAS Flexible V2 sends signals to an MS, the DMB performs the OFDMA signal processing on the traffic signals received from the ACR, 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 U-RAS Flexible V2 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.

Main Functions

- Creation and distribution of the reference clock
- Fast Ethernet/Gigabit Ethernet interface with ACR
- 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:

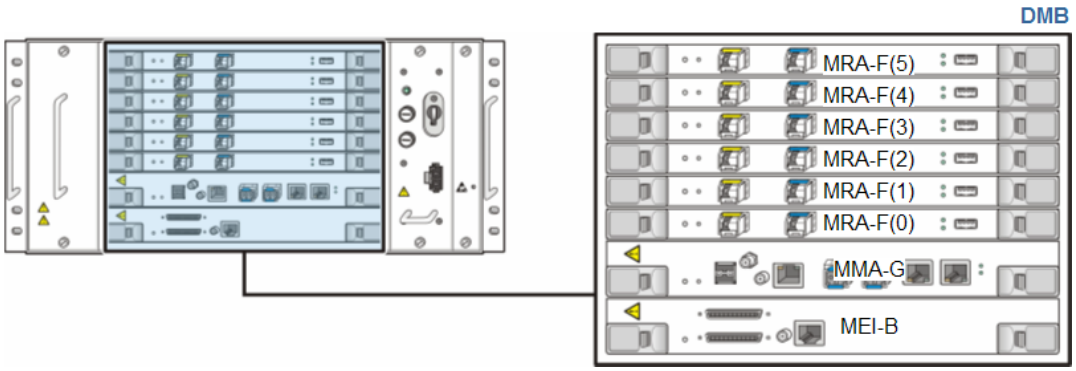


Figure 3.5 DMB Configuration

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 – Non-volatile memory support

Board Name	Quantity (Sheet)	Function
MRA-F	Max. 6	Mobile WiMAX base station RAS board Assembly-Flexible – 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
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 U-RAS Flexible V2, 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 U-RAS Flexible V2 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, Ethernet switch function in the U-RAS Flexible V2, system operation and maintenance and TDD signal control.
  The MMA-G manages the status of all hardware and software in the U-RAS Flexible V2 and reports each status information to WSM via ACR. In addition, the MMA-G allocates and manages the resources of the U-RAS Flexible V2 and the connection of the MMA-G and a PC for the Web-EMT enables to maintain the U-RAS Flexible V2 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 U-RAS Flexible V2 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 U-RAS Flexible V2 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 as provided in the existing system.
- Network Interface Function
  The MMA-G interfaces with an ACR 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: Four 100/1000Base-T Copper ports
– MMA-GM: Two 100/1000Base-T ports and two 1000Base-X Small Form factor Pluggable (SFP) ports

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

The MRA-F provides a modem function of the U-RAS Flexible V2 and interfacing with the RRH.

- 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 External Interface board assembly-Basic (MEI-B)

The MEI-B provides paths for alarm information that is generated from external devices (additional equipment provided by the operator).
The MEI-B also collects alarms for the fan mounted on the DU to report to the MMA-G.

3.1.2 RRH

The RRH is a remote RF device that supports Mobile WiMAX services.
It is installed at a remote location from the DU. It performs the function that connects mobile WiMAX calls to an MS, as defined in the 802.16d/e standard.

Main Functions

Below are the major functions of the RRH.

- High-power amplification of RF transmission signal
- Interfaces optically with the MRA-F 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
- Remote Electrical Tilting (RET) function(option)


NOTE

RET

The RET is an optional function that the service provider can select. Refer to 'RET'.

RRH-B4 Description

The RRH-B4 is a RF module of the U-RAS Flexible V2, and supports 4Tx/4Rx RF paths.

Category	EA	Capacity	RF Path	Antenna Output
RRH-B4	Max. 3	4Carrier/1Sector (2Carrier within 40 MHz + 2Carrier within 40 MHr)	MIMO (2Tx/2Rx Split)	5 W+5W/Carrier 10 W+10W/Carrier @Power Boosting at antenna ports each

The RRH-B4 is an RRH-B4 that integrates the transceiver, power amplifier, TDD switch, and filters in a single module.
In the case of downlink signals, the RRH-B4 converts baseband signals received through the 'Digital I/Q and C & M' interface from the MRA-F 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-B4 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 MRA-F.
RRH-B4 has 4Tx/4Rx transmit and receive paths and can be operated in Split Mode divided by the 2Tx/2Rx. In Split Mode, multiple carriers in the same transmission path must be within the 40MHz bandwidth on the frequency. But carriers in the different 2Tx/2Rx has no restriction for configuring operating frequency.

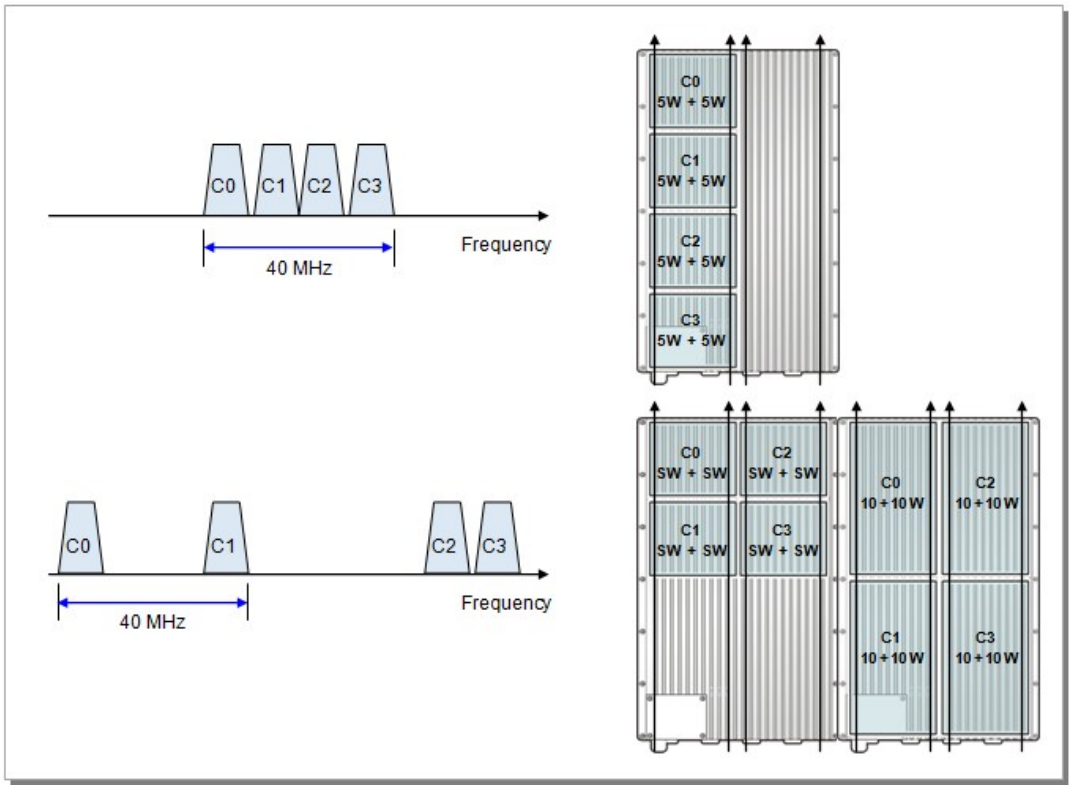


Figure 3.6 2T2R Split Mode of RRH-B4

Network Configuration Using the RRH-B4

The RRH-B4 cannot operate on its own, but operates by being linked to the DU. The RRH-B4 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.

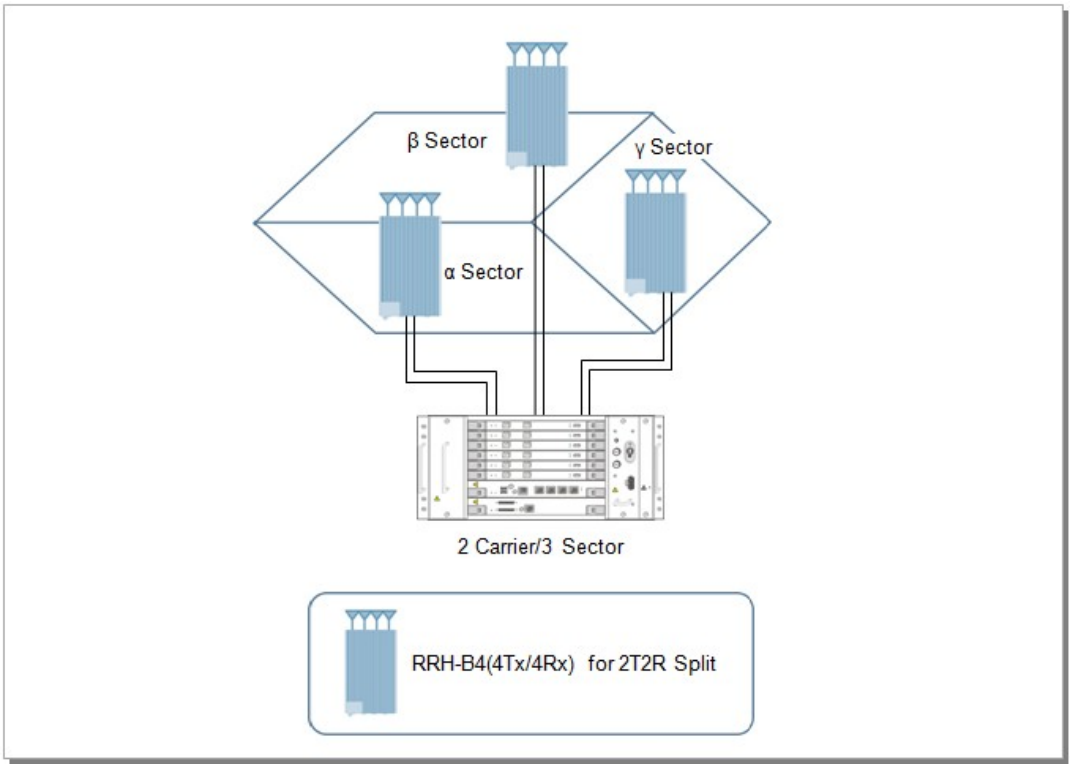


Figure 3.7 Sector Configuration Example Using RRH-B4

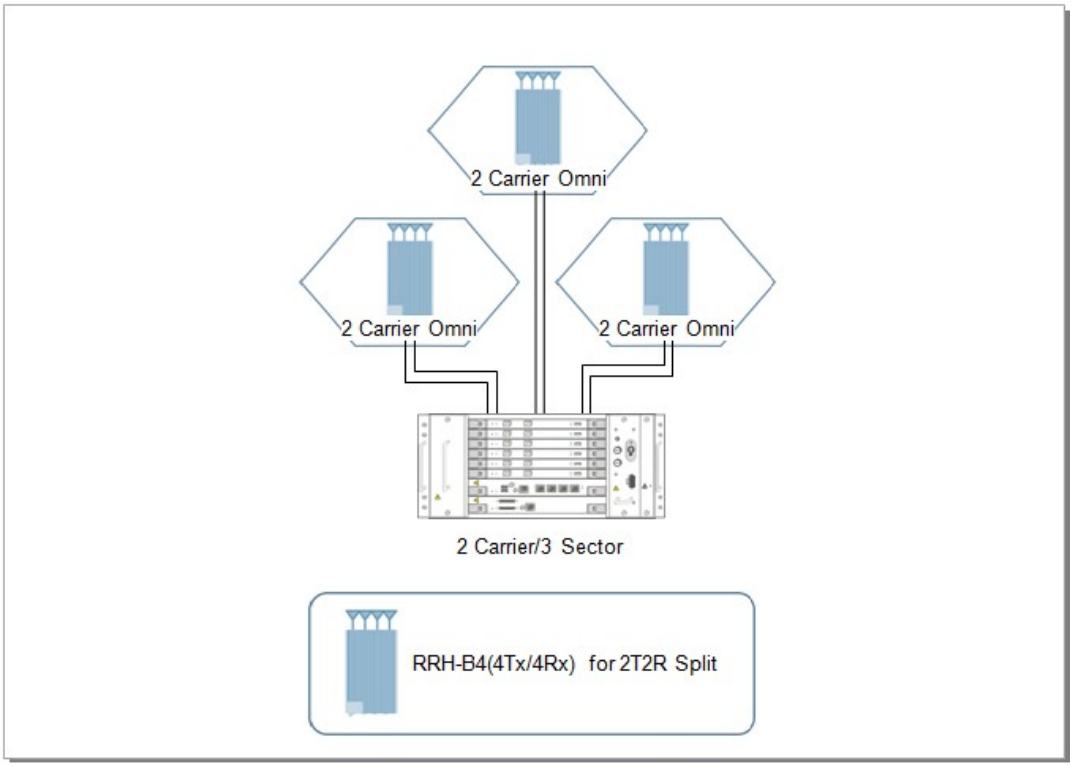


Figure 3.8 Omni Configuration Example Using RRH-B4

NOTE

Conditions for Omni Configuration Using RRH-B4

– Multiple cells connected to a single DU must belong to a single paging group.
– Omni cells must be independent, and not be adjacent to each other.

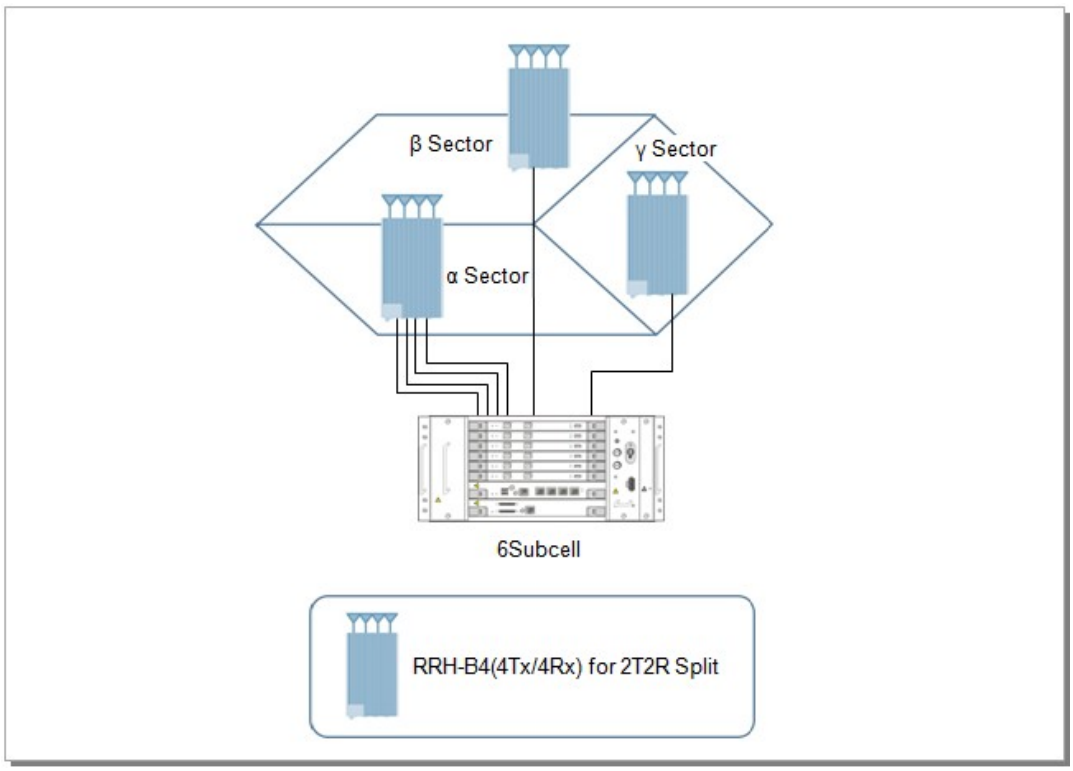


Figure 3.9 6 Subcell Configuration Example Using RRH-B4

NOTE

Conditions for 2T2R Split Mode

Up to four WiMAX can be operated by one RRH-B4.

3.1.3 DPM-FI

The DPM-FI is mounted to the right of the U-RAS Flexible V2 DMB.

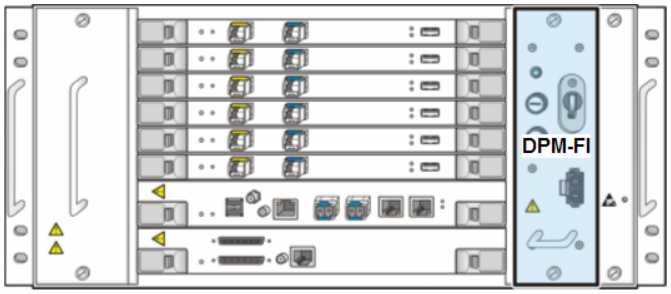


Figure 3.10 DPM-FI Configuration

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 U-RAS Flexible V2 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.

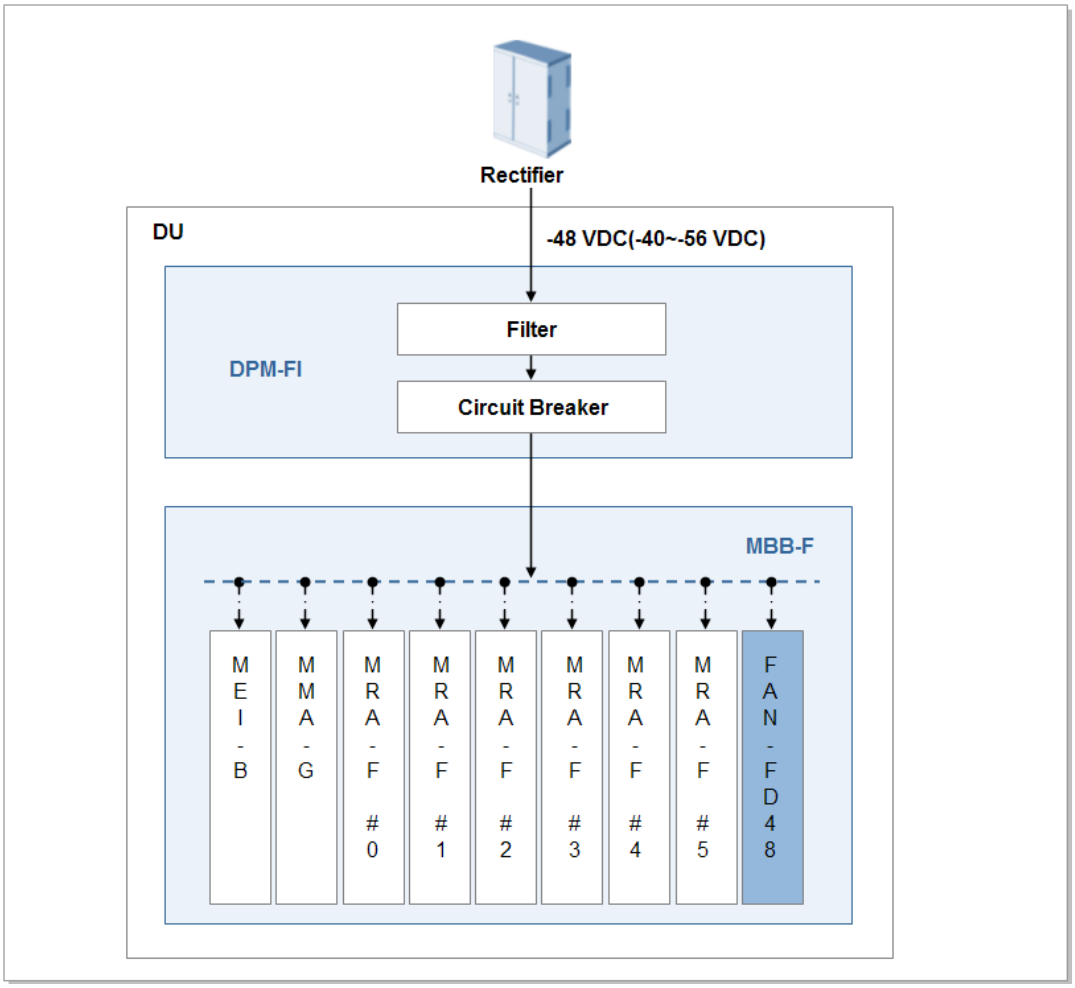


Figure 3.11 Power Structure of U-RAS Flexible V2

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 U-RAS Flexible V2 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.

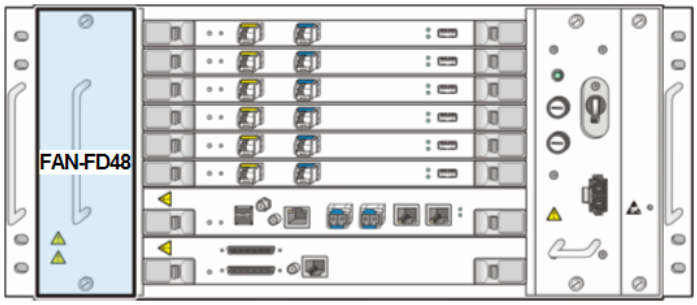


Figure 3.12 Fan Configuration

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 U-RAS Flexible V2 is as follows.

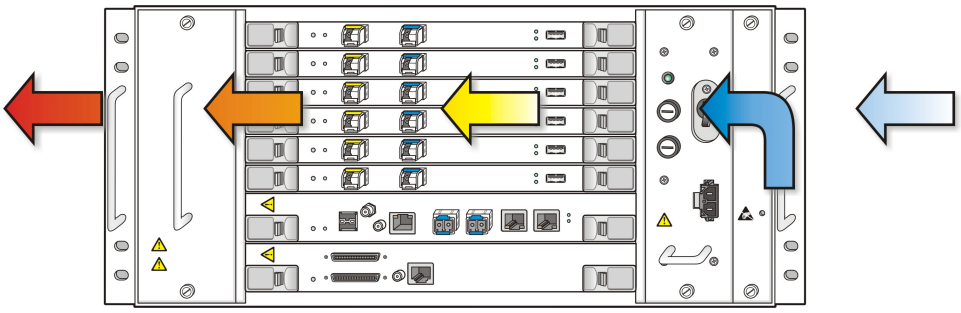


Figure 3.13 Cooling Structure of the DU

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

RRH

The RRH of the U-RAS Flexible V2 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 U-RAS Flexible V2 interfaces is as shown in the figure below:

MIMO Support

The U-RAS Flexible V2 supports MIMO and provides the administrator with the following external interface.

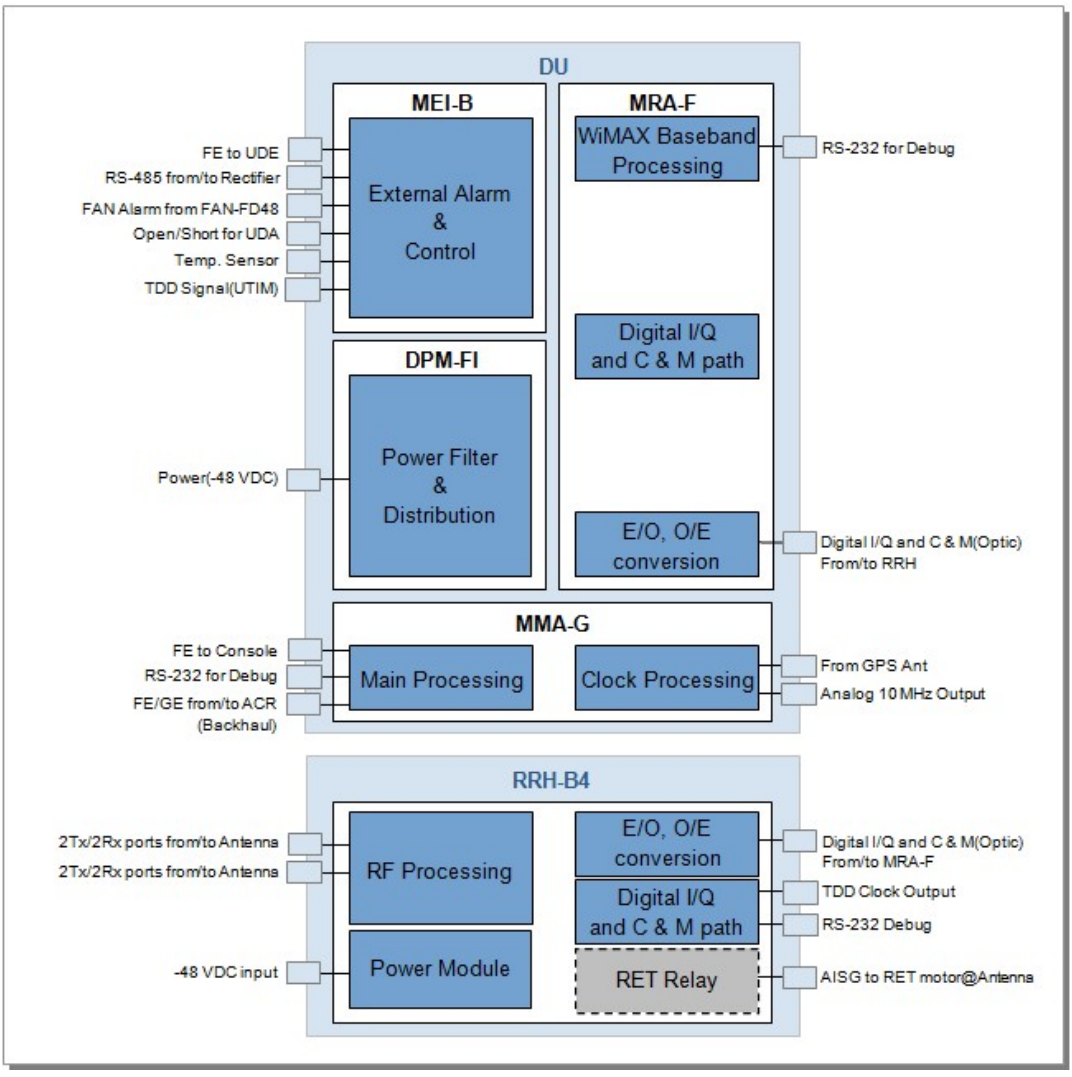


Figure 3.14 External Interfaces of U-RAS Flexible V2 (MIMO)

- External Interfaces of DU

Category	Interface Type	Port No.	Connector Type
Backhaul	Simultaneous operation of 1000Base-X and 100/1000Base-TX	2	1000 Base-X: SFP(LC)
		2	100/1000 Base-Tx: RJ-45
	100/1000 Base-TX	4	RJ-45
UDE	10/100 Base-Tx	1	RJ-45
GPS Antenna	Analog RF	1	SMA
UDA	Open/Short	1	68Pin Champ Connector
Power	DC power (-48 VDC)	1	Molex 42816-0212

Category	Interface Type	Port No.	Connector Type
Rectifier Interface	RS-485	1	RJ-45
Analog 10MHz	Analog 10MHz (RF)	1	SMA
RRH Interface	Digital I/Q and C & M	Max. 6	SFP(Single mode)
Console	100 Base-Tx	1	RJ-45
MMA-G Debug	RS-232	2	USB
MRA-F Debug	RS-232	1	USB
TDD	TDD clock	1	SMA

- External Interface of RRH-B4

Category	Interface Type	Port No.	Connector Type
Antenna Interface	Analog RF(Main Traffic)	4	DIN (female)
DU interface	Digital I/Q and C & M	8	SFP(single mode;LC)
Power	DC power(-48 VDC)	1	Grand type (2C,O-Ring LUG)
RET	AISG 2.0 (Power/Control)	1	SU-20SP-8P
Debug window	TDD signal output	1	MCX
	Debug	1	USB

3.2 Software Structure

3.2.1 Software Basic Structure

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) block for the call processing and the OAM block for operation and maintenance of the system.

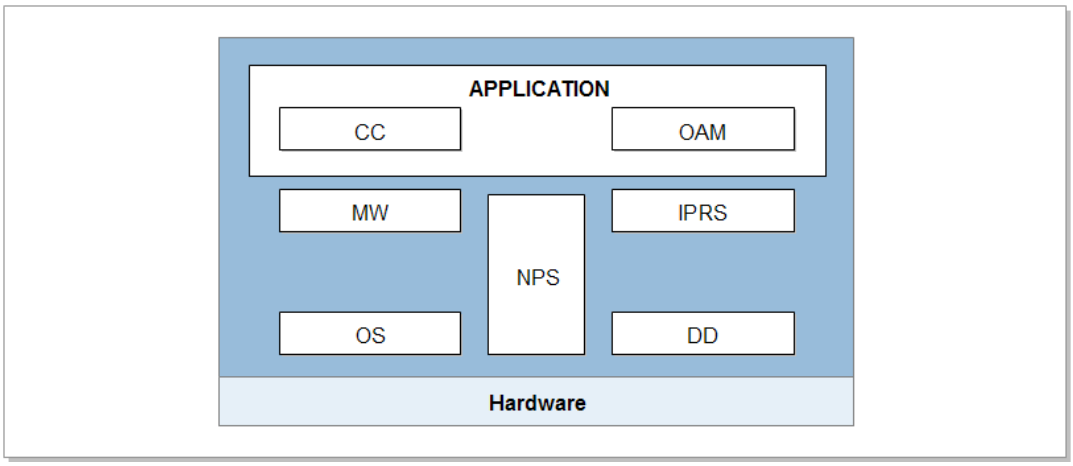


Figure 3.15 Software Structure of System

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 manages the normal operation of applications that OS does not control in the system. 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)

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.

Operation And Maintenance (OAM)

The OAM provides the interface (SNMPv2c, FTP, 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.

3.2.2 CC Block

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:

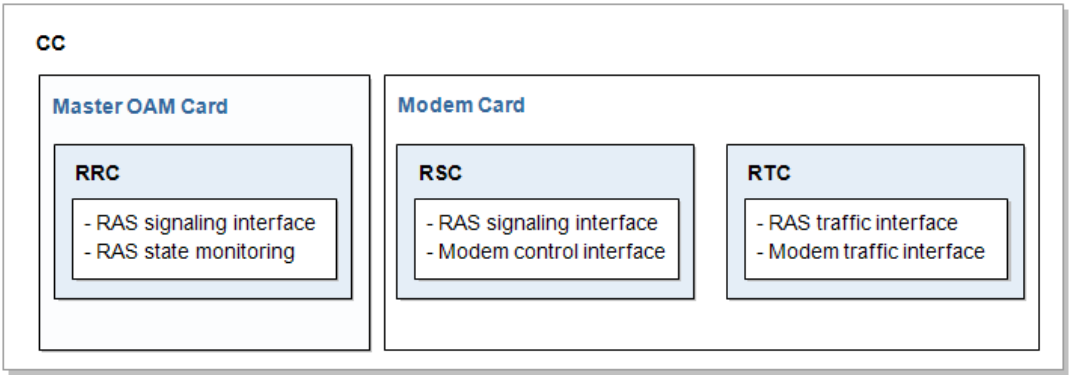


Figure 3.16 CC Block Structure

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. 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.

3.2.3 OAM Block

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

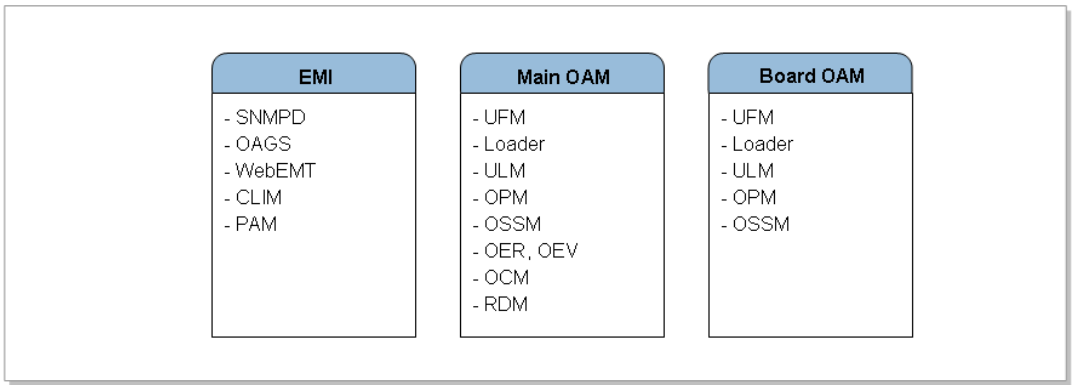


Figure 3.17 OAM Software Structure

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

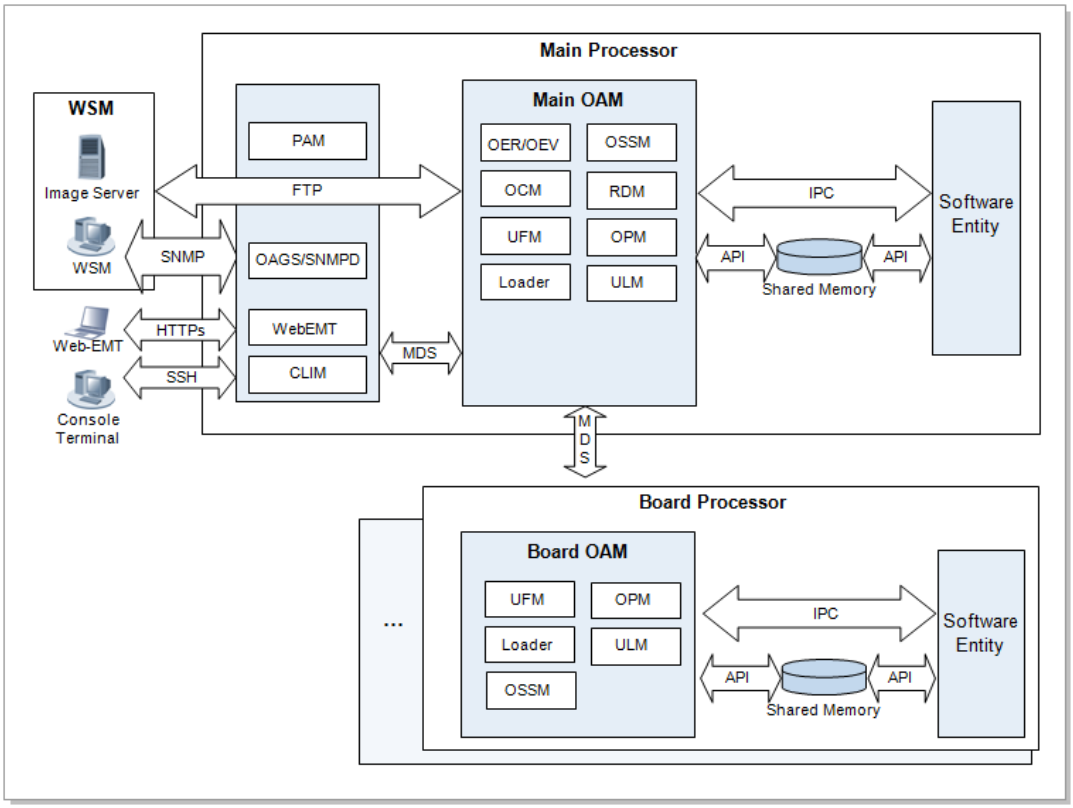


Figure 3.18 Interface between OAM Blocks

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) 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.

OAGS

Common SNMP Agent Subagent (OAGS) plays the SNMP subagent role to support the standard SNMP.
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.

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.

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.

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 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
  Management and saving the failure history and periodically saving the failure information to the own no-volatile storage
- 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.
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 via the own non-volatile storage
    - Loading via the console port (at this time, omitting the registration of the system to the RS)
    - Loading via the remote IS
    - Loading as the latest version via the version comparison
- 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.

Loader is implemented on MMA and all lower boards.

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 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.
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 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 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.

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.
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, sector, the auxiliary devices in the system

OCM is implemented on the MMA.

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.
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 and measurement the loss, delay and delay variance of external path(ping-based)
  - Traffic path test: Test for the UDP message-based bearer path between ACR and the system

  - Signal path test: Test for the UDP message-based signaling path between ACR and the system

- Software Block Test
  Ping test for main programs by processors
- RF Exchange Test
  Tx path, Receive Signal Strength Indicator-based (RSSI-based) Rx path 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

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.

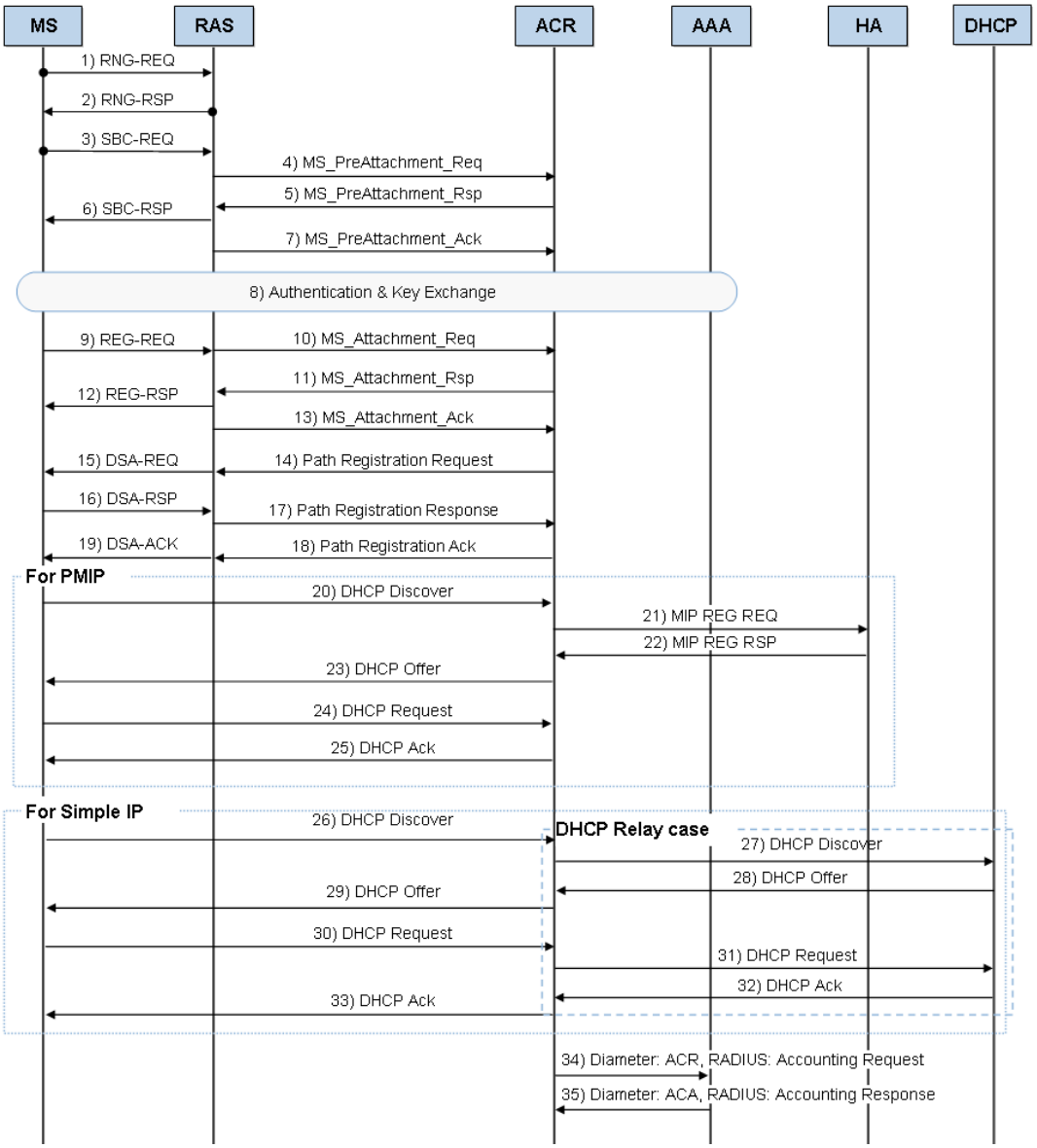

Figure 4.1 Initial Entry Procedure

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.

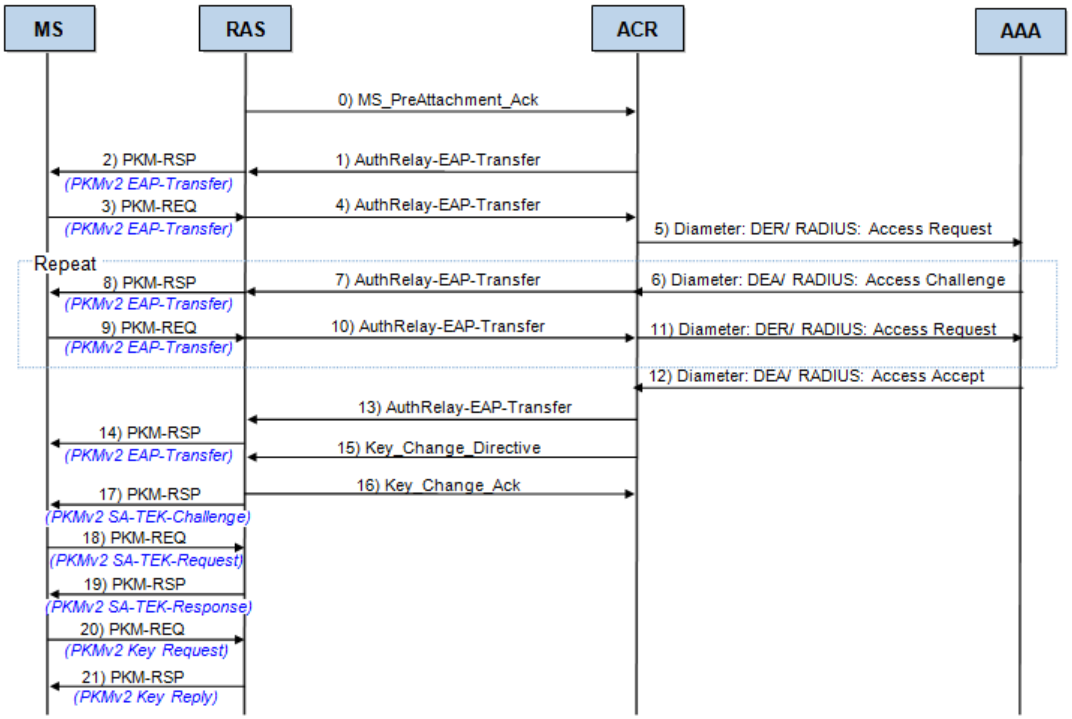

Figure 4.2 Authentication Procedure (During Initial Entry)

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.

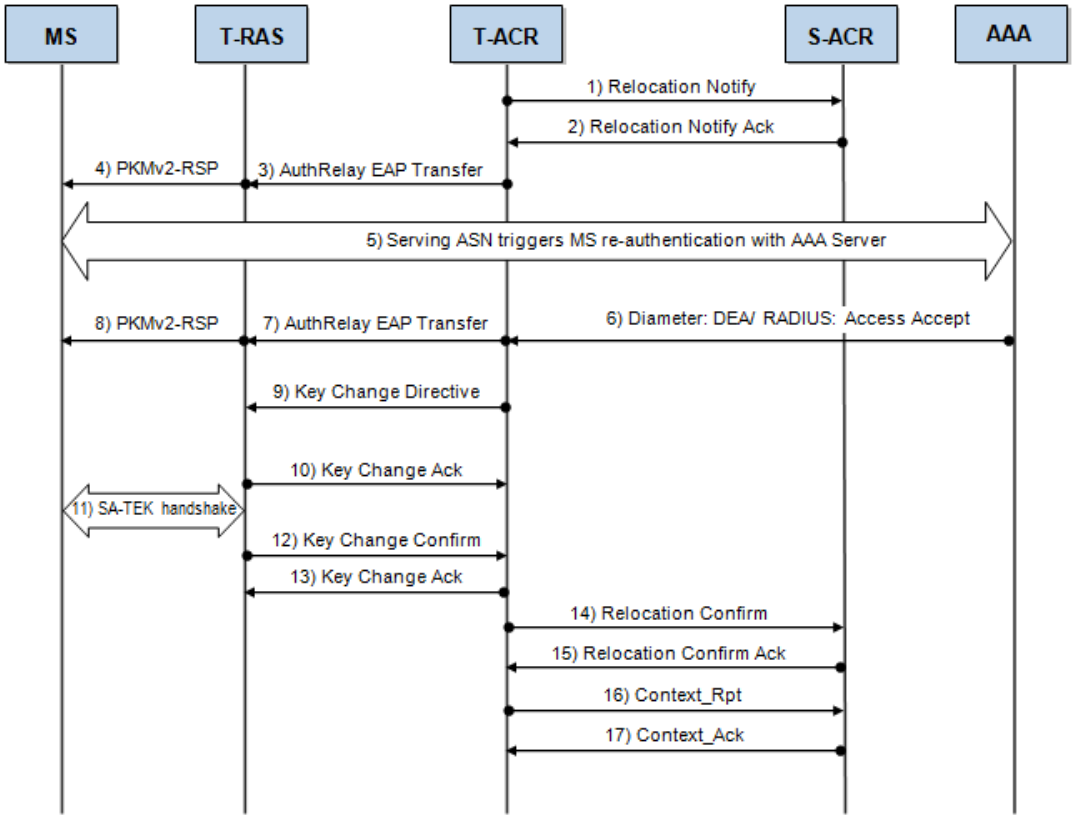

Figure 4.3 Authentication Procedure (During Authenticator Relocation)

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.

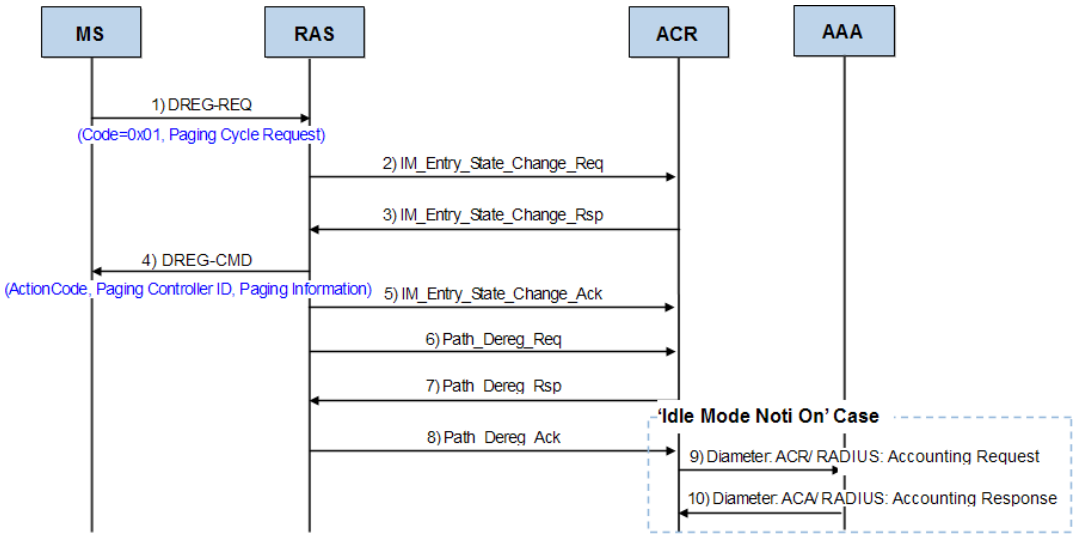

Figure 4.4 Awake Mode → Idle Mode State Transition Procedure (MS-Initiated)

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.

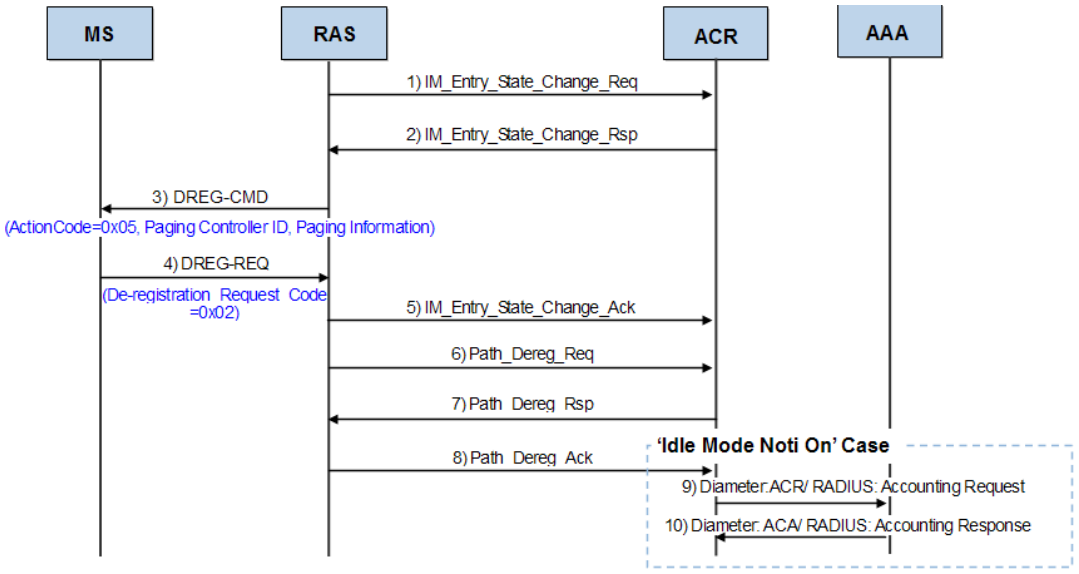

Figure 4.5 Awake Mode → Idle Mode State Transition Procedure (Network-Initiated)

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_Request_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.

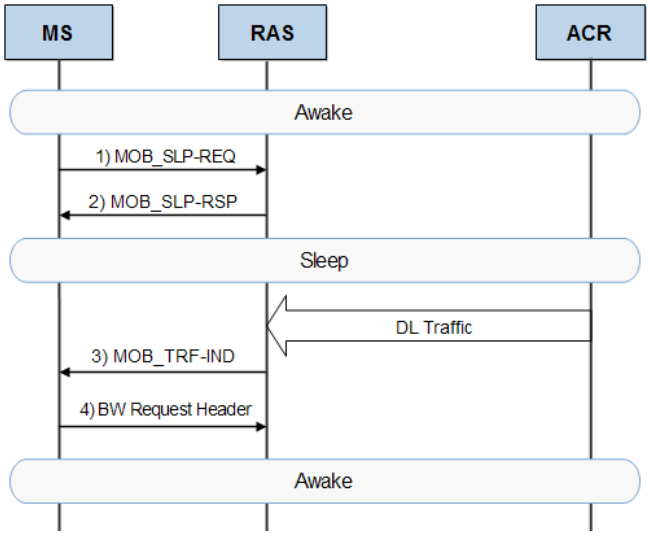

Figure 4.6 Awake Mode → Sleep Mode State Transition Procedure

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.

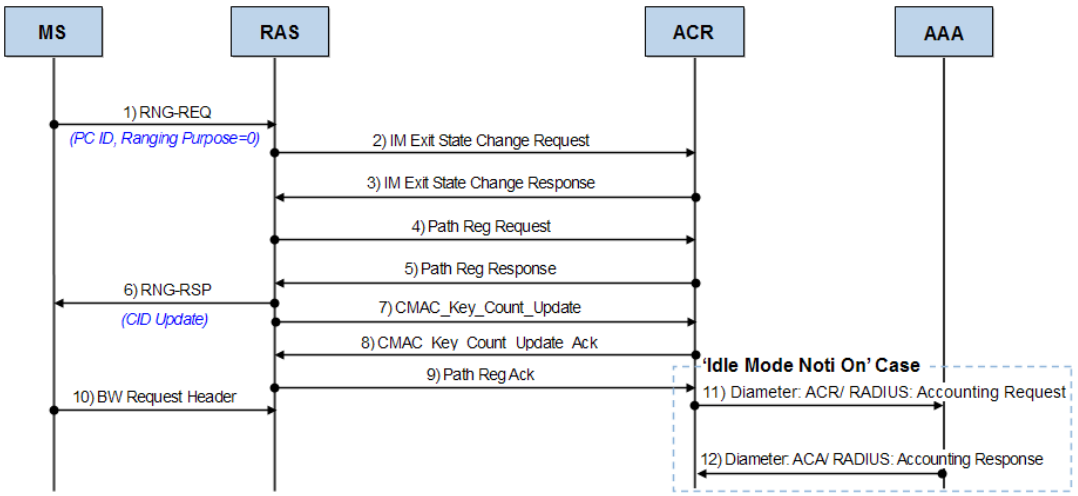

Figure 4.7 Idle Mode → Awake Mode State Transition Procedure (QCS)

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.

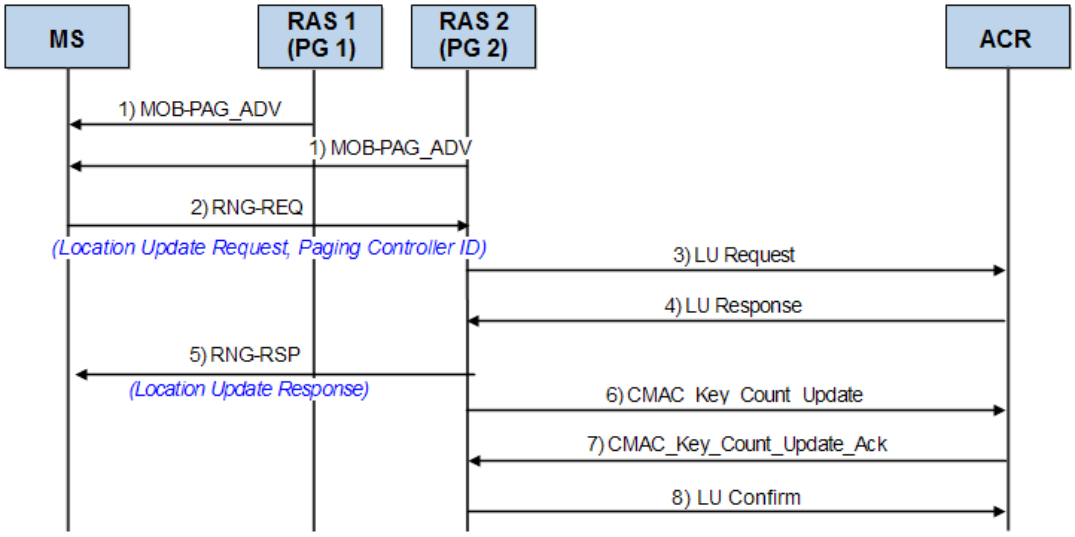

Figure 4.8 Inter-RAS Location Update Procedure

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.

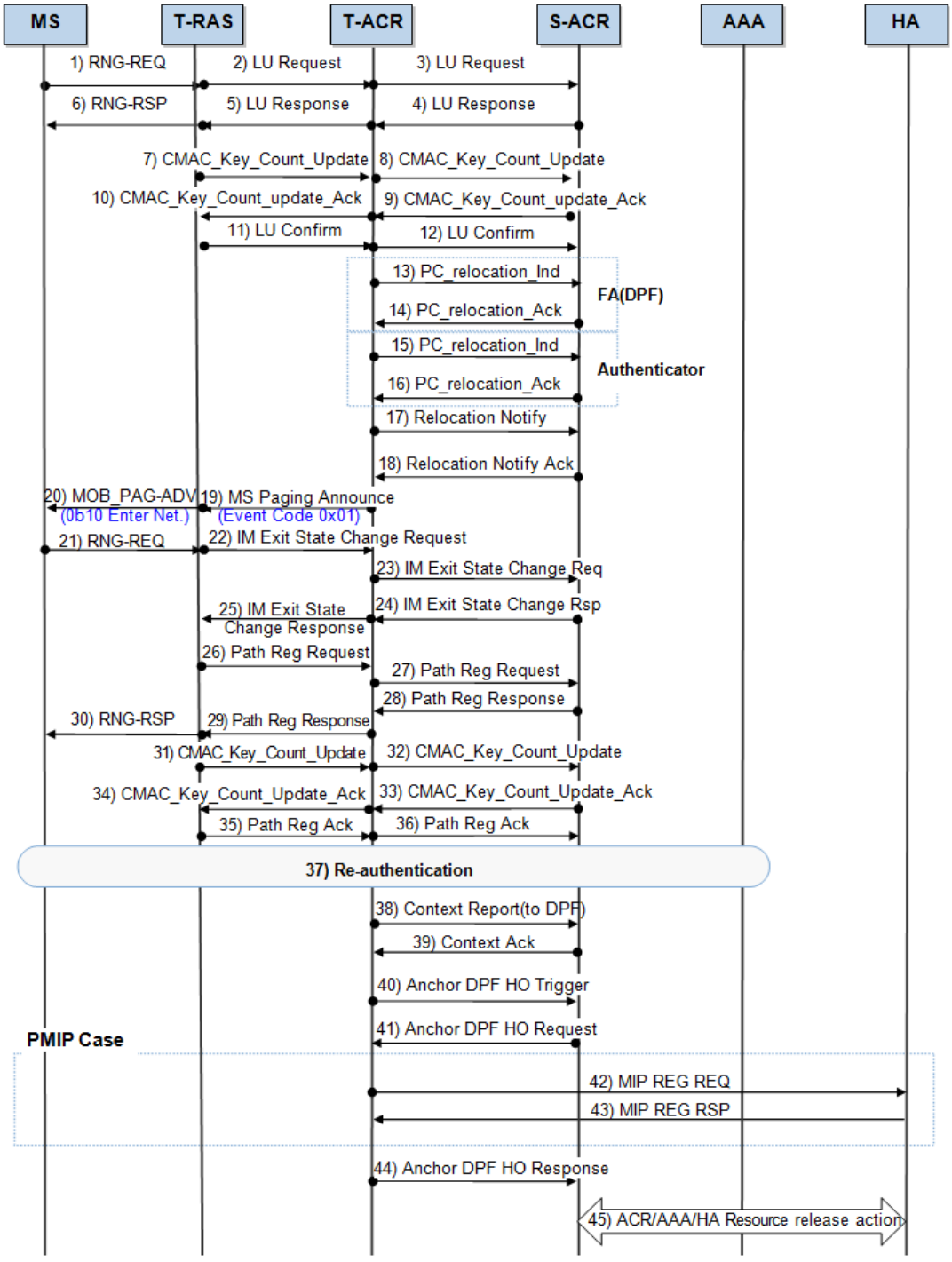

Figure 4.9 Inter-ACR Location Update Procedure (PMIP)

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

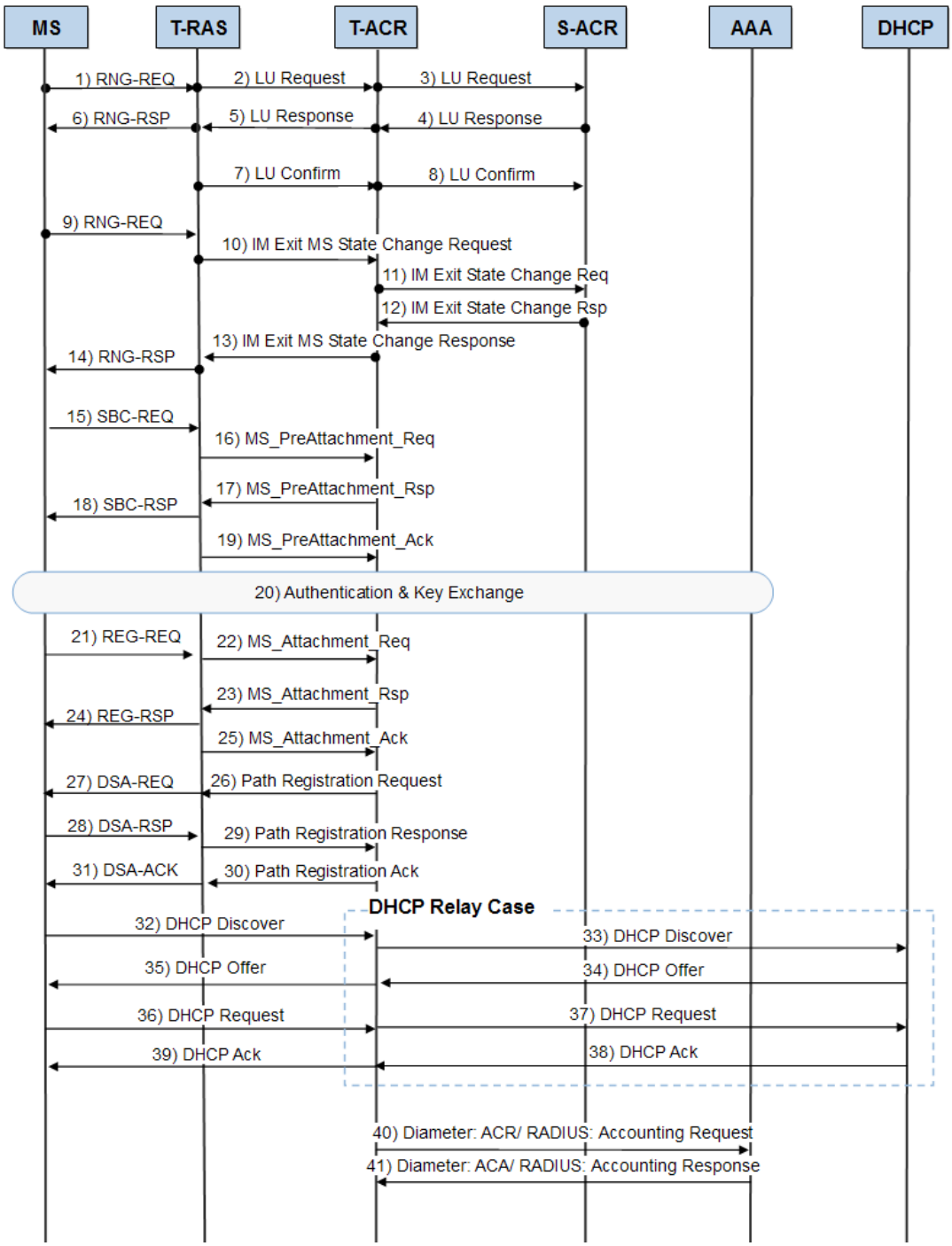

Figure 4.10 Inter-ACR Location Update Procedure (Simple IP)

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.

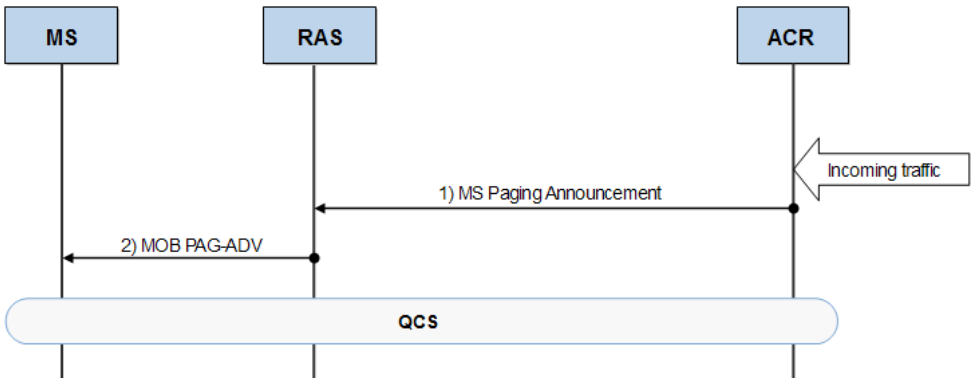

Figure 4.11 Paging Procedure

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.

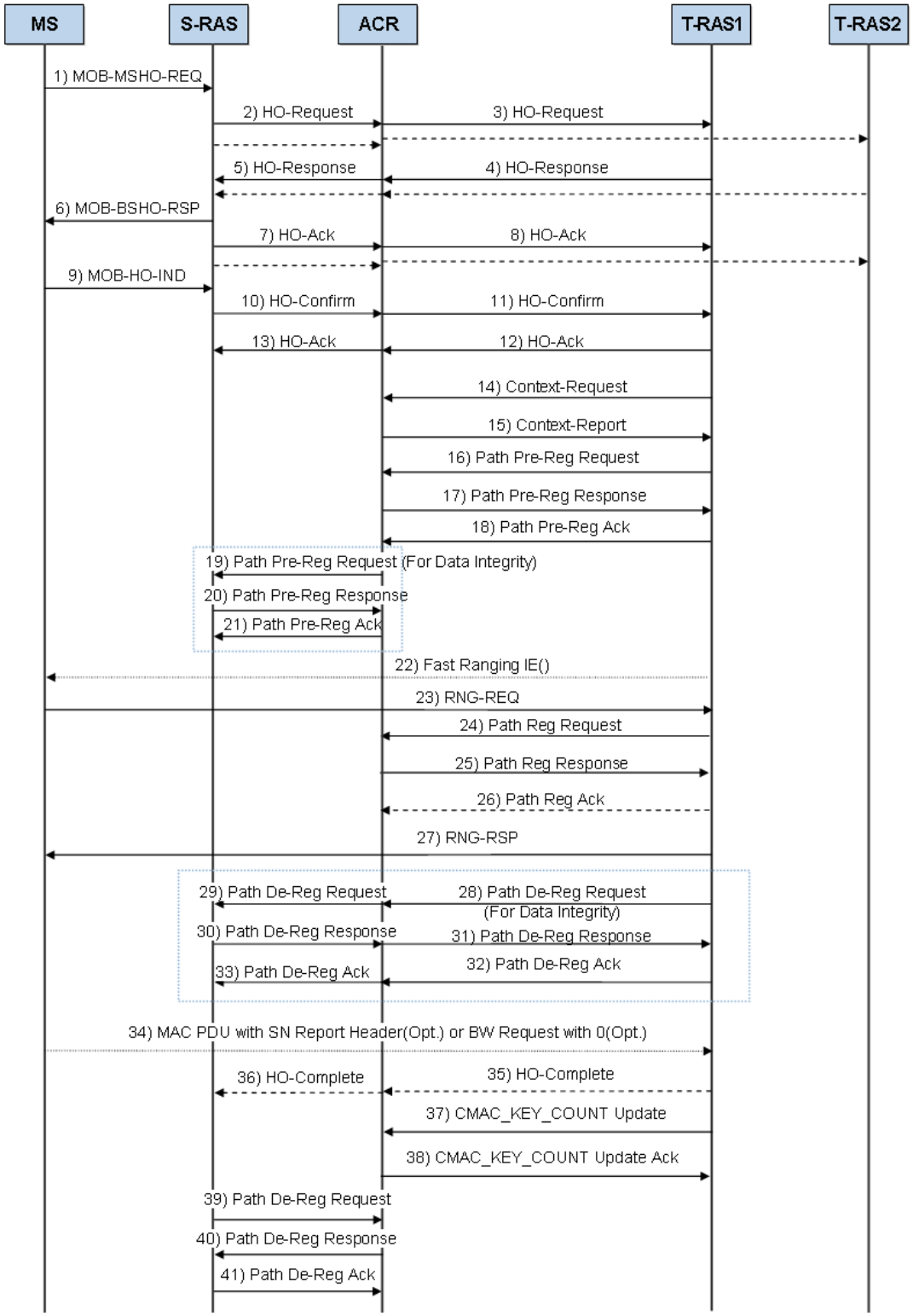

Figure 4.12 Inter-RAS Handover Procedure

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.

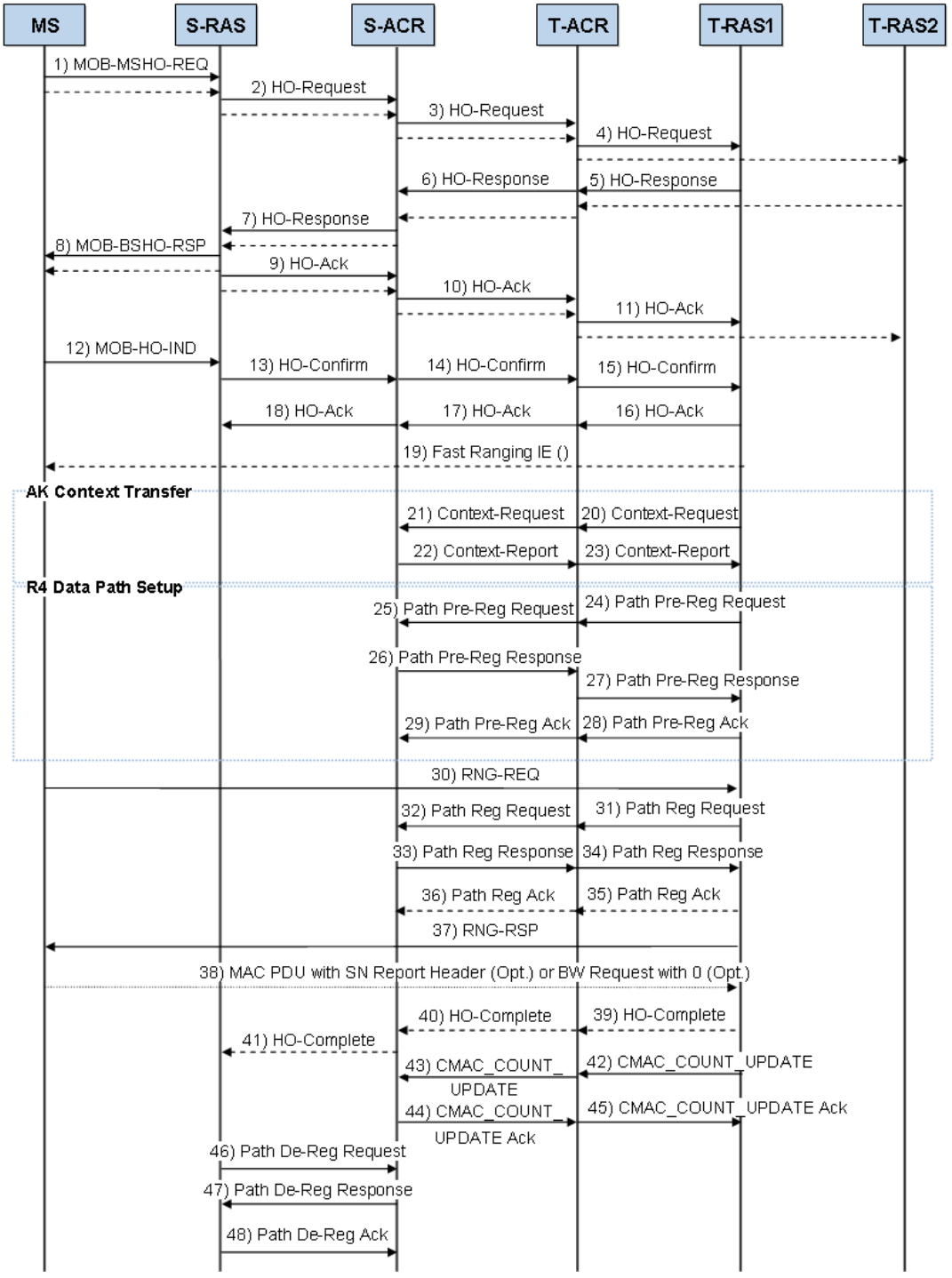

Figure 4.13 Inter-ASN Handover (ASN-Anchored Mobility)

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.

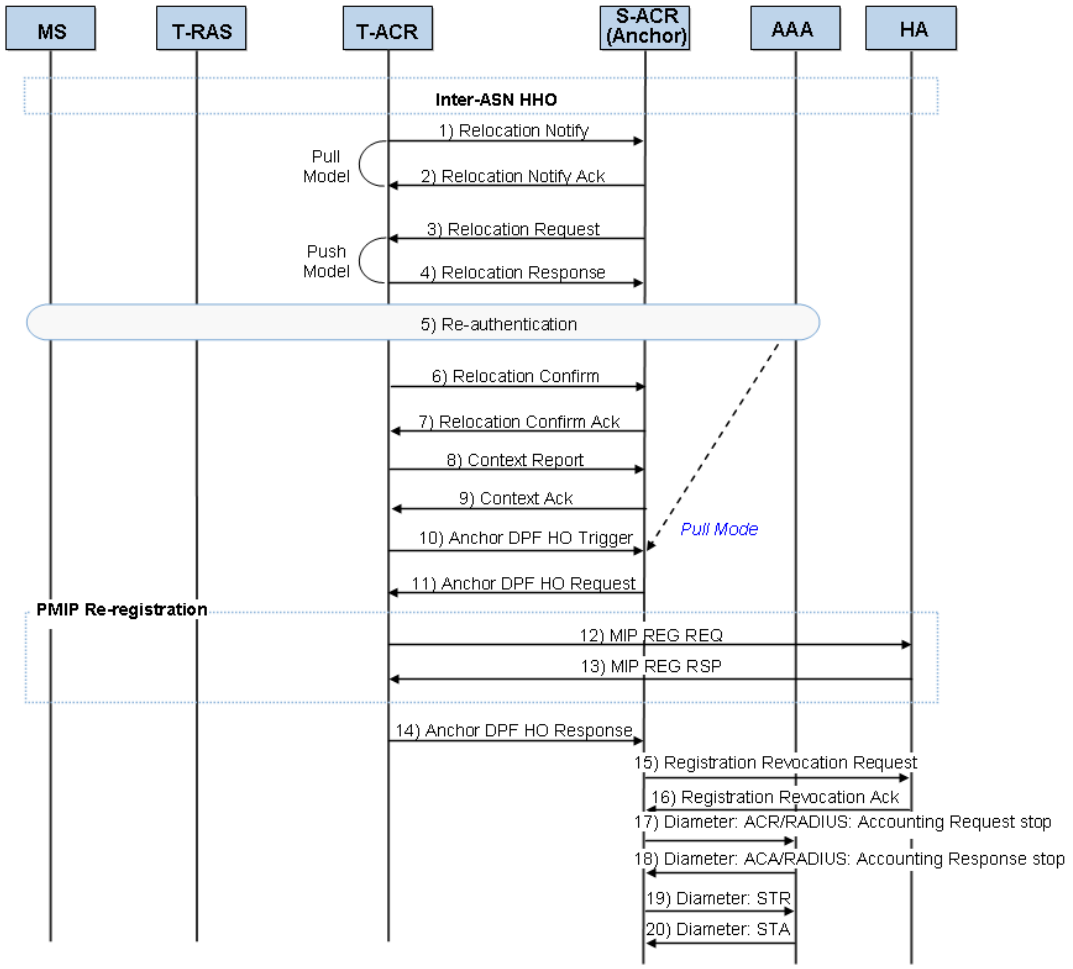

Figure 4.14 Inter-ASN Handover (CSN-Anchored Mobility)

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.

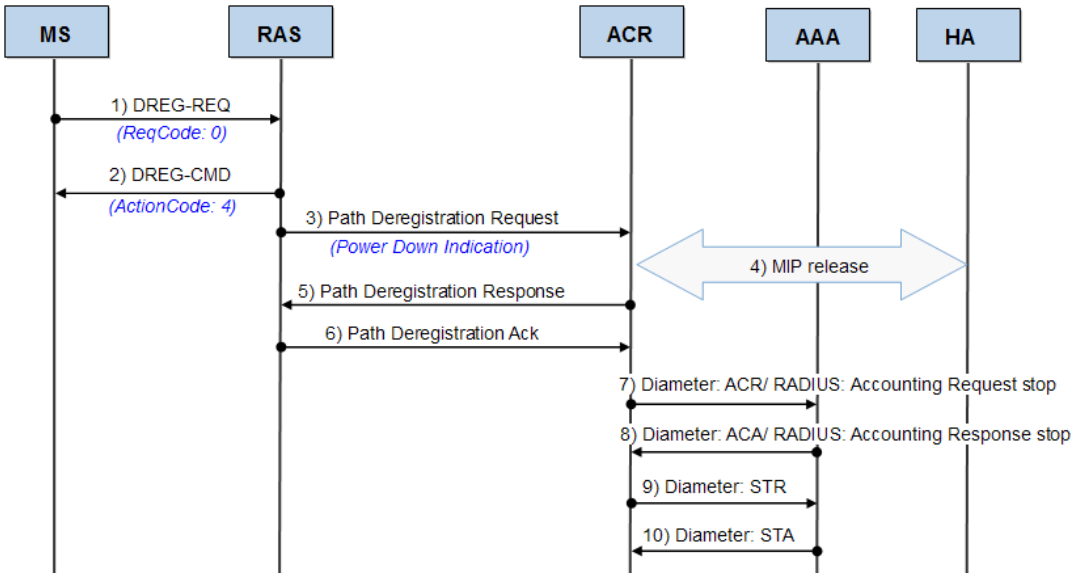

Figure 4.15 Disconnection (Awake Mode)

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.

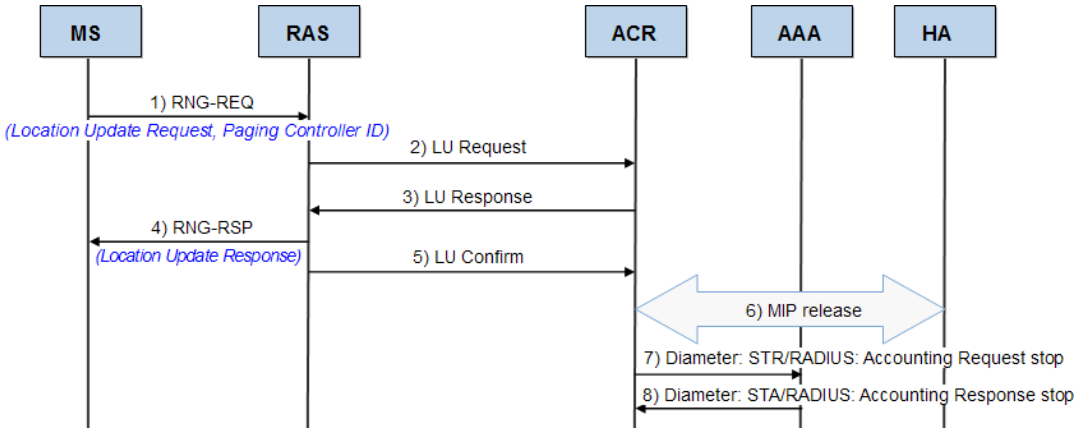

Figure 4.16 Disconnection (Idle Mode)

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 Network Synchronization Message Flow

The U-RAS Flexible V2 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 U-RAS Flexible V2.

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.

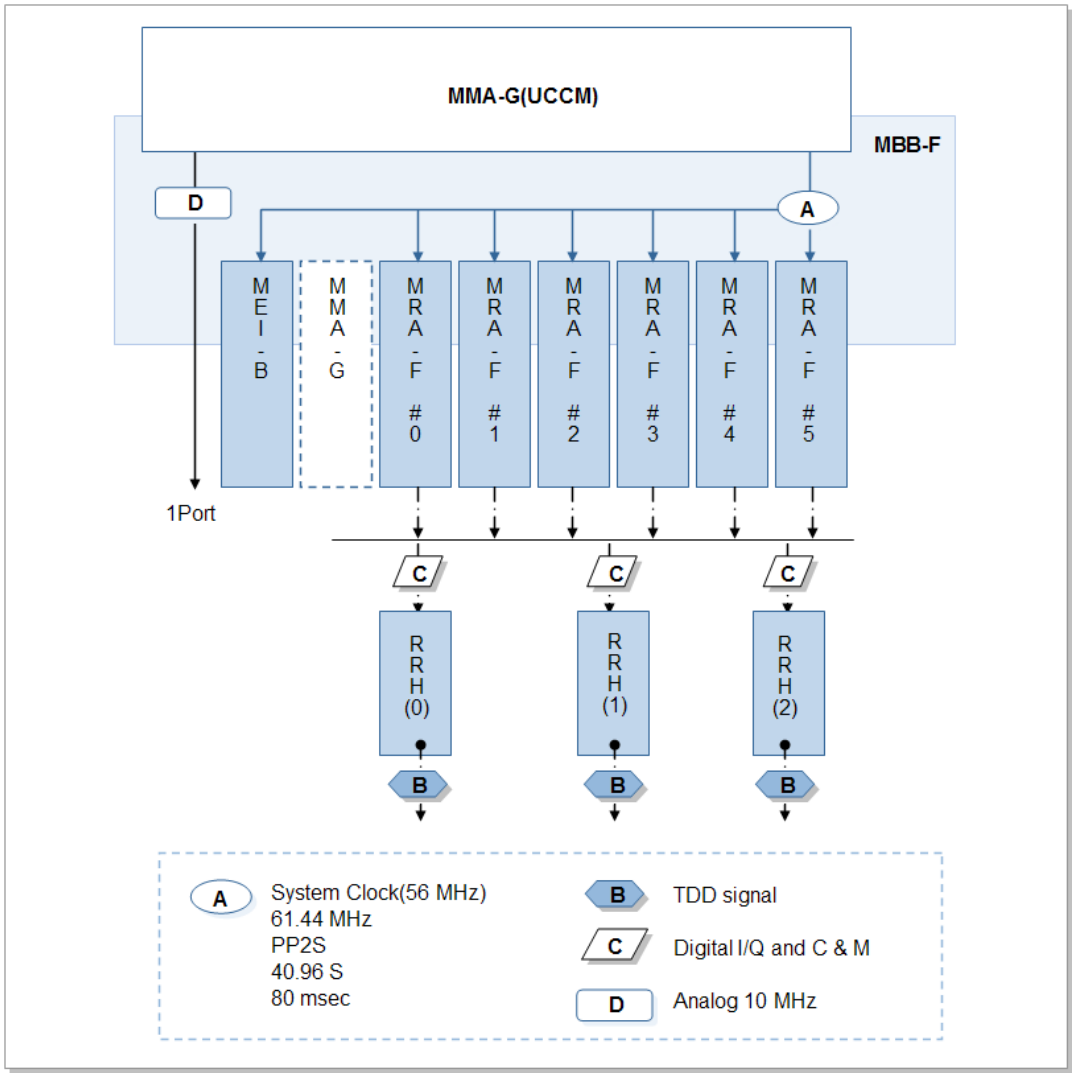

Figure 4.17 Network Synchronization Flow of U-RAS Flexible V2

4.3 Alarm Signal Flow

The detection of failures in the U-RAS Flexible V2 can be implemented by hardware interrupt or software polling method. The failures generated in the U-RAS Flexible V2 are reported to the management system via the SNMP trap message.

Failure Alarm Types

- System Failure Alarms
  NTP Update Error, 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, etc.
- UDA
  Support of 24 alarms(input) and 6 control(output)

Failure Report Message Flow

The main OAM (UFM) collects the failures detected from each board and UDA interface of the U-RAS Flexible V2 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:

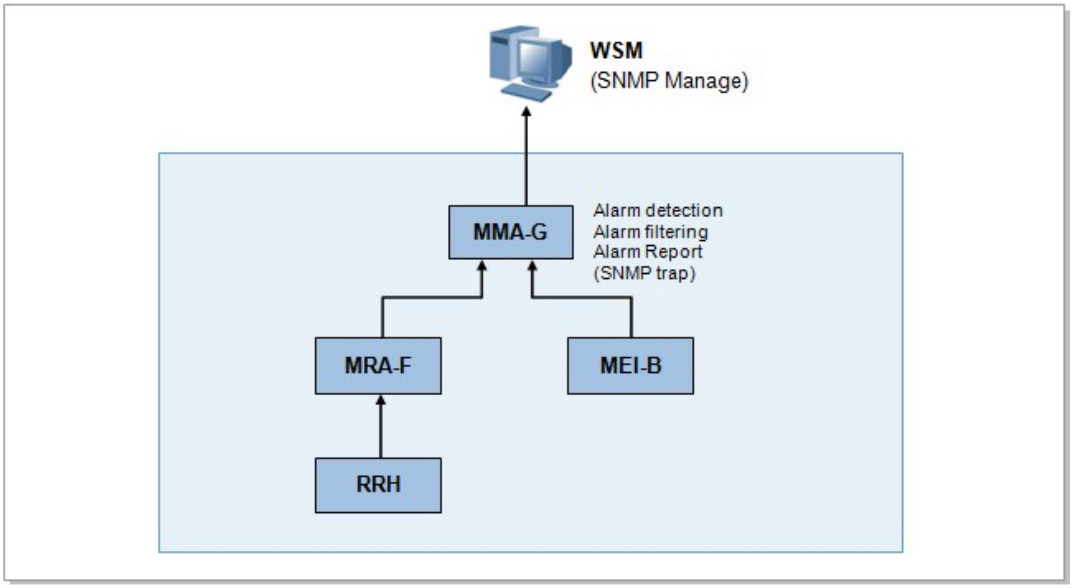

Figure 4.18 Alarm Signal Flow of U-RAS Flexible V2

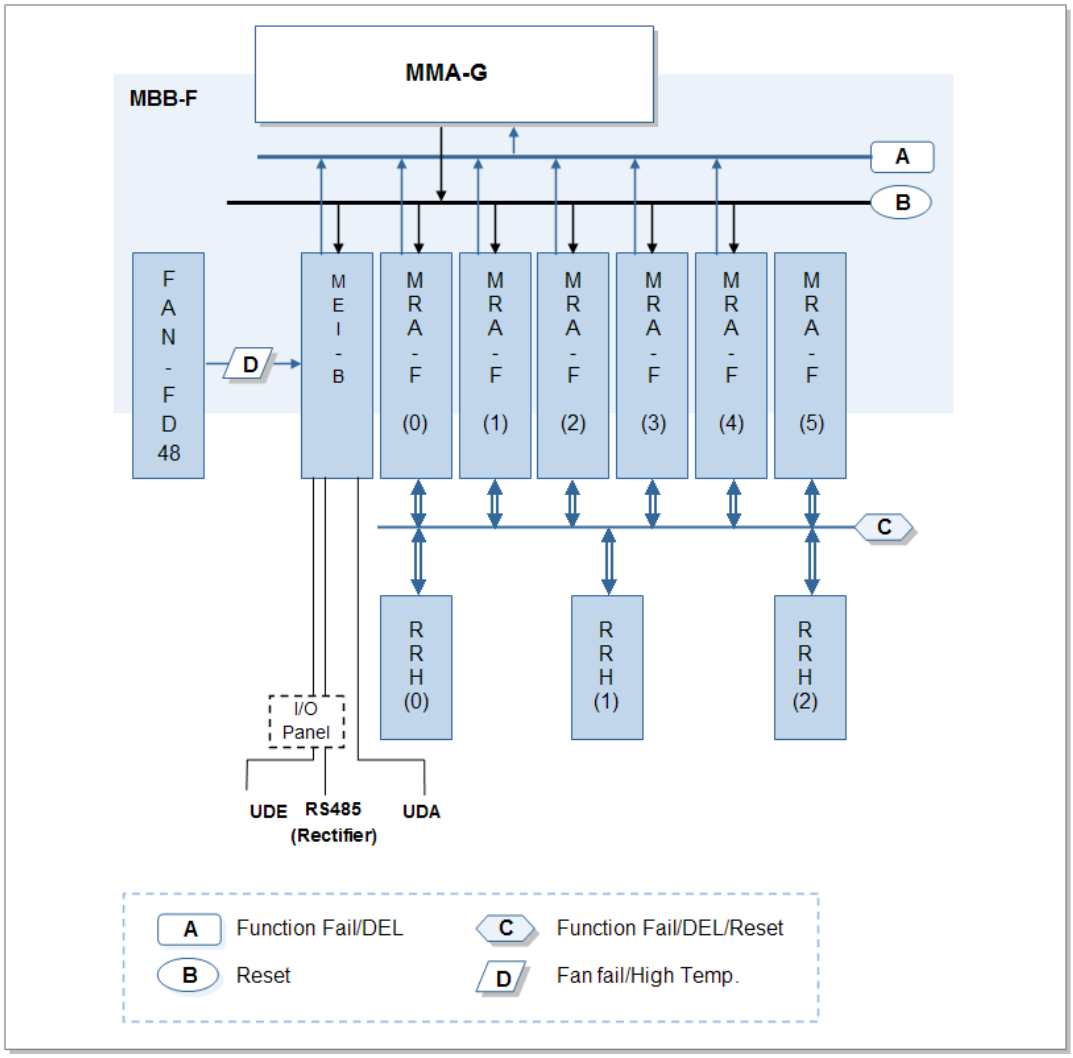

Figure 4.19 Alarm and Control Structure of U-RAS Flexible V2

4.4 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 U-RAS Flexible V2. Loading the U-RAS Flexible V2 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 U-RAS Flexible V2 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 U-RAS Flexible V2 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 U-RAS Flexible V2 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 U-RAS Flexible V2, 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, U-RAS Flexible V2 acquires automatically L3 information such as IP address, subnet mask and gateway IP address for communication by using DHCP. U-RAS Flexible V2 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 U-RAS Flexible V2 performs loading by using the FTP 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 U-RAS Flexible V2 can be checked in the upper management system.
The loading message flow is as the following figure:

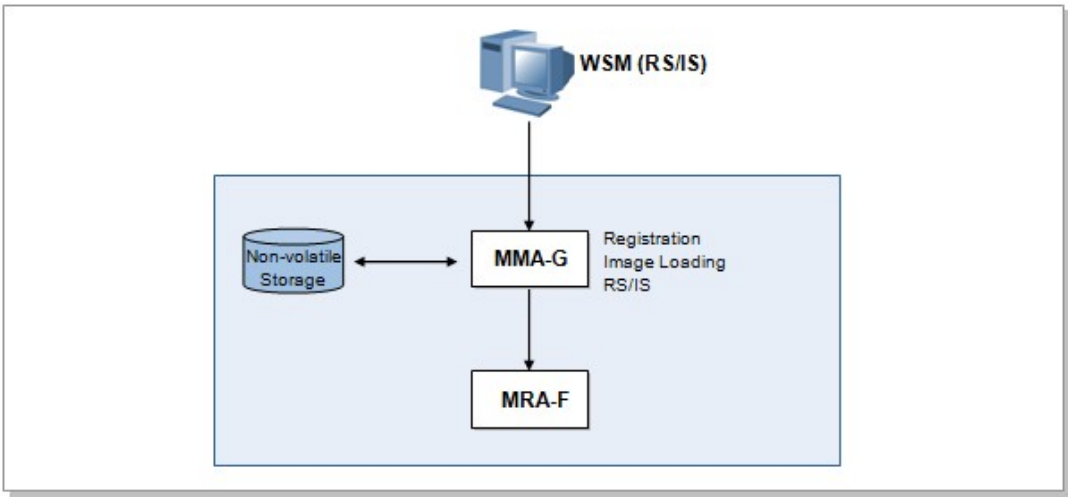

Figure 4.20 Loading Message Flow

4.5 Operation and Maintenance Message Flow

An operator can check and change the status of the U-RAS Flexible V2 by means of the management system. To this end, the U-RAS Flexible V2 provides the SNMP agent function. The function enables the WSM operator to perform the operation and maintenance function of the U-RAS Flexible V2 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 U-RAS Flexible V2 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 U-RAS Flexible V2 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 U-RAS Flexible V2 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:

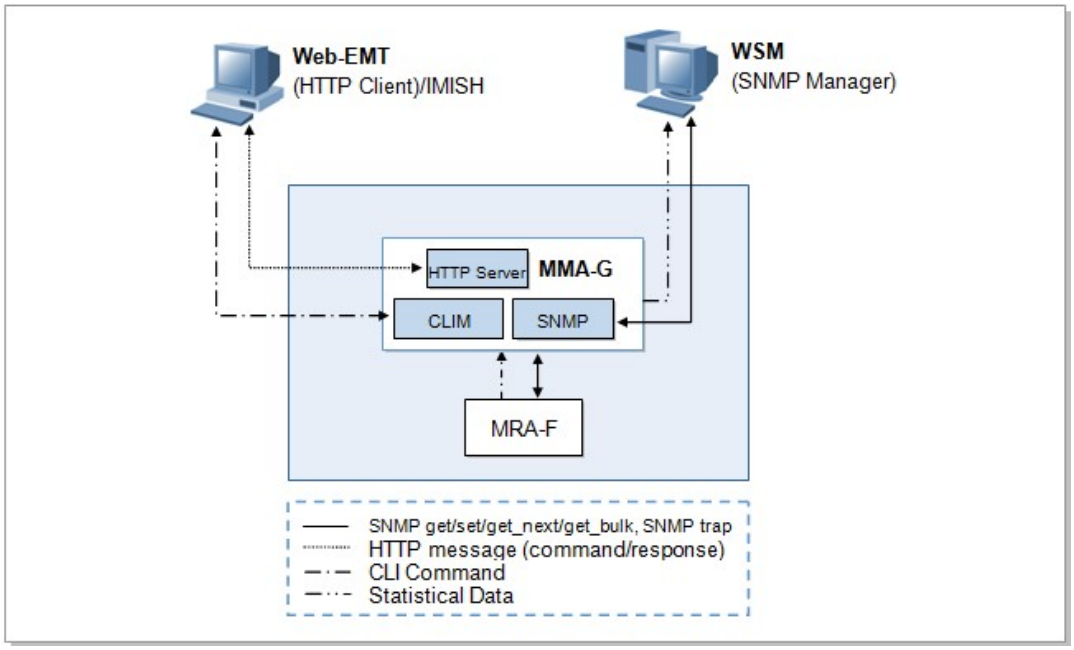

Figure 4.21 Operation and Maintenance Signal Flow

CHAPTER 5. Additional Functions and Tools

5.1 RET

The U-RAS Flexible V2 can support the RET function by connecting an antenna with an AISG 2.0 interface and an RRH-B4 with an AISG 2.0 interface.
To provide the RET function, the U-RAS Flexible V2 sends and receives control messages to and from the WSM through the RET controller within the RRH-B4 (AISG2.0 interface), MRA-F (Digital I/Q and C & M: Optic) and RET controller of MMA-G. By using this path, the WSM can carry out the RET function that controls the antenna tilting angle remotely. In addition, for the RET operation, the RRH-B4 provides power to every antenna connected to it.

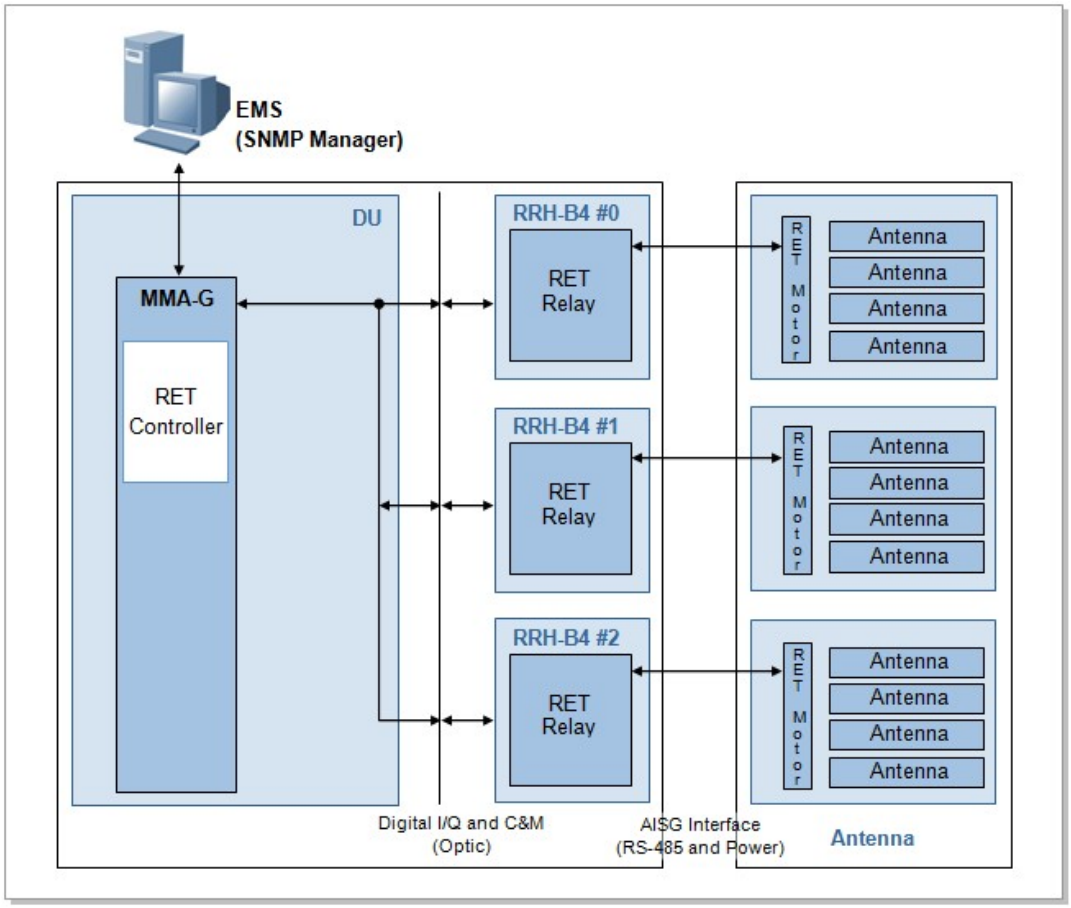

Figure 5.1 RET Interface

5.2 Web-EMT

The Web-EMT is a type of GUI-based consol terminals and the tool to access the U-RAS Flexible V2 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.
Web-EMT is provided to service provider as an option.

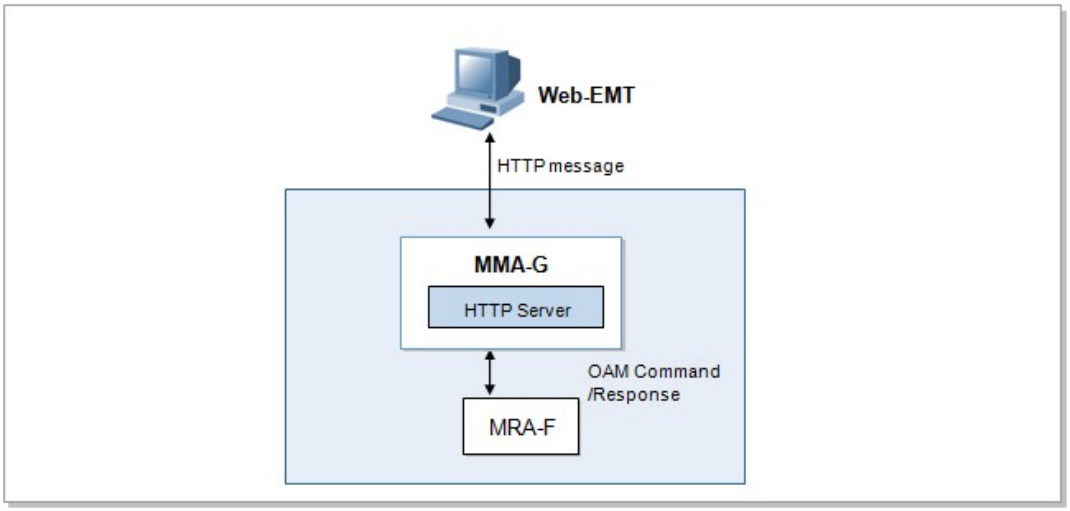

Figure 5.2 Web-EMT Interface

The Web-EMT enables the operator to restart the U-RAS Flexible V2 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.

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
AMC	Adaptive Modulation and Coding
API	Application Programming Interface
ARQ	Automatic Repeat request
ASN	Access Service Network

B

BI	Bucket Interval
BP	Board Processor

C

C & M	Control & Management
CAC	Call Admission Control
CC	Call Control
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
CSN	Connectivity Service Network
CTC	Convolutional Turbo Code

D

DAM	Diameter AAA Management
DCD	Downlink Channel Descriptor
DD	Device Driver
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
EMI	Electro-Magnetic Interference
EMI	EMS Interface
EMS	Element Management System

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
GE	Gigabit Ethernet
GPS	Global Positioning System
GPSR	GPS Receiver
GRE	Generic Routing Encryption
GUI	Graphical User Interface

H

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

I

IEEE	Institute of Electrical and Electronics Engineers
IMISH	Integrated Management Interface Shell
IP	Internet Protocol
IPRS	IP Routing Software

IS	Image Server

M

MAC	Medium Access Control
MBB-F	Mobile WiMAX base station Backplane Board-Flexible
MEI-B	Mobile WiMAX base station External Interface board assembly-Basic
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
MRA-F	Mobile WiMAX base station RAS board Assembly-Flexible
MS	Mobile Station
MW	Middleware

N

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

PBA	Panel Board Assembly
PCB	Printed Circuit Board
PCRF	Policy & Charging Rules Function
PDU	Protocol Data Unit
PF	Proportional Fair
PGID	Paging Cycle, Paging Offset
PHY	Physical Layer
PLD	Programmable Loading Data
PMIP	Proxy Mobile IP
PP2S	Pulse Per 2 Seconds

PPP	Point to Point Protocol

Q

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

R

RAS	Radio Access Station
RDM	RAS Diagnosis Management
RET	Remote Electrical Tilting
RFS	Root File System
ROHC	Robust Header Compression
RRC	RAS Resource Controller
RRH	Mobile WiMAX base station 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
SDU	Service Data Unit
SFF	Small Form Factor Fixed
SFP	Small Form Factor Pluggable
SFTP	Secure File Transfer Protocol
SMFS-C	Samsung Mobile WiMAX U-RAS Flexible Shelf assembly-Center mount
SMFS-F	Samsung Mobile WiMAX U-RAS Flexible Shelf assembly-Front mount
SNMP	Simple Network Management Protocol
SNMPD	SNMP Daemon
SSH	Secure Shell
SSL	Secure Sockets Layer

T

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
UL	Uplink
UL-MAP	Uplink-MAP
ULM	Universal Loading Management

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

	Warning: Exposure to Radio Frequency Radiation The radiated output power of this device is far below the FCC radio frequency exposure limits. Nevertheless, the device should be used in such a manner that the potential for human contact during normal operation is minimized. In order to avoid the possibility of exceeding the FCC radio frequency exposure limits, human proximity to the antenna should not be less than 300cm during normal operation. The gain of the antenna is 17 dBi. The antenna(s) used for this transmitter must not be co-located or operating in conjunction with any other antenna or transmitter.

Mobile WiMAX RAS U-RAS Flexible V2

System Description

SAMSUNG ELECTRONICS