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Mobile WiMAX Outdoor RAS SPI-2210

100RAS Outdoor Premium RAS

System Description

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INTRODUCTION

Purpose

This description describes the characteristics, functions and structures of the Outdoor Premium RAS of Mobile WiMAX, also referred to as the outdoor SPI-2210. Throughout this document the SPI-2210 designation will be used.

Document Content and Organization

This description is composed of five Chapters, an Abbreviation and Index as follows:

CHAPTER 1. Overview of Mobile WiMAX System

- Mobile WiMAX System Introduction
- Characteristics of Mobile WiMAX System
- Components of Mobile WiMAX Network
- Functions of Mobile WiMAX System

CHAPTER 2. Overview of Outdoor SPI-2210

- Outdoor SPI-2210 Introduction
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- Call Processing Message Flow
- Network Synchronization Message Flow
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- Operation and Maintenance Message Flow

CHAPTER 5. Additional Functions and Tools

- TTLNA
- Web-EMT

ABBREVIATION

Describes the acronyms used in this description.

INDEX

Index provides main searching keywords to be found.

Conventions

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

NOTE

NOTE

Indicates additional information as a reference.

Revision History

EDITION	DATE OF ISSUE	REMARKS
00	10. 2007.	First Draft
01	11. 2007.	Cabinet configuration is changed.
02	01. 2008.	- Delete the information related DHCP Server - sFTP → SFTP - Modify the 'PSMR/PSFMR' information - Modify the external interface (3.2.7) - Modify the figure 3.1 and figure 4.15 - Modify the ‘4.1’ - Modify the beamforming explanation
03	06. 2008.	- Abbreviations are changed. - Rel. 5 information is added.
04	03. 2009.	- The RADIUS protocol support for interfacing with the AAA server is added. (1.3, 2.5.1, 4.1) - ‘Disabling ZCS’ function is added. (2.2.5) - Figure 3.5 is changed. - The alarm port specification is changed from 10 Tx UDA to 6 Tx UDA. (3.2.5, 3.2.6) - The path test-related content is modified. (3.3.3.13) - The failure alarm types are modified. (4.3) - The acronyms in The ABBREVIATION section are modified.
05	06. 2009.	- Modify Figures 1.1, 1.2, 2.4, 4.1 to 4.4, 4.6 to 4.8, and 4.13 to 4.15 - Add Figures 4.9 - Modify Sections 1.3, 3.3.3.6, 4.1.1 to 4.1.4, and 4.1.6

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CHAPTER 1. Overview of Mobile WiMAX System

1.1 Introduction to Mobile WiMAX

The Mobile WiMAX system is the wireless network system that supports IEEE 802.16e-2005 base service. The IEEE 802.16 standard constitutes the basis for Mobile WiMAX, and includes IEEE Std 802.16-2004 which defines the fixed wireless Internet connection service, and IEEE Std 802.16, P802.16-2004/Cor/D3 which defines mobility technology such as handover or paging.

NOTE

Mobile WiMAX Standard

In this description, the entire 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 Packet Access (HSPA) for the data services.

Mobile WiMAX can, therefore, overcome the limitations of the WLAN and present mobile communication networks, and accommodate only the advantages of the system.
Mobile WiMAX can ultimately provide the high speed wireless internet services with low cost at any time and in anyplace.

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.

The Mobile WiMAX system consists of Radio Access Station (RAS), Access Control Router (ACR) and Mobile WiMAX System Manager (WSM). RAS manages 802.16 Medium Access Control (MAC)/Physical Layer (PHY) function for Mobile Station (MS), ACR manages various control functions and interworking function between Mobile WiMAX ASN system and CSN system.

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). Samsung's RAS 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.

1.2 Characteristics of the Mobile WiMAX System

The major characteristics of Mobile WiMAX system are listed below.

High Compatibility and Cross-Interworking

The Mobile WiMAX system is based on IEEE 802.16 standard and complies with Wave 2 Profile and ASN Profile C of the Mobile WiMAX Forum. Therefore, the Mobile WiMAX system provides high compatibility and excellent cross-interworking.

High Performance Module Structure

The 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 Mobile WiMAX system provides the redundancy structure for main modules to ensure higher stability.

Variant Advance RF and Antenna Solution Support

The Mobile WiMAX system supports Multiple Input Multiple Output (MIMO) and applies the power amplifier to support wideband operation bandwidth. In addition, it can readily support 4-branch diversity and beamforming.

Evolution Possibility into Next Generation Networking

The 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 Mobile WiMAX system can easily evolve into the next generation network.

Maintenance Function with Strengthened Security

The Mobile WiMAX system provides the security function (SNMPv3, SSH, SFTP and HTTPs) to all channels for operation and maintenance. The Mobile WiMAX system provides the operator Authentication, Authorization and Accounting (AAA) function to authenticate the operator and assign the right for system access and store the operation history in a log.

1.3 Mobile WiMAX Network Configuration

Mobile WiMAX network is composed of ASN and CSN. ACR and RAS are involved in ASN and WSM is the Network Element (NE) to manage ACR and RAS. CSN is composed of AAA server, HA, and PCRF server. ASN is connected with CSN by router and switch.

The following diagram shows the composition of Mobile WiMAX network.

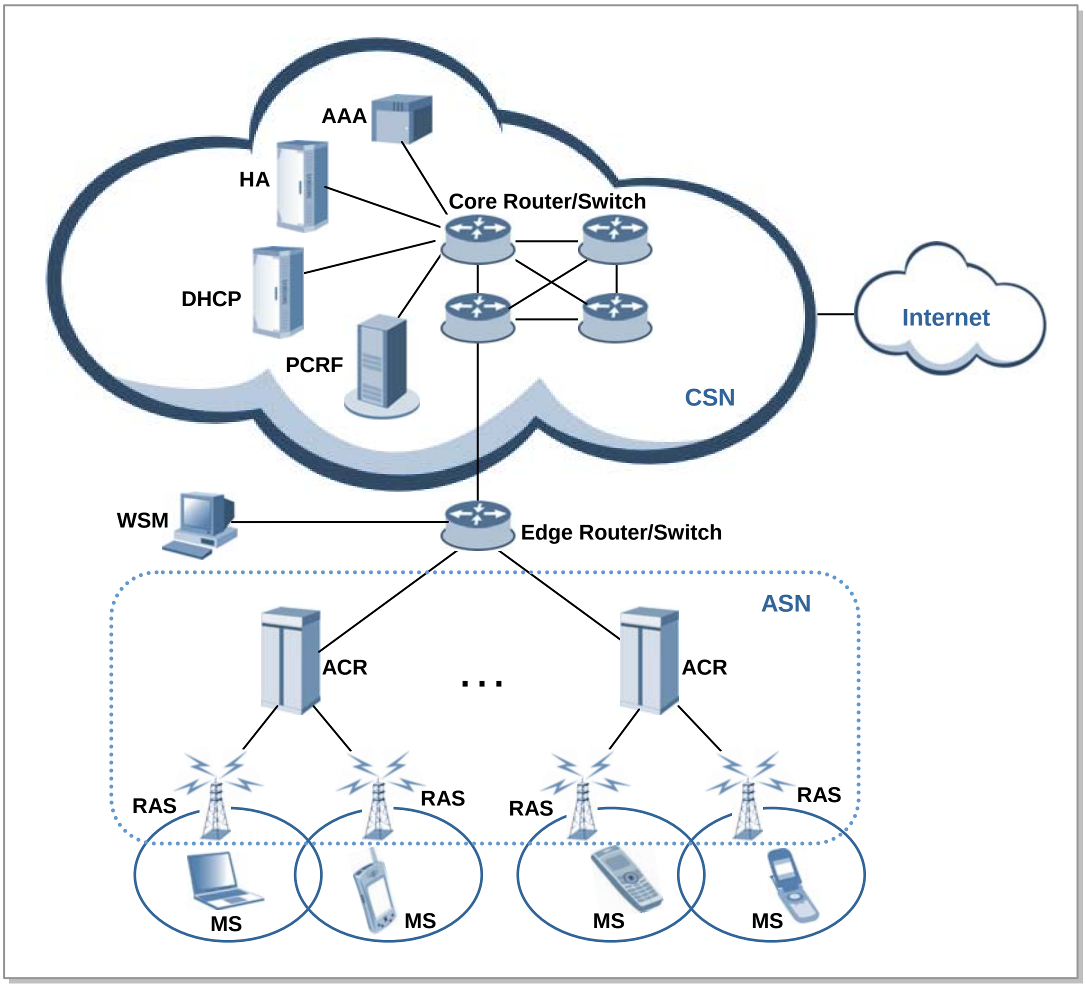

Figure 1.1 Mobile WiMAX Network Configuration

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, Admission Control, 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. The ACR interfaces with the Authentication, Authorization and Accounting (AAA) server using the DIAMETER/RADIUS protocols and with the Policy & Charging Rules Function (PCRF) server using the Diameter protocol. For Mobile IP services the ACR interacts with the Home Agent.

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 for Mobile IPv4 and interworks with MS to exchange data for Mobile IPv6.

Dynamic Host Configuration Protocol (DHCP) Server

The DHCP server allocates IP addresses to simple IP users. When an MS requests an IP address to be allocated, the DHCP server allocates an IP address by interacting with the ACR that functions as a DHCP relay agent and sends it to the ACR.

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.

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.

1.4 Mobile WiMAX System Functions

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.

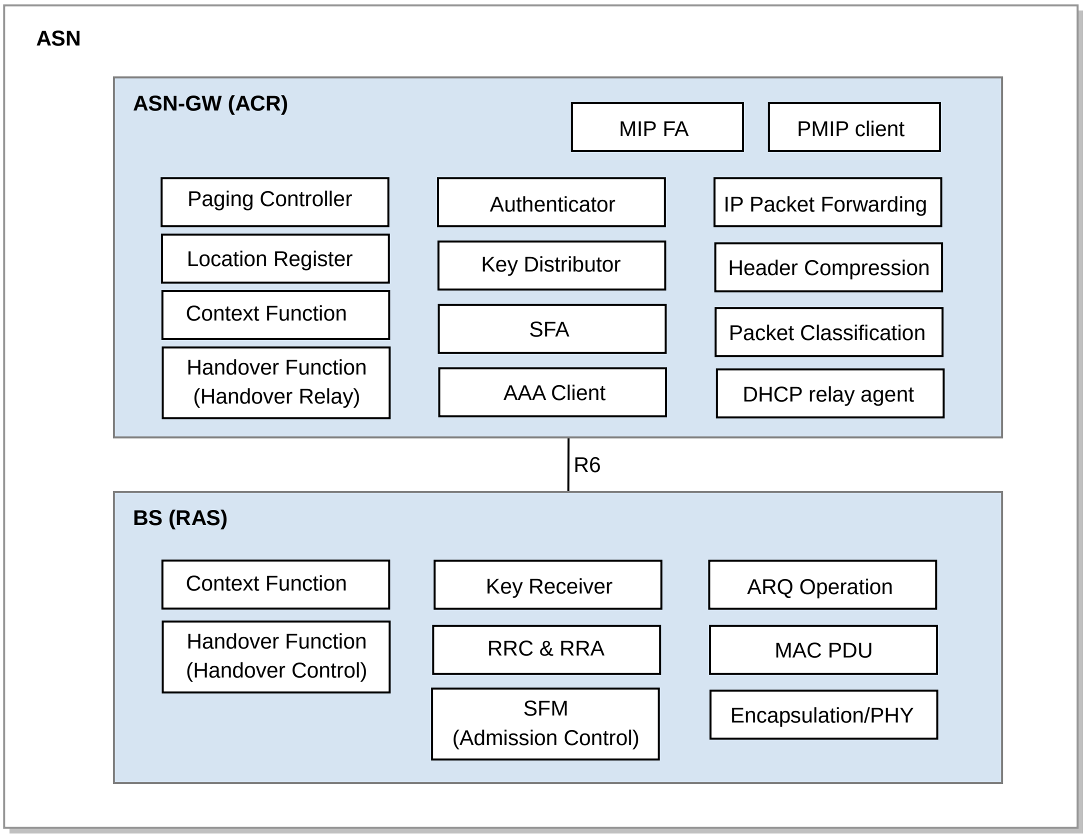

Figure 1.2 Configuration of Mobile WiMAX System Functions (Based on Profile C)

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 ROHC defined in the NWG standard.
In addition, the ACR performs the paging controller and location register functions for a 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 BS 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 provides admission control to collect/manage the MS's radio resource information and the RAS's own radio resource information (e.g., BSID). When load balancing is required based on admission control results, it performs resource management through FA overriding and BS init HO (Handover).

NOTE

ASN System Function

For the detailed description about the RAS functions, refer to Chapter 2 of this system description. For the description about the ACR functions, refer to the system description for ACR provided by Samsung.

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CHAPTER 2. Overview of Outdoor SPI-2210

2.1 Introduction to Outdoor SPI-2210

The outdoor SPI-2210, RAS of Mobile WiMAX, is controlled by ACR and connects Mobile WiMAX calls to MS.

The outdoor SPI-2210 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 outdoor SPI-2210 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 outdoor SPI-2210 and set/hold/disconnect the packet call connection, handover control and ACR interface function and system operation management function.

The outdoor SPI-2210 interfaces with ACR in one way of Fast Ethernet/Gigabit Ethernet and can exchange various control signals and traffic signals stably.

The outdoor SPI-2210 is installed in the outdoor environment and managed in the omni or sector method according to the property of the installed area. In addition, the outdoor SPI-2210 supports the capacity of the maximum 3Carrier/3Sector and MIMO only with the basic cabinet.

The characteristics of the outdoor SPI-2210 are as follows:

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.

Support of Broadband Channel Bandwidth

The outdoor SPI-2210 supports wide bandwidth of 5/10 MHz per carrier and high-speed and high capacity packet service.

Support of 3Carrier/3Sector

The outdoor SPI-2210 can support 3Carrier/3Sector by the basic cabinet.

Support of MIMO

The outdoor SPI-2210 basically supports MIMO of 2Tx/2Rx RF path. There are methods of MIMO as follows;

- Downlink
  - Space Time Coding (STC): method for raising reliability of link
  - Spatial Multiplexing (SM): method for raising data transmission rate
- Uplink
  Collaborative SM (CSM): Doubled frequency efficiency

Support of Frequency Reuse Pattern (FRP)

The outdoor SPI-2210 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 4-Branch Rx Diversity (Optional)

The outdoor SPI-2210 supports 4-branch Rx diversity providing four Rx paths to each sector to raise the Rx performance. In the outdoor SPI-2210, Mobile WiMAX base station RF Receiver (MRR), an Rx module, should be additionally mounted to support 4-branch Rx diversity.

Support of Various Frequency Allocation

The outdoor SPI-2210 supports various frequency allocation methods such as contiguous carrier, noncontiguous carrier, FRP N=1 or FRP N=3. The outdoor SPI-2210 can apply RF combiner optionally to such frequency allocation methods.

Support of Beamforming (Option)

The outdoor SPI-2210 is designed as the structure to support beamforming later.
The outdoor SPI-2210 mitigates the interference efficiently by uplink and downlink beamforming to raises the average capacity and expand the data coverage. Also the outdoor SPI-2210 needs the process to calibrate the reciprocity between uplink channel and downlink channel.

NOTE

Schedule to Provide the System Feature

For the schedule to provide the features described in this system description, see separate document.

2.2 Main Functions

The main functions of the outdoor SPI-2210 are as follows:

- Physical layer processing function
- Call processing function
- IP processing function
- Auxiliary device interface function
- Convenient operation and maintenance function
- Function of supporting the outdoor environment

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 outdoor SPI-2210 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 outdoor SPI-2210 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 outdoor SPI-2210 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 outdoor SPI-2210 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 outdoor SPI-2210 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 outdoor SPI-2210 performs the subchannelization to mitigate the interference between cells.

The outdoor SPI-2210 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 outdoor SPI-2210 transmits the column of the QAM symbol structure to the MS via the sub-carriers pertained to each subchannel.

DL/UL MAP Construction

The outdoor SPI-2210 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 outdoor SPI-2210 and includes various control information for the MS.

Power Control

The outdoor SPI-2210 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 outdoor SPI-2210 transmits the power correction command to each MS and then makes the MS power intensity be the level required in the outdoor SPI-2210 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 outdoor SPI-2210 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 outdoor SPI-2210 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 (CSM)
    CSM is the technology that doubles the frequency efficiency in view of the outdoor SPI-2210 as two MSs with each individual antenna send data simultaneously by using the same channel.

Beamforming

The outdoor SPI-2210 can carry out the following beamforming function later according to Mobile WiMAX Wave 2 Profile: For the beamforming, the outdoor SPI-2210 is designed on the basis of 4Tx and 4Rx.

- Downlink
  DL dedicated pilots for Partial Usage of Subchannels (PUSC) and B-AMC (2 × 3)
- Uplink
  - UL sounding channel (type A) with decimation and cyclic shift
  - UL PUSC and B-AMC (2 × 3)

The beamforming operation method following the Wave 2 Profile is as follows:

1) If an MS in a specific area transmits the sounding signal to the outdoor SPI-2210, the outdoor SPI-2210 analyzes this signal.
2) The outdoor SPI-2210 estimates an appropriate beamforming coefficient on the basis of the result analyzed in step 1).
3) The outdoor SPI-2210 carries out the beamforming for the uplink and the downlink.

Since the uplink and downlink channels have the high correlation in TDD method, the beamforming can be supported.

2.2.2 Call Processing Function

Cell Initialization Function

The outdoor SPI-2210 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 outdoor SPI-2210 enables an MS to enter to or exit from the network. When an MS enters to or exit from the network, the outdoor SPI-2210 transmits/receives the signaling message required for call processing via R1 interface with the MS or R6 interface with ACR.

The outdoor SPI-2210 allocates various management/transport Connection Identifier (CID) required for the network entry and service to a MS. When the MS exit from the network, the outdoor SPI-2210 collects and release the allocated CID.

Handover

The outdoor SPI-2210 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 outdoor SPI-2210 performs the data switching function. In handover, the outdoor SPI-2210 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 Chapter 4 'Message Flow'.

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 outdoor SPI-2210 carries out the related call processing function by receiving/sending the signaling message required for the MS's status transition into Sleep Mode and the MS return from the Sleep Mode to Awake Mode.

Admission Control (AC) Function

If the outdoor SPI-2210 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 outdoor SPI-2210 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 outdoor SPI-2210 checks if the air resources of the requested subcell exceed the threshold and determines the creation of the service

MAC ARQ Function

The outdoor SPI-2210 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 outdoor SPI-2210 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 Outdoor SPI-2210 is delivered to the modem in the outdoor SPI-2210. At this time, the outdoor SPI-2210 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 outdoor SPI-2210 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 outdoor SPI-2210 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 outdoor SPI-2210 supports between Differentiated Services Code Point (DSCP) and 802.3 Ethernet MAC service class.

Simultaneous Support of IPv4/IPv6

ACR communicates with the outdoor SPI-2210 through the GRE tunnel and the backhaul IP version between the outdoor SPI-2210 and ACR is managed independently from the service IP version for the MS.
Even if, therefore, IPv4 is used in backhaul between the outdoor SPI-2210 and ACR, all of IPv4, IPv6 and IPv4/IPv6 dual stack services can be supported.

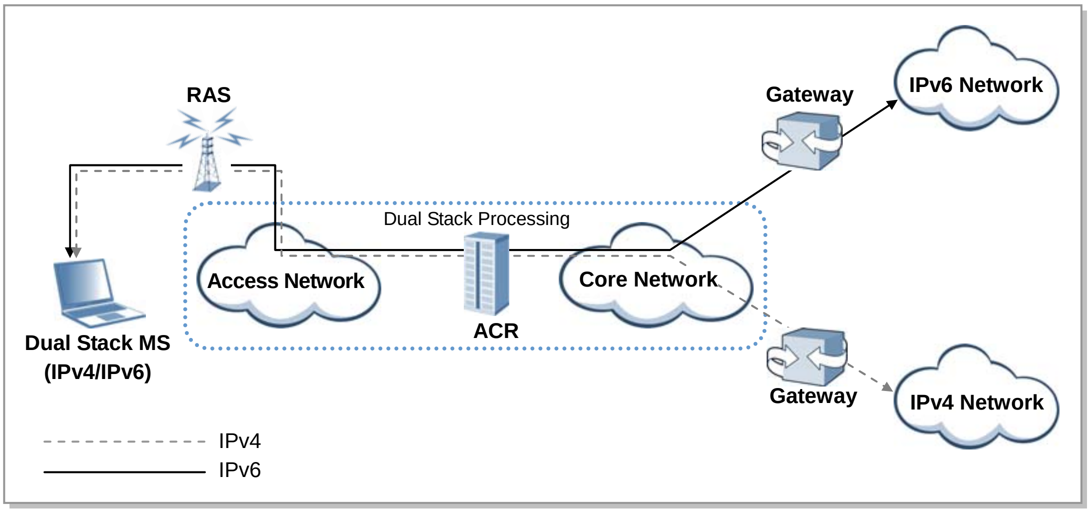


Figure 2.1 IPv4/IPv6 Dual Stack Operation

IP Routing Function

Since the outdoor SPI-2210 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 outdoor SPI-2210 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 outdoor SPI-2210 supports the static routing configuration only and not the router function for the traffic received from the outside. When the outdoor SPI-2210 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 outdoor SPI-2210 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 outdoor SPI-2210 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 outdoor SPI-2210 can support better performance service and convenience by supporting various auxiliary devices.

Wireless Backhaul Interface

Auxiliary device part of the outdoor SPI-2210 can mount a wireless backhaul device provided by a service provider. The outdoor SPI-2210 supplies the power to the wireless backhaul device.
When the server that manages the wireless backhaul device exist, the outdoor SPI-2210 supports the User Define Ethernet (UDE) port to provide path for maintenance traffic between that server and wireless backhaul device.

UDA Support

The outdoor SPI-2210 receives or sends alarm history from/to outside through UDA.
The outdoor SPI-2210 provides a total of 24 UDA Rx ports and 10 UDA Tx ports.
The outdoor SPI-2210 provides UDA Tx 1 port to AICU for interoperation with TTLNA.
When subcell output of RAS is blocked by an operator command for the TTLNA receiver test, the UDA informs the AICU that TTLNA becomes Rx only mode.
An operator uses UDA control commands to expand UDA ports, name UDA ports, and transmit UDA Tx signals.

Auxiliary Device Interface

The outdoor SPI-2210 provides the Ethernet interface to connect auxiliary devices such as TTLNA and allocates IP addresses by operating as a DHCP server for the auxiliary devices.
In addition, the outdoor SPI-2210 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 outdoor SPI-2210 carries out the NAT function to change the address into a public IP address (i.e., the IP address of the outdoor SPI-2210) for the communication with an external monitoring server.

2.2.5 Maintenance Function

The outdoor SPI-2210 interworking with the management system carries out the following maintenance functions: system initialization and restart, management for system configuration, management for the operation parameters, failure and status management for system resources and services, statistics management for system resources and various performance data, diagnosis management for system resources and services and security management for system access and operation.

Graphic and Text-based Console Interface

WSM manages the entire Mobile WiMAX system by using Database Management System (DBMS) and Outdoor SPI-2210 interworks with this WSM. Moreover, the outdoor SPI-2210 interoperates with the console terminal so that the operator can connect to an NE directly without using the WSM to perform the operational and maintenance functions.

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 consol 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 outdoor SPI-2210 provides the authentication and the permission management functions for the operator who manages the Mobile WiMAX system. The operator accesses the outdoor SPI-2210 by using the operator's ID and password via Web-EMT or IMISH and the outdoor SPI-2210 assigns the operation right in accordance with the operator's level.
The outdoor SPI-2210 carries out the logging function for successful access, access failure and login history.

Maintenance Function with Enhanced Security Function

For the security, the outdoor SPI-2210 supports Simple Network Management Protocol version 3 (SNMPv3) and SSH File Transfer Protocol (SFTP) in the communication with WSM and 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 outdoor SPI-2210 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 outdoor SPI-2210 updates the package stored in a non-volatile storage.
In addition, the outdoor SPI-2210 can re-perform the 'Change to New package' stage to roll back into the previous package before upgrade.

Call Trace Function

The outdoor SPI-2210 supports the call trace function for a specific MS. The outdoor SPI-2210 can carry out the call trace function up to 10 MSs. 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 outdoor SPI-2210, 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 outdoor SPI-2210 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 outdoor SPI-2210, and the outdoor SPI-2210 creates and stores a file for each period.

Threshold Cross Alert (TCA) Control

The outdoor SPI-2210 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 outdoor SPI-2210 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 outdoor SPI-2210 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 outdoor SPI-2210 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 outdoor SPI-2210 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 outdoor SPI-2210 provides a throughput test for the backhaul to the ACR. The outdoor SPI-2210 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 outdoor SPI-2210 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 outdoor SPI-2210 is running may affect the system performance.

Disabling Zero Code Suppression (ZCS)

The outdoor SPI-2210 collects statistics data and generates statistics files periodically.
The WSM collects these statistics files. A statistics file is composed of the header used to indicate a statistics group and its detailed index (for example, a specific carrier, sector, CPU, port, etc.) and the statistics data for that index.
In a statistics period, the statistics data for a specific index can become zero in a statistics file in the following cases:

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

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

2.2.6 Function of Supporting the Outdoor Environment

The outdoor SPI-2210 controls the temperature inside the system, collects and reports the environmental alarms to operate normally in the outdoor environment. Thus, the outdoor SPI-2210 can operate in the outdoor environment without any special equipment.
Especially, the outdoor SPI-2210 has the structure of the Direct Air Cooling System (DACS) which consists of the membrane filter and the Heater and Damper Module (HDM), and it supports the outdoor environment with low power consumption by optimizing the air flow.

2.3 Specifications

Capacity

The capacity of the outdoor SPI-2210 is as follows:

Category	System Capacity
Channel Bandwidth	5MHz/10 MHz
RF Band	- 2496MHz ~ 2596MHz (BW: 100MHz) - 2642MHz ~ 2672MHz (BW: 30MHz) - 2624MHz ~ 2690MHz(BW: 66MHz)
Maximum Number of Carriers/Sectors	3Carrier/3Sector
Interface between ACR-SPI-2210	Select one of Fast Ethernet and Gigabit Ethernet
FFT size/Carrier/sector	512/1,024
Channel Card Capacity	1Carrier/1Sector
Rx Diversity	4-branch Rx Diversity (option)
MIMO	MIMO (2Tx/2Rx)
BF	4 path BF (option)
Output	Antenna Port-based - 5 W/Carrier/Path @ 5 MHz - 10 W/Carrier/Path @ 10 MHz

Input Power

The table below lists the power standard for the outdoor SPI-2210. The outdoor SPI-2210 satisfies the electrical safety standard prescribed in UL60950.

Category	Standard
System Input Voltage	-48 VDC (Voltage Variation Range: -40~-56 VDC)
Heater Input Voltage	240 VAC (Volt fluctuation range: +/- 10%)

NOTE

System Input Voltage

If the system input voltage that the service provider wants is AC, it can be supplied via a separate external rectifier.

Cabinet Size and Weight

The table below lists the cabinet size and weight of the outdoor SPI-2210. The cabinet height includes the foot part of the cabinet.

Category	Standard
Cabinet (SMOR) size (mm)	1,828 (H) × 900 (W) × 762 (D)

Cabinet Weight (kg)	About 410 or less

Environmental Condition

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

Category	Range	Applied Standard
Temperature Condition[a]	-40~50°C (-40~122°F)	GR-487-CORE Sec. 3.26
Humidity Condition[a]	5~95% However, the vapor content for air of 1 kg should not exceed 0.024 kg.	GR-487-CORE Sec.3.34.2
Altitude	-60~1,800 m (-197~6,000 ft)	GR-63-CORE Sec.4.1.3
Earthquake	Zone 4	GR-63-CORE Sec.4.4.1
Vibration	Commercial Transportation Curve 2	GR-63-CORE Sec.4.4.4
Noise (sound pressure level)	Under 65 dBA in distance of 1.5 m (5 ft) and height of 1.0 m (3 ft).	GR-487-CORE Sec.3.29
Electromagnetic Wave (EMI)	Standard satisfied	FCC Title47 Part 15 Class B GR-1089-CORE Sec. 3.2
US Federal Regulation	Standard satisfied	FCC Title47 Part27

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

Environmental Alarm

The table below lists the environmental alarm provided in the outdoor SPI-2210 in default. For the details on the environmental alarm, refer to the specific items.

Category	Description
UCM Status	Universal Control Module (UCM) Fail Report
Temperature Alarm	High Temperature
Fan Fail	- DMB (Digital Main Block) Fan Fail - RFB (RF Block) Fan Fail
Others	Flood, Fire, Door open, etc.

NOTE

Details

For the details, refer to '3.2.5 UCM'.

GPSR Specification

The table below lists the GPS Receiver (GPSR) characteristics of Outdoor SPI-2210.

Category	Description
Received Signal from GPS	1PPS, ToD
Reference signal	8 kHz
Accuracy/Stability	0.01 ppm

RF Specification

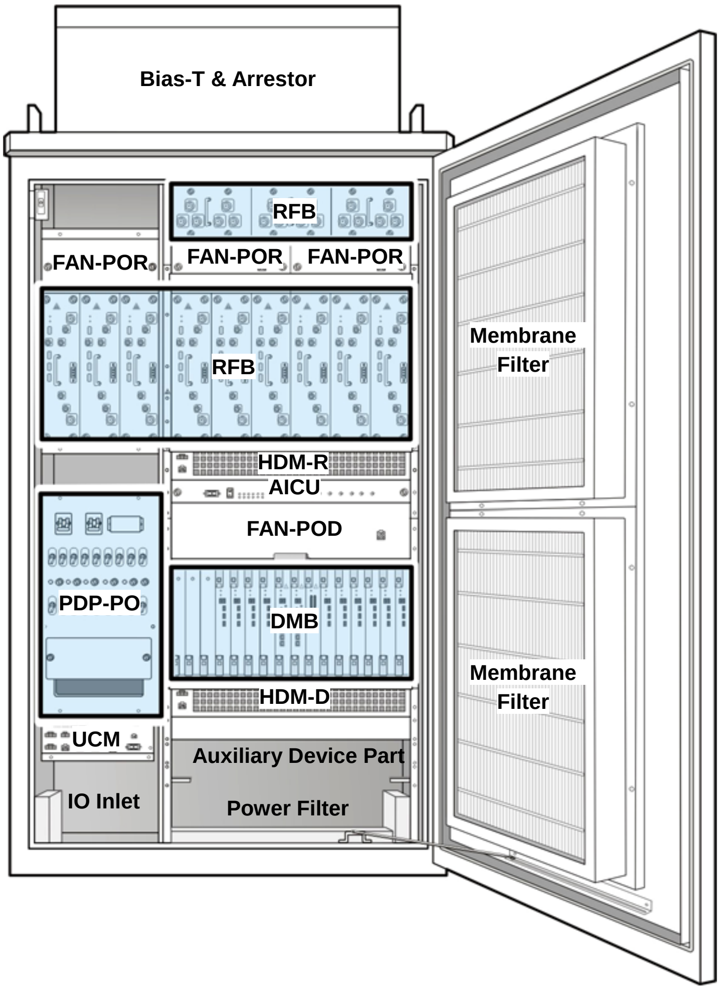
The table below lists the RF characteristics of the outdoor SPI-2210.

Category	Description
Tx Output Power	20 W @avg power (MIMO) per carrier/sector
Tx Constellation error	802.16 standard is observed.
RX Sensitivity	802.16 standard is observed.

2.4 System Configuration

The outdoor SPI-2210 consists of the following cabinet.

- Samsung Mobile WiMAX base station Outdoor Rack (SMOR)



RFB	RF Block
HDM-R	Heater and Damper Module-RFB
FAN-POR	Fan module-Premium Outdoor RFB
AICU	Antenna Interface Control Unit
PDP-PO	Power Distribution Panel-Premium Outdoor
FAN-POD	Fan module-Premium Outdoor DMB
DMB	Digital Main Block
HDM-D	Heater and Damper Module-DMB
UCM	Universal Control Module

Figure 2.2 SMOR Configuration

The outdoor SPI-2210 provides up to 3Carrier/3Sector capacities and basically supports MIMO, which is 802.16 Wave 2 standard. The outdoor SPI-2210 can support 4-branch Rx diversity only with the basic cabinet (SMOR).

2.5 Interface between Systems

2.5.1 Interface Structure

The outdoor SPI-2210 interfaces with another RAS and ACR as shown in the figure below:

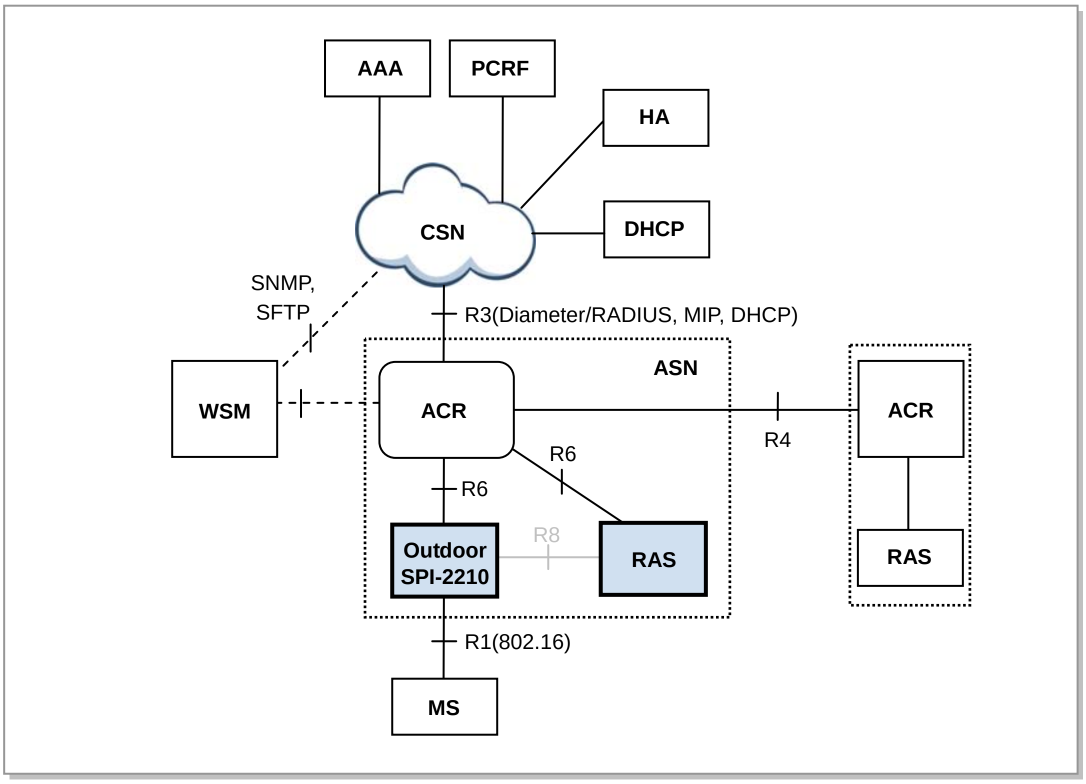


Figure 2.3 Structure of Outdoor SPI-2210 Interface

Interface between Outdoor SPI-2210 and MS

The outdoor SPI-2210 interfaces with an MS according to the IEEE 802.16 radio access standard to exchange the control signal and the subscriber traffic.

Interface between Outdoor SPI-2210 and ACR

The interface between an ACR and the outdoor SPI-2210 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 Outdoor SPI-2210 and WSM

The interface between the outdoor SPI-2210 and the WSM complies with SNMPv2c or SNMPv3c of IETF standard, SFTP and Samsung’s proprietary standard and its physical access method is GE/FE.

2.5.2 Protocol Stack

Protocol Stack between NEs

The figure below shows the protocol stack between NEs.

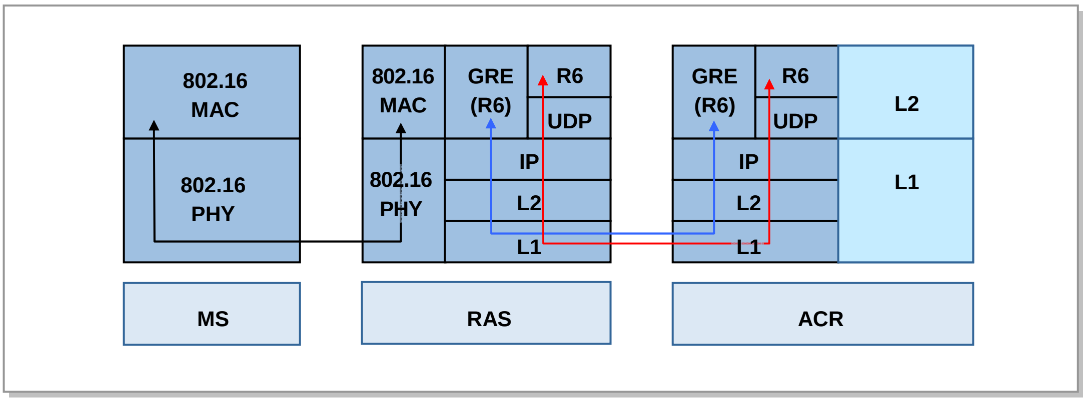


Figure 2.4 Protocol Stack between NEs

The outdoor SPI-2210 interworks with MSs via R1 interface according to IEEE 802.16 standard and the interface between the outdoor SPI-2210 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

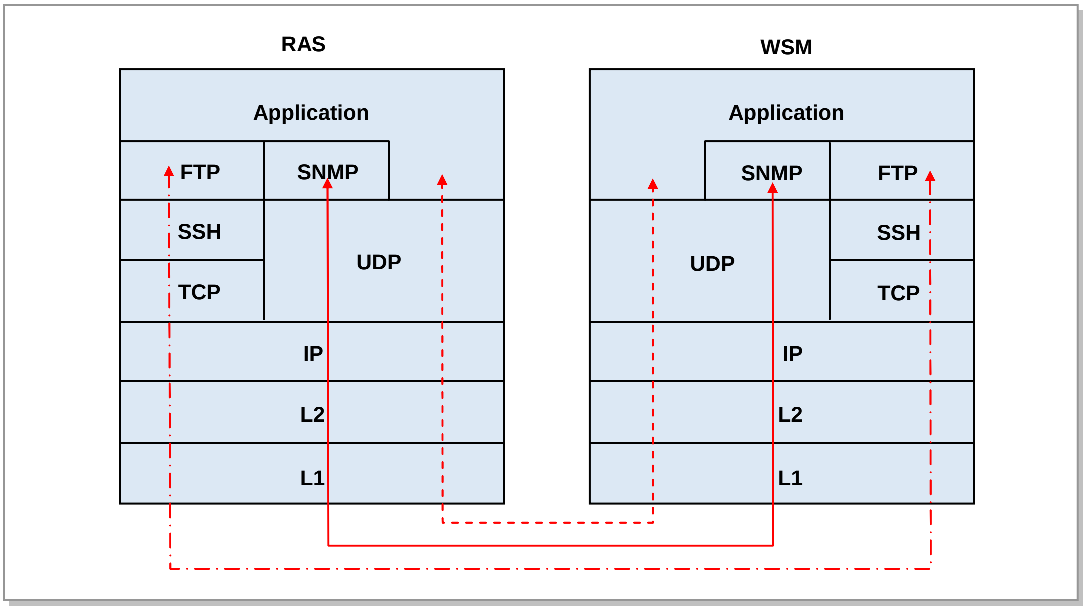


Figure 2.5 Protocol Stack between Outdoor SPI-2210 and WSM

The ACR interworks with WSM in IP/UDP-based SNMP method to carry out the operation and maintenance functions. In particular, the outdoor SPI-2210 interworks with WSM in IP/TCP-based SFTP (FTP over SSH) method to collect the statistical data periodically, initialize & restart the system and download software.

2.5.3 Physical Interface Operation Method

ASN Interface

The outdoor SPI-2210 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 types of interfaces cannot be operated simultaneously. The number of interfaces can be optionally managed depending on the capacity and the required bandwidth of the outdoor SPI-2210.
The types of interfaces are as follows:

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

Ethernet interface operate several links as 802.3ad-based static link aggregation.

Operation and Maintenance Interface

The operation and maintenance interface (interface with WSM) is operated in in-band method, which shares the common user traffic interface.

CHAPTER 3. Outdoor SPI-2210 Architecture

3.1 System Configuration

The outdoor SPI-2210 is roughly composed of two blocks (DMB and RFB), PDP-PO and auxiliary device part.

Digital Main Block (DMB)

The DMB operates and maintains the outdoor SPI-2210, enables the outdoor SPI-2210 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.

RF Block (RFB)

The RFB is equipped with MRU-2 which integrates transceiver, power amplifier, filter and TDD switch.
The MRU-2 changes the signal received from an external antenna or MRA-S of the DMB into RF or baseband signal and transmits to the MRA-S or the external antenna.
When the outdoor SPI-2210 supports 4-branch Rx diversity on a user’s request, Mobile WiMAX base station RF Receiver (MRR), which is a dedicated Rx module, and Mobile WiMAX base station Combiner Unit (MCU) to combine noncontiguous carriers in the frequency band can be mounted on RFB.

Power Distribution Panel-Premium Outdoor (PDP-PO)

The PDP-PO receives DC power via a rectifier composed in a separate cabinet and distributes the power to each block in the corresponding cabinet. An operator can control the DC power supply by switching on/off the circuit breaker in the front of the PDP-PO.

Auxiliary Device Part

The auxiliary device part is a separate space to mount auxiliary modules for the operator's convenient network operation. The modules to be mounted on the auxiliary device part are provided by service provider.

The internal configuration of the outdoor SPI-2210 is as shown in the figure below:

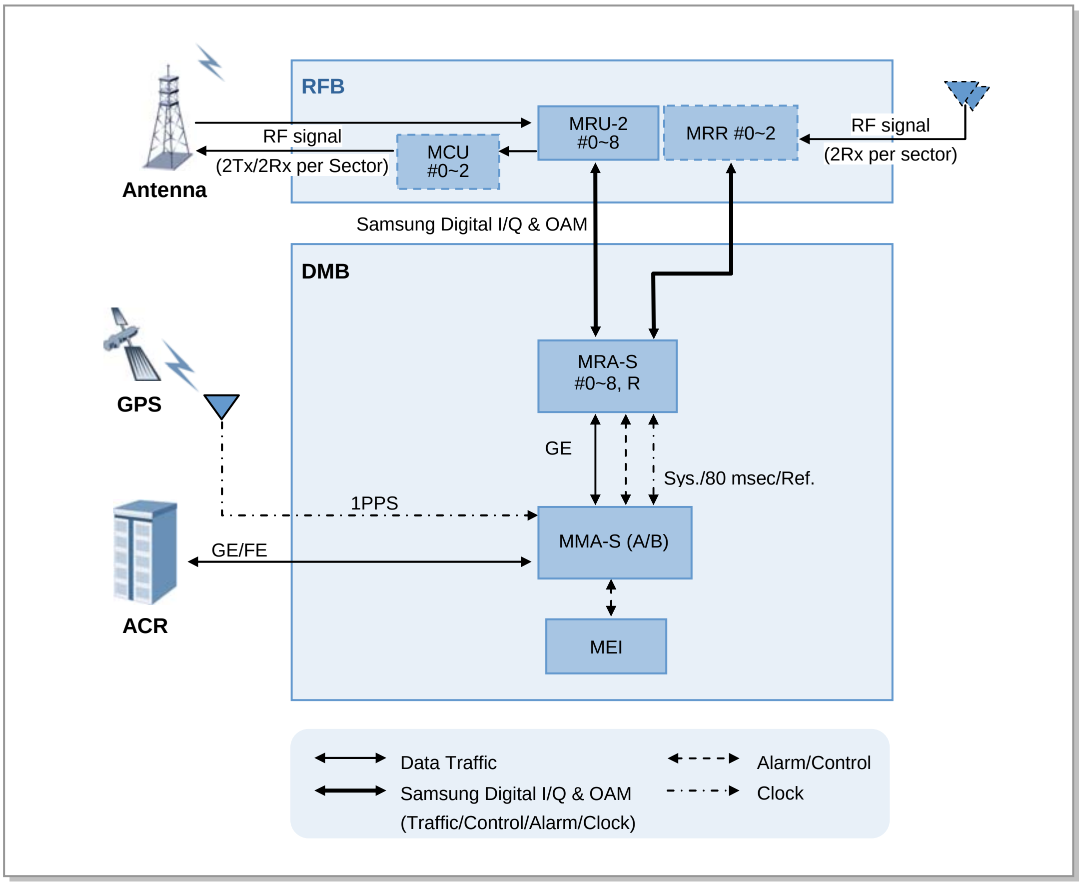


Figure 3.1 Internal Configuration of Outdoor SPI-2210

According to frequency allocation history and FRP condition of carriers, the MCU can be mounted between the MRU-2 and an antenna of the outdoor SPI-2210.

3.2 Detailed Structure

3.2.1 Digital Main Block (DMB)

The DMB operates and maintains the outdoor SPI-2210, is in charge of the interface between the outdoor SPI-2210 and the router and provides the communication path between processors in the system. In addition, the DMB creates a clock, provides the clock to the lower hardware block and performs the channel processing function for the subscriber signal.

When the outdoor SPI-2210 transmits a signal to an MS, the DMB performs the OFDMA signal processing for the traffic signal received from the ACR and then converts the signal via the 'Samsung Digital I/Q and OAM' converter to transmit it to RFB. On the contrary, if the outdoor SPI-2210 receives a signal from an MS, the DMB receives the 'Samsung Digital I/Q and OAM' signal from the RFB, performs the OFDMA signal processing for the signal and transmits the signal 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

The DMB is configured as shown in the figure below:

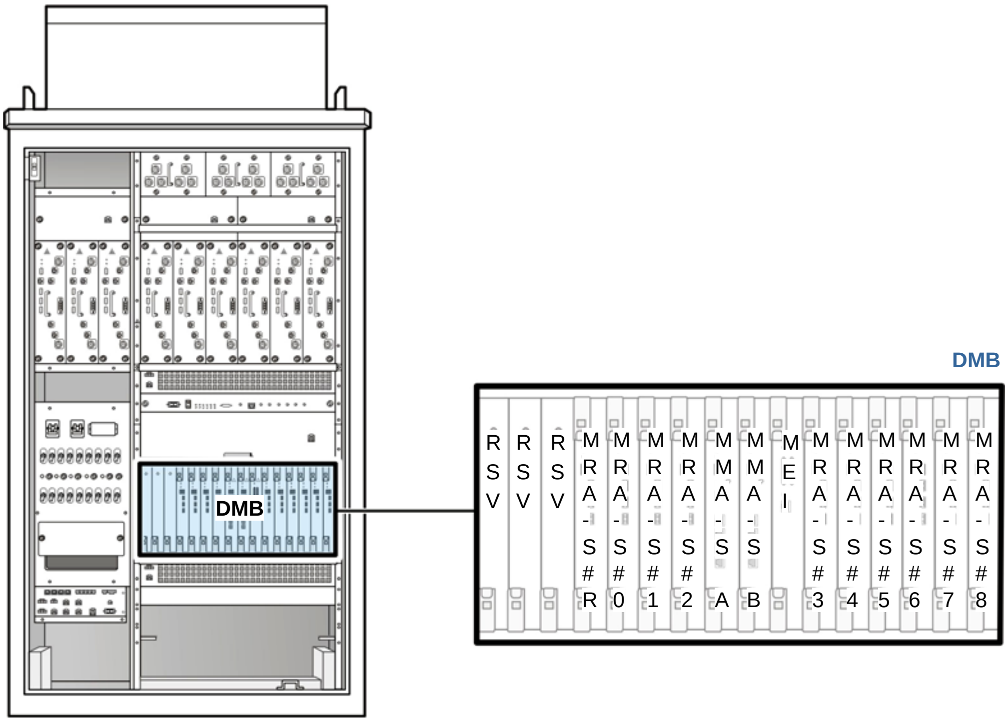


Figure 3.2 DMB Configuration

Board Name	Quantity (Sheet)	Function
MBB-P	1	Mobile WiMAX base station Backplane Board-Premium - DMB backboard - Signal routing function for traffic, control signal, clock, power, etc.
MMA-S	Max. 2	Mobile WiMAX base station Main control board Assembly-Standard - 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 - FE/GE interface support with ACR - Redundancy support
MRA-S	Max. 10	Mobile WiMAX base station RAS board Assembly-Standard - Subscriber data traffic processing - OFDMA Processing - 1Carrier/1Sector MIMO - 'Samsung Digital I/Q and OAM' data formatting - N:1 redundancy support only for 1st carrier
MEI	1	Mobile WiMAX base station External Interface board assembly - User Defined Alarm (UDA) provided - User Defined Ethernet (UDE) provided - Collection of system environmental alarm and rectifier alarm via UCM - TDD signal support for auxiliary devices

Mobile WiMAX base station Main control board Assembly-Standard (MMA-S)

The MMA-S carries out the main processor function and the GPS reception function. The MMA-S has the redundancy configuration for reliability.

- Main Processor Function
  The MMA-S is the board that carries out the role as the highest layer in the outdoor SPI-2210 and is equipped with the main processor. The main processor of the MMA-S performs the functions, such as communication path setting between MS and ACR, Ethernet switch function in the outdoor SPI-2210, system operation and maintenance and TDD signal control.
  The MMA-S manages the status of all hardware and software in the outdoor SPI-2210 and reports each status information to WSM via ACR. In addition, the MMA-S allocates and manages the resources of the outdoor SPI-2210 and the connection of the MMA-S and a PC for the Web-EMT enables to maintain the outdoor SPI-2210 with no interworking with ACR.
  The MMA-S has the redundancy configuration of active/standby to allow the standby MMA-S to replace the function of the active MMA-S when a fault occurs in the active MMA-S.
- GPS Reception and Clock Distribution Function
  The MMA-S is equipped with Universal Core Clock Module (UCCM) for GPS reception.
  The UCCM enables each block of the outdoor SPI-2210 to be operated in the synchronized clock system. The UCCM mounted on the MMA-S 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 outdoor SPI-2210 and operate the system.
  If no GPS signal is received due to a fault, the UCCM carries out the holdover function to provide the normal clock for a certain time as provided in the existing system. In addition, if a fault occurs in the UCCM of the active MMA-S, the redundancy status between the UCCMs of the active MMA-S and the standby MMA-S is switched and then the redundancy status between MMA-Ss is, also, switched immediately.
- Network Interface Function
  The MMA-S interfaces with an ACR in Gigabit Ethernet or Fast Ethernet method.
  The MMA-S can provide maximum two Gigabit Ethernet ports or four Fast Ethernet ports per board, and support the link aggregation redundancy method. The MMA-S can be divided as follows depending on the interface types provided by MMA-S, and the service provider can choose the interface type.
  – MMA-SC: Four 100/1000Base-T Copper ports
  – MMA-SF: Four 100Base-FX Small Form factor Fixed (SFF) ports
  – MMA-SM: Two 100/1000Base-T ports and two 1000Base-X Small Form factor Pluggable (SFP) ports
  – MMA-SG: Two 1000Base-X Gigabit Interface Converter (GBIC) ports

Mobile WiMAX base station RAS board Assembly-Standard (MRA-S)

The MRA-S 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-S.

The MRA-S modulates the packet data received through the MMA-S, converts the modulated signal into the 'Samsung Digital I/Q and OAM' format and transmits to the MRU-2. In the contrary, the MRA-S demodulated the data received from the MRU-2 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-S via Ethernet.

The MRA-S supports 1carrier/1sector 2Tx/2Rx MIMO in default and can support 4-branch Rx diversity.

The MRA-S can support N:1 Redundancy only for 1st carrier to continuously support service to the corresponding sector if a fault occurs in a certain sector when the outdoor SPI-2210 serves the service by using a carrier initially.

Mobile WiMAX base station External Interface board assembly (MEI)

MEI collects the environmental alarm and rectifier alarm via UCM in the outdoor SPI-2210, and provides the path for the alarm information generated in external devices via UDA and UDE. And MEI reports the alarm information to the MMA-S.

MEI provides the TDD signal for external devices.

3.2.2 RF Block (RFB)

The RFB is equipped with the MRU-2, which is the integrated RF module, in default and the MCU for combining between noncontiguous carriers in the same sector according to the service provider's frequency operation plan.

Main Functions

- High-power amplification of RF transmission signal
- Interface for traffic, alarm, control signal and TDD signal by interfacing with the MRA-S in 'Samsung Digital I/Q and OAM' method
- 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
- TDD switching function for Tx/Rx path
- MRU-2 output combining function when various noncontiguous carriers are supported.
- Support of additional RF Rx path for 4-branch Rx diversity (optional)

The RFB is configured as follows:

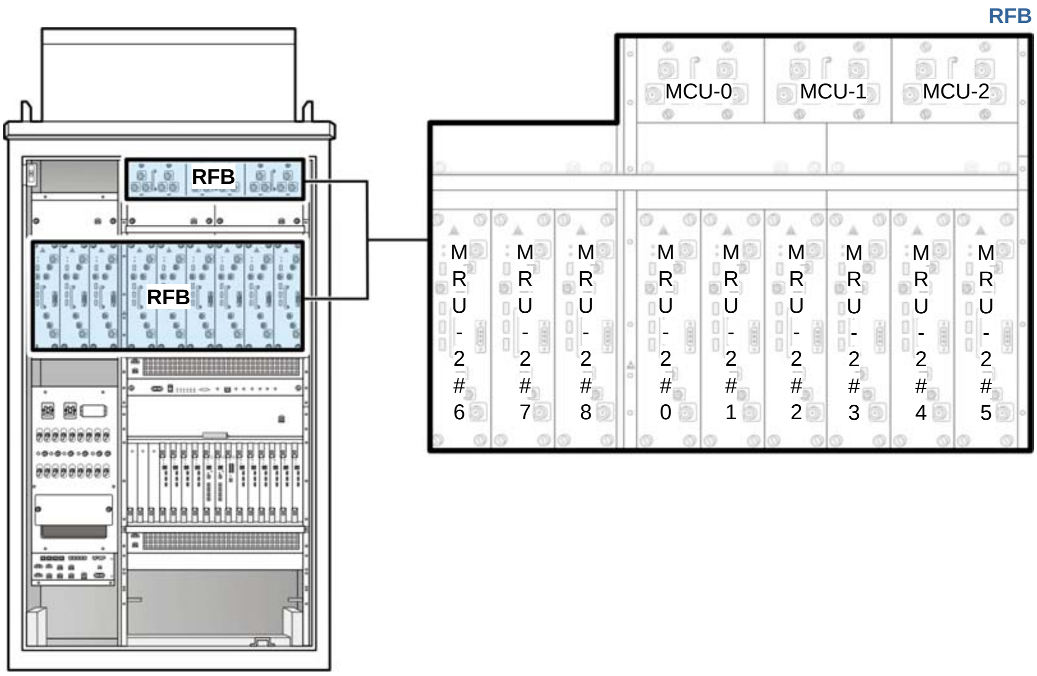


Figure 3.3 RFB Configuration

Board Name	Qtty. (Sheet)	Function
MRU-2	Max. 9	Mobile WiMAX base station RF Unit-20 MHz - RF upconversion/downconversion - Low Noise Amplifier (LNA) function - TDD switch to separate the Tx/Rx path - MIMO (2Tx/2Rx) RF path - RF high-power amplification - Suppression of the spurious waves out-of-band - 20W (10W x 2Carrier) output from each of two Tx ports (antenna ports) - Support of 2Carrier/1Sector per MRU-2 - Filter part connected to an antenna
MRR	Max. 2	Mobile WiMAX base station RF Receiver - Six dedicated Rx paths to support 4-branch Rx diversity - Support of 2Carrier/3Sector per MRR - Sharing of the mounted space with MRU-2 slot #6 and #7 - Optional
MCU	Max. 3	Mobile WiMAX RF Combiner Unit - One sheet of MCU per sector when several noncontiguous carriers (two or three carriers) are supported - Combining the MRU-2 output - MCU-2 (2way) or MCU-3 (3way) is mounted as applicable

Mobile WiMAX base station RF Unit-20 MHz (MRU-2)

The MRU-2 is the integrated RF unit that transceiver, power amplifier, TDD switch and filter in the existing RAS are integrated into a module and supports the contiguous bandwidth of 20 MHz. In short, up to two carriers can be supported by the MRU-2 in the contiguous 10 MHz carrier over the frequency domain.
In addition, the MRU-2 supports 2Tx/2Rx RF path per MRU-2 for the support of MIMO and transmits 20W(10W x 2carrier) RF power per Tx path.

There are 3 kinds of MRU-2 according to operating frequency and frequency bandwidth.

- MRU-2FH (FH block) : 2642MHz~2672MHz (30MHz)
- MRU-2LB (LBS) : 2496MHz~2596MHz (100MHz)
- MRU-2UB (UBS) : 2624MHz~2690MHz(66MHz)

As for the downlink signal, the MRU-2 combines the baseband signal received from the MRA-S via the ‘Samsung Digital I/Q and OAM’ interface according to sectors/carriers and then converts it into the analog RF signal through Digital to Analog Conversion (DAC). This RF signal is transmitted to an antenna through the filter part via the power amplification process.

As for the uplink signal, the frequency of the signal received through the filter part of the MRU-2 is down converted by the Low Noise Amplifier (LNA) and converted into the baseband signal via the Analog to Digital Conversion (ADC) process. This baseband signal is transmitted to the MRA-S via the 'Samsung Digital I/Q and OAM' interface.

Mobile WiMAX base station RF Receiver (MRR)

On the service provider's request of 4-branch Rx diversity to enhance the Rx performance of the system, the 4-branch Rx diversity can be supported by additionally mounting a MRR to the outdoor SPI-2210.
The MRR is the dedicated RF Rx module to support six Rx paths and can support two Rx paths per sector. The MRR can serve 2-carrier located within the 72 MHz band for each module.
If the MRR is provided, the MRR is mounted on MRU-2 slot #6 and #7. The MRR is provided to service providers optionally.

Mobile WiMAX base station Combiner Unit -2way(MCU-2)

If the outdoor SPI-2210 supports noncontiguous carriers located on the frequency domain in any sector, the MCU-2 is mounted. MCU-2 outputs two Tx paths combined into one path
There are 3 kinds of MCU-2 according to combined frequency segments.

- MCU-2A
  : 2496~2596MHz(MRU-2LB) + 2624~2690MHz(MRU-2FH or MRU-2UB)
- MCU-2B
  : 2625.5~2635.5MHz(MRU-2UB)+2642~2672MHz(MRU-2FH or MRU-2UB)
- MCU-2C
  : 2642~2672MHz(MRU-2FH or MRU-2UB)+2678.5~2688.5MHz(MRU-2UB)

NOTE

MCU-3 (Mobile WiMAX base station Combiner Unit-3way)

If SPI-2210 supports 3 noncontiguous carriers in any sector, MCU-3 is mounted instead of MCU-2. MCU-3 outputs three Tx paths combined into one path.

3.2.3 PDP-PO

On the bottom left of the outdoor SPI-2210, the PDP-PO is mounted.

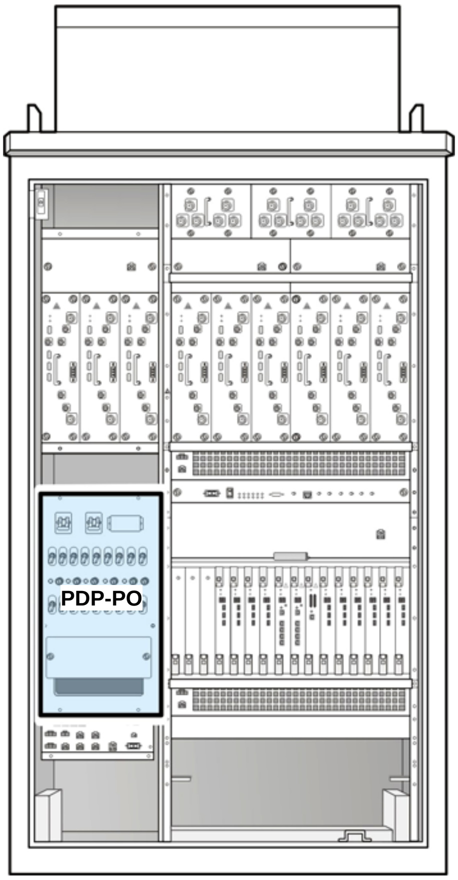


Figure 3.4 PDP-PO Configuration

Board Name	Quantity	Function
PDP-PO	1	Power Distribution Panel-Premium Outdoor PDP-PO receives DC power via a rectifier and distributes it to each block in a cabinet.

MRU-2/MRR on the RFB, AICU, UCM, and auxiliary device part receive -48 VDC from the PDP-PO and the UCM branches the supplied power to four fans in the outdoor SPI-2210. The PDP-PO supplies the power to each board of DMB via MBB-P and each board uses -48 VDC supplied after converting into the required power for the corresponding board.

NOTE

Antenna Interface Control Unit (AICU)

The AICU is the unit to supply the power and to receive/transmit alarm/control message to TTLNA (service provider's optional device). For more detailed information, refer to section '5.1'.

The PDP-PO is duplicated to supply -48 VDC to the MBB-P via two paths. Each path is divided into two input power sources, and the power which consists of ORing is supplied to the boards of the DMB from the input power sources.

The figure below shows the power layout indicating the type of the powers supplied to the PDP-PO from the cabinet input power source and their connection points:

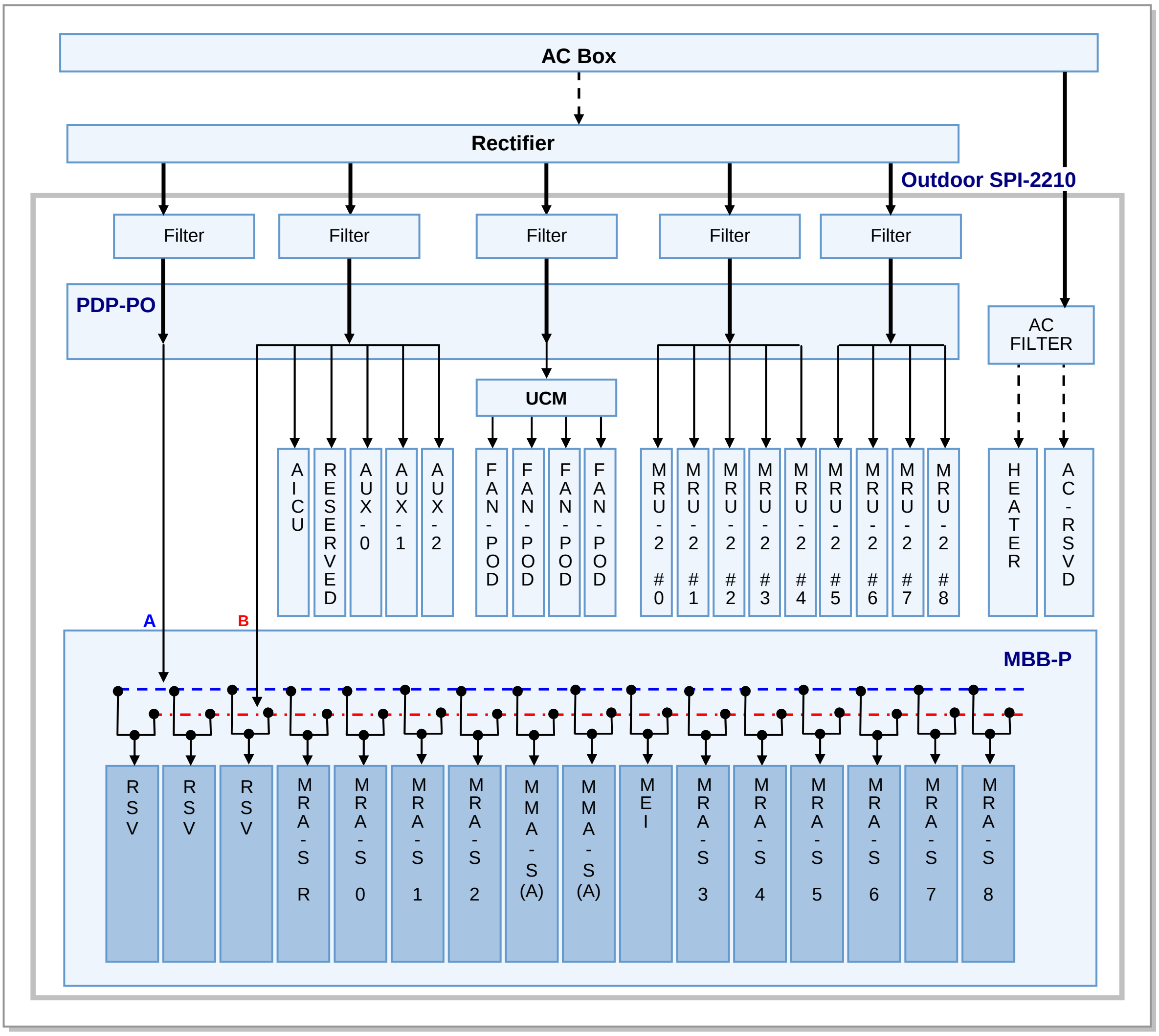


Figure 3.5 Power Structure

3.2.4 Direct Air Cooling System (DACS)

The DACS consists of the membrane filter and HDM, etc, and it controls the temperature of the system according to the control of the UCM.

DACS Configuration

The DACS is configured as follows:

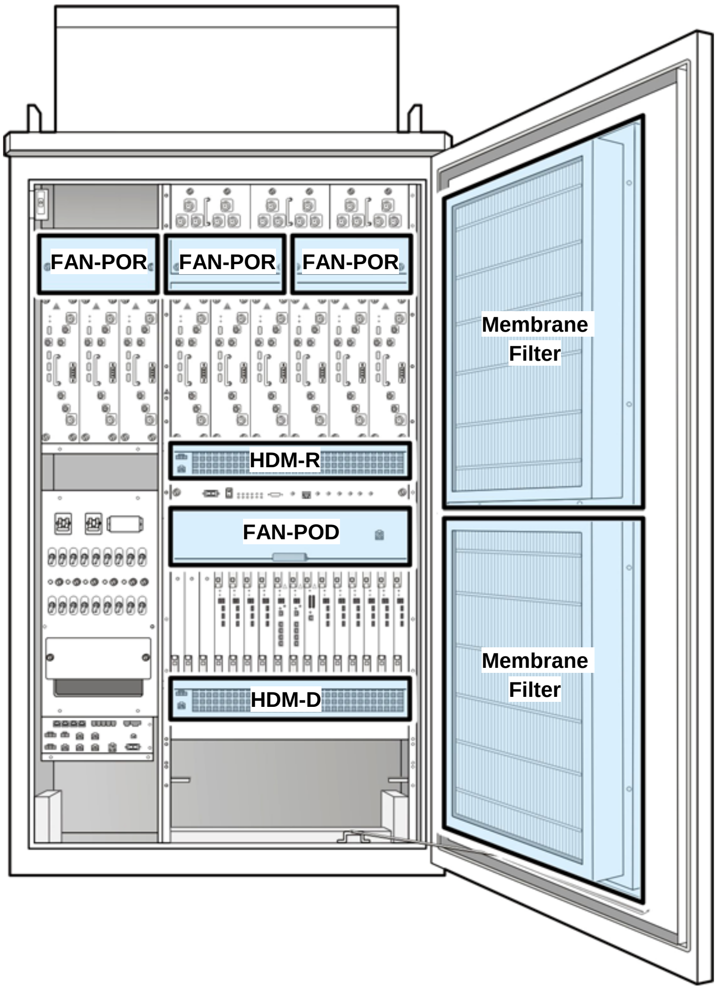


Figure 3.6 DACS Configuration

Board Name	Quantity	Function
FAN-POD	1	Fan module-Premium Outdoor DMB DMB cooling fan
FAN-POR	3	Fan module-Premium Outdoor RFB RFB cooling fan
HDM-R	1	Heater and Damper Module-RFB - HDM-R raise the temperature inside the system. (Heater: 2EA) - Open/close the exhauster of cabinet in the back of RFB

(Continued)

Board Name	Quantity	Function
HDM-D	1	Heater and Damper Module-DMB - HDM-D raise the temperature inside the system. (Heater: 1EA) - Open/close the exhauster of cabinet in the back of DMB
Membrane Filter	2	Protect the outdoor SPI-2210 from dust and rain

- Membrane filter
  The membrane filter enables the cool air to flow into the outdoor SPI-2210 and to protect the outdoor SPI-2210 from dust and rain.
- HDM-R/HDM-D
  The HDM consists of the heater and damper. On the outdoor SPI-2210, HDM-R mounted on the bottom of the RFB and HDM-D mounted on the bottom of DMB are mounted.
  The function of damper and heater is as follows:
  – Damper
    If the outdoor SPI-2210 is in the cold start or low temperature mode, the damper blocks the ventilating opening of the cabinet to prevent the outdoor SPI-2210 from heat loss in case of internal heating and to circulate the air in the inside.
    - Cold Start & low temperature mode: Damper Close
    - Normal temperature & high temperature mode: Damper Open
  – Heater
    The heater enables to raise the temperature inside the system when the temperature inside the system becomes the permissible level or less when initializing the system, operating the system. The heater is installed in the DMB and in the RFB, respectively, in order that the DMB and the RFB can operate normally when the system is in the low temperature.
    The UCM operates the heater according to the temperature inside the system detected by the temperature sensor mounted inside the outdoor SPI-2210.
    - Cold Start & low temperature mode: Operating the heater
    - Normal temperature & high temperature mode: Stopping the heater
- Fan
  On the outdoor SPI-2210, the fan (FAN-POD) dedicated for the DMB, which consists of a set of two fans is mounted, and three fans (FAN-POR) dedicated for RFB are mounted. The FAN-POD and the FAN-POR maintain the temperature inside the cabinet appropriately in order that the system can operate normally. The UCM controls the fan according to the temperature inside the system detected by the temperature sensor mounted inside the outdoor SPI-2210.
  – Cold Start & low temperature mode: Operating at low speed
  – Normal temperature & high temperature mode: Operating at high speed

DACS Operation

If the temperature inside the outdoor SPI-2210 becomes the permissible level or less, the DACS operates the damper of HDM as the closed loop mode to circulate the air inside the system, and maintains the appropriate temperature inside the system by using the generation of heat of the system or the heater.
To the contrary, if the temperature inside the outdoor SPI-2210 becomes the permissible level or more, the DACS operates the damper of HDM as the open loop mode. The open loop mode enables the cool air outside the system to flow into the inside of the system and cool the module inside the system, and it also enables the hot air inside the system to be released out of the system and cool the system.

Fan Operation

If the temperature inside the outdoor SPI-2210 is low, FAN-POD and FAN-POR operate at low speed by the control of UCM. To the contrary, if the temperature inside the outdoor SPI-2210 is high, FAN-POD and FAN-POR operate at high speed by the control of UCM.

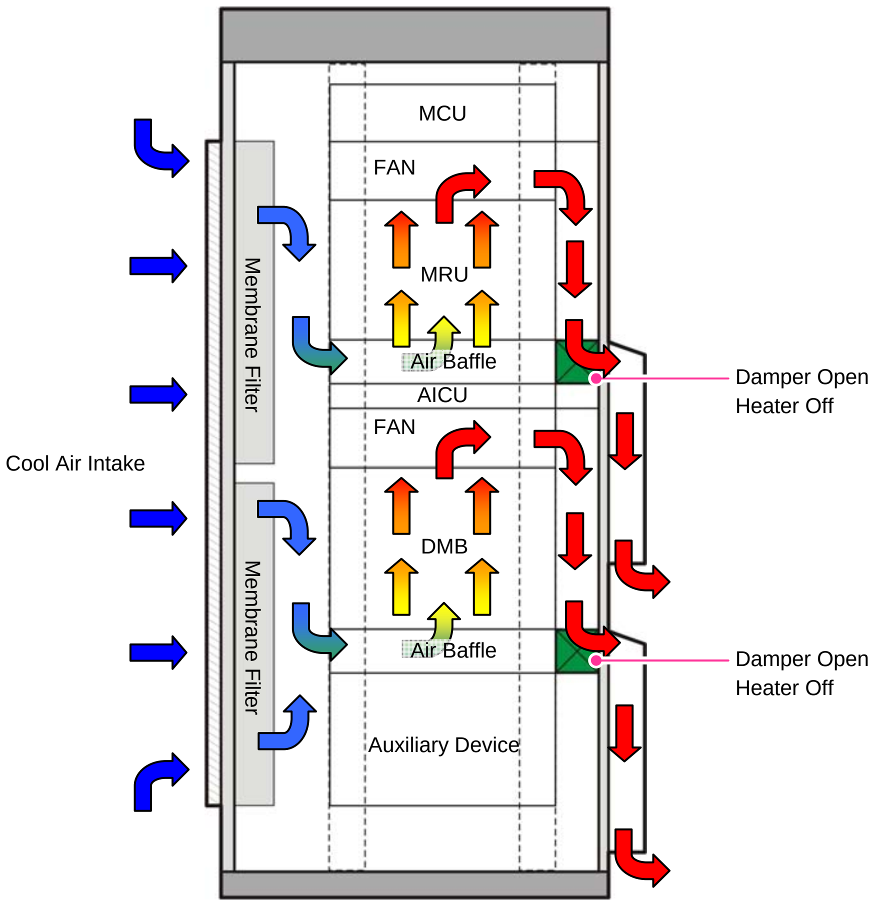


Figure 3.7 Heat Radiation Structure of the Outdoor SPI-2210

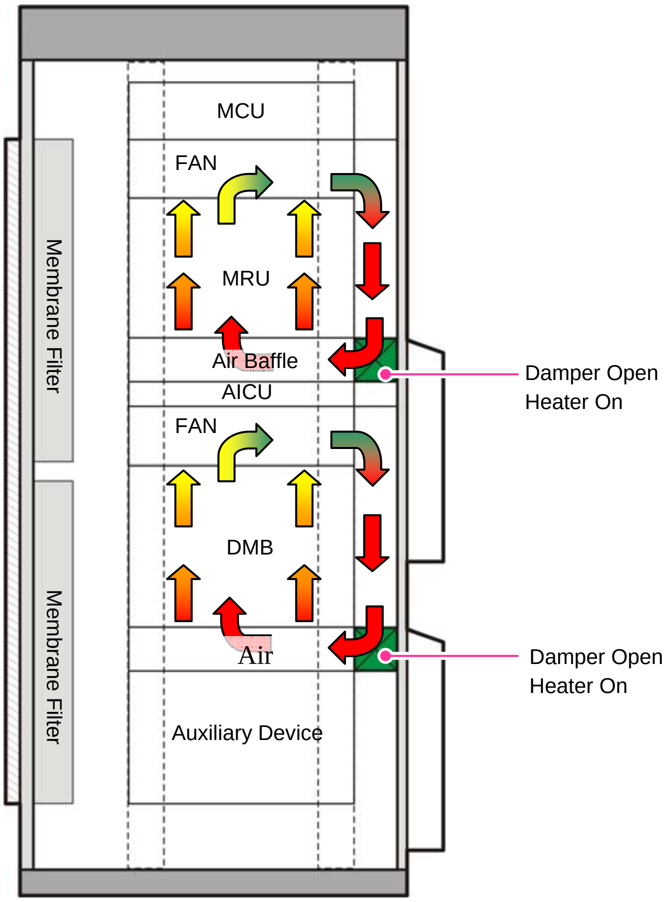


Figure 3.8 Heating Structure of the Outdoor SPI-2210

3.2.5 Universal Control Module (UCM) and Sensor

The configuration of the UCM and sensor is as follows.

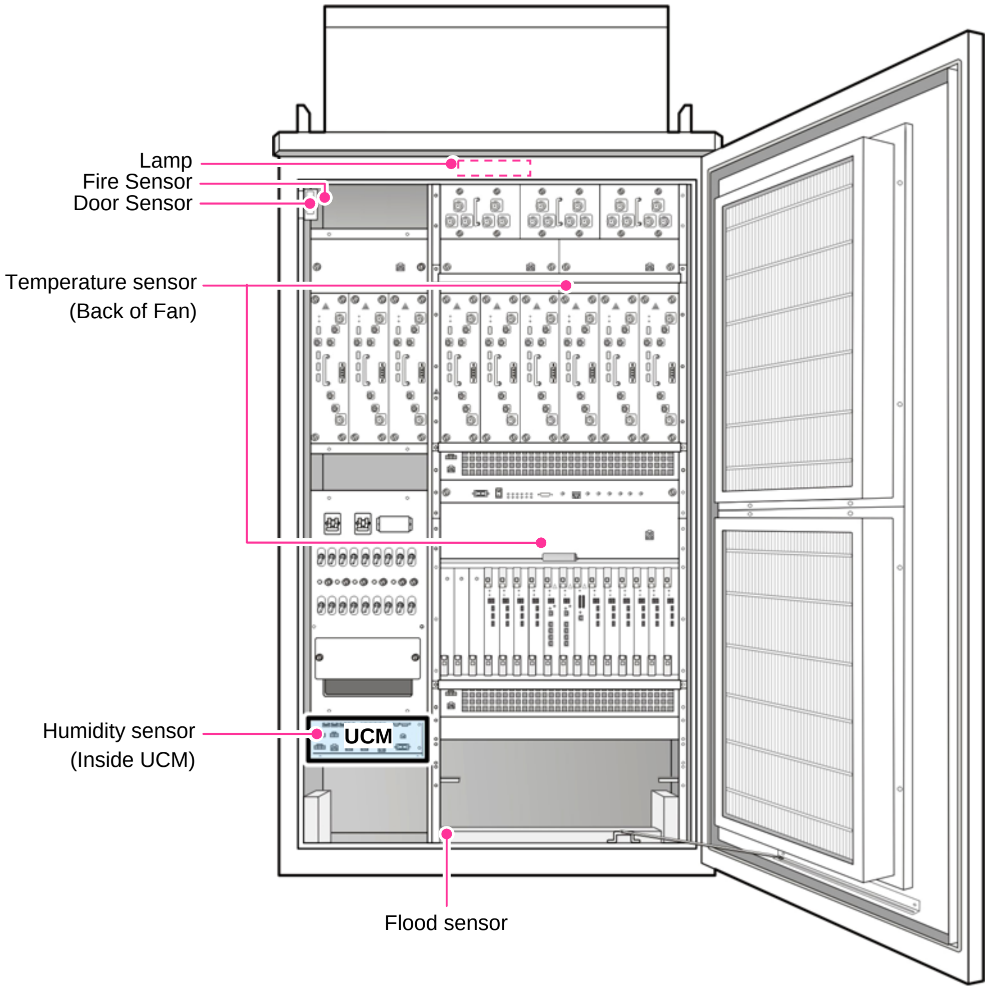


Figure 3.9 UCM and Sensor Configuration

Board Name	Quantity	Function
UCM	1	Universal Control Module - Fan control and alarm collection - Damper close/open control and alarm collection - Heater control and alarm collection - Detecting the temperature by the temperature sensor and collecting the alarms on mounting/dismounting the temperature sensor - Temperature alarm collection - Flood/fire alarm collection - Rectifier alarm collection - Door Open alarm collection - Reporting the collected alarms to the MEI
Sensor	6	Temperature sensor (2), humidity sensor (1), flood sensor (1), fire sensor (1), door sensor (1)

The UCM maintains and controls the temperature inside the outdoor SPI-2210, collects and reports the external environment alarms. The UCM detects the temperature inside the cabinet by the sensors of the exit of the DMB and the entrance of the RFB, and operates and controls the fan, the heater and the damper according to this, and if the alarm is generated, the UCM reports this to the upper part via the MEI. In addition, the UCM collects the data on the environment in real time by being connected to the environment monitoring sensor installed inside the cabinet, and if the environmental alarm is generated, the UCM reports this to the upper part via the MEI.
The UCM also performs the function of monitoring the environment of the rectifier cabinet according to the RS-485 method.

The UCM turns on the lamp installed in the cabinet when the cabinet door is open by being connected to the sensor which detects the opening/closed status of the cabinet door.

If the outdoor SPI-2210 is initialized, the rectifier supplies the power only to the UCM and the DACS, first, to measure the temperature inside the system. If the temperature inside the system is less or more than the permissible level, the UCM raises or decreases the temperature by controlling the HDM (HDM-R/D) and fan (FAN-POD/FAN-POR). If the temperature inside the system becomes normal, the UCM controls the rectifier to supply the power to other blocks other than the UCM.

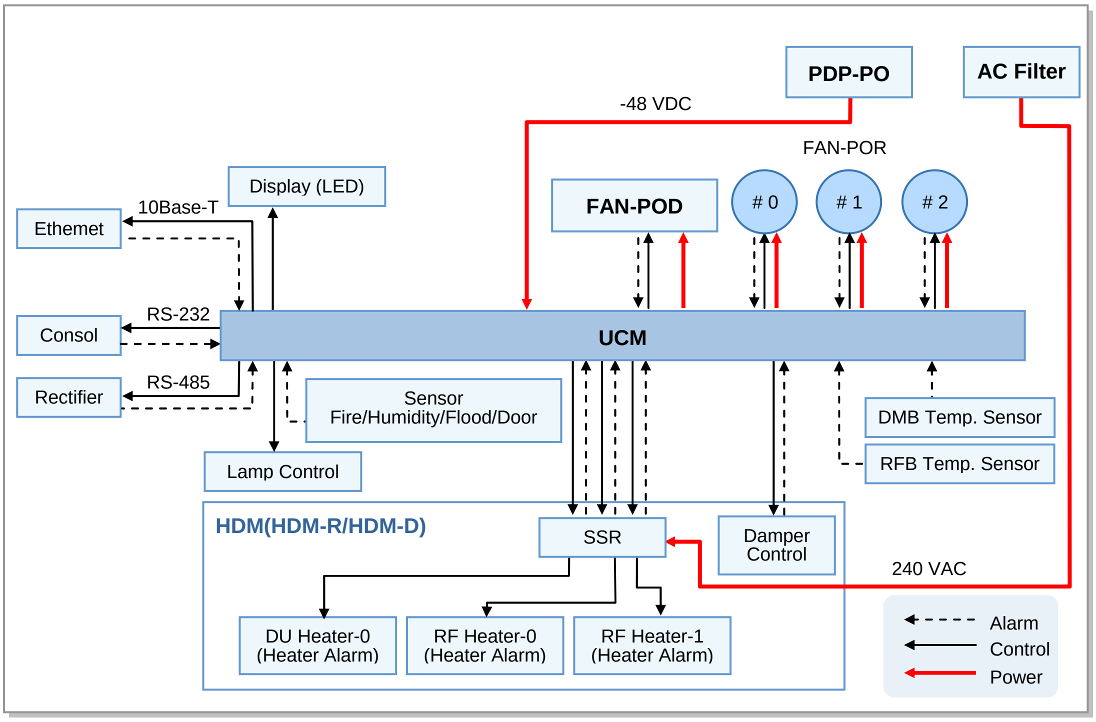


Figure 3.10 UCM Configuration Diagram of the Outdoor SPI-2210

> NOTE
>
> **Solid State Relay (SSR)**
>
> SSR turns the heater on or off by controlling of UCM.

3.2.6 I/O Module

The I/O module is configured as shown in the figure below:

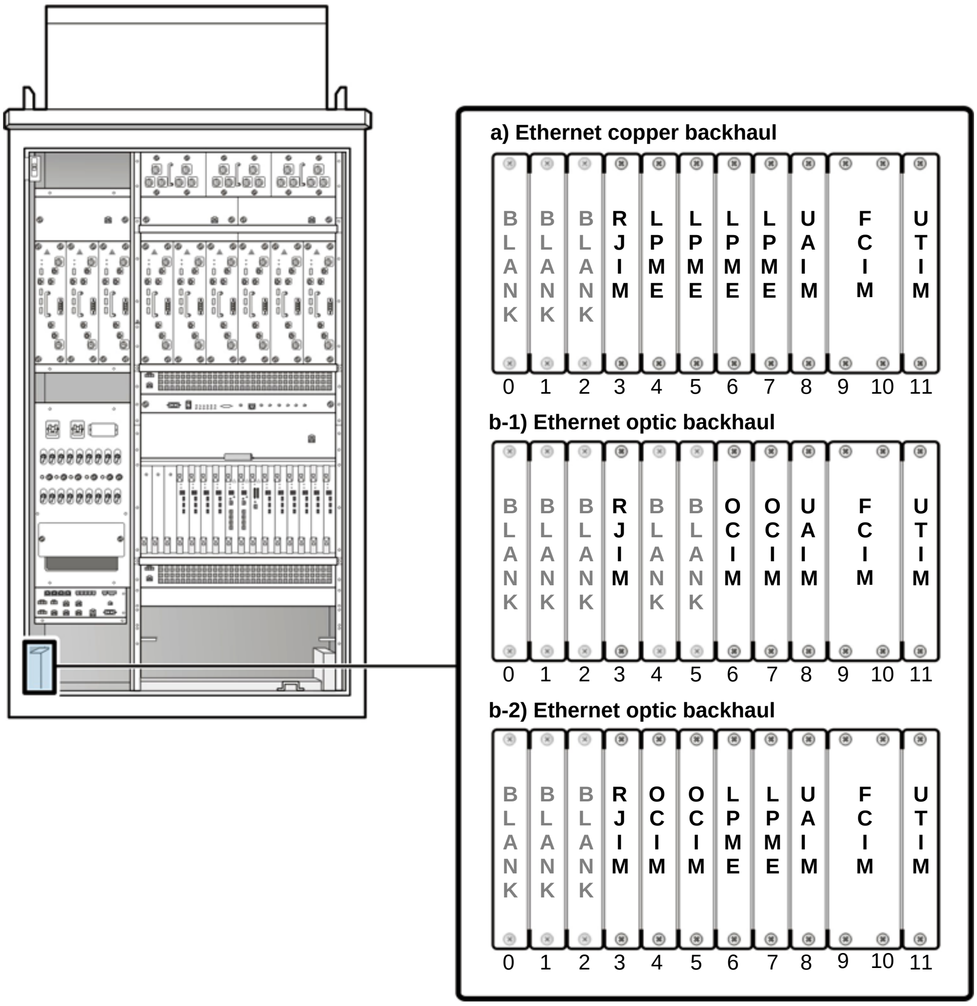


Figure 3.11 I/O Module Configuration

Board Name	Quantity	Function
RJIM	1	RJ-45 IO Module RJ-45 connector cable termination stiffener (optional item)
LPME	Max. 4	Line Protection Module for Ethernet 100/1000Base-T trunk line protection module
UAIM	1	User Defined Alarm IO Module 24 Rx/6 Tx UDA alarm port module
FCIM	1	Form C Interface Module 4 ports Form C interface module
UTIM	1	UDE and TDD IO Module UDE (3), TDD (2), fan alarm (1), Temperature sensor (1), Form C control (1) port
OCIM	Max. 2	Optic Cable IO Module FE/GE optic trunk cable stiffener

3.2.7 External Interface Structure

The layout of Outdoor SPI-2210 external interfaces is as shown in the figure below:

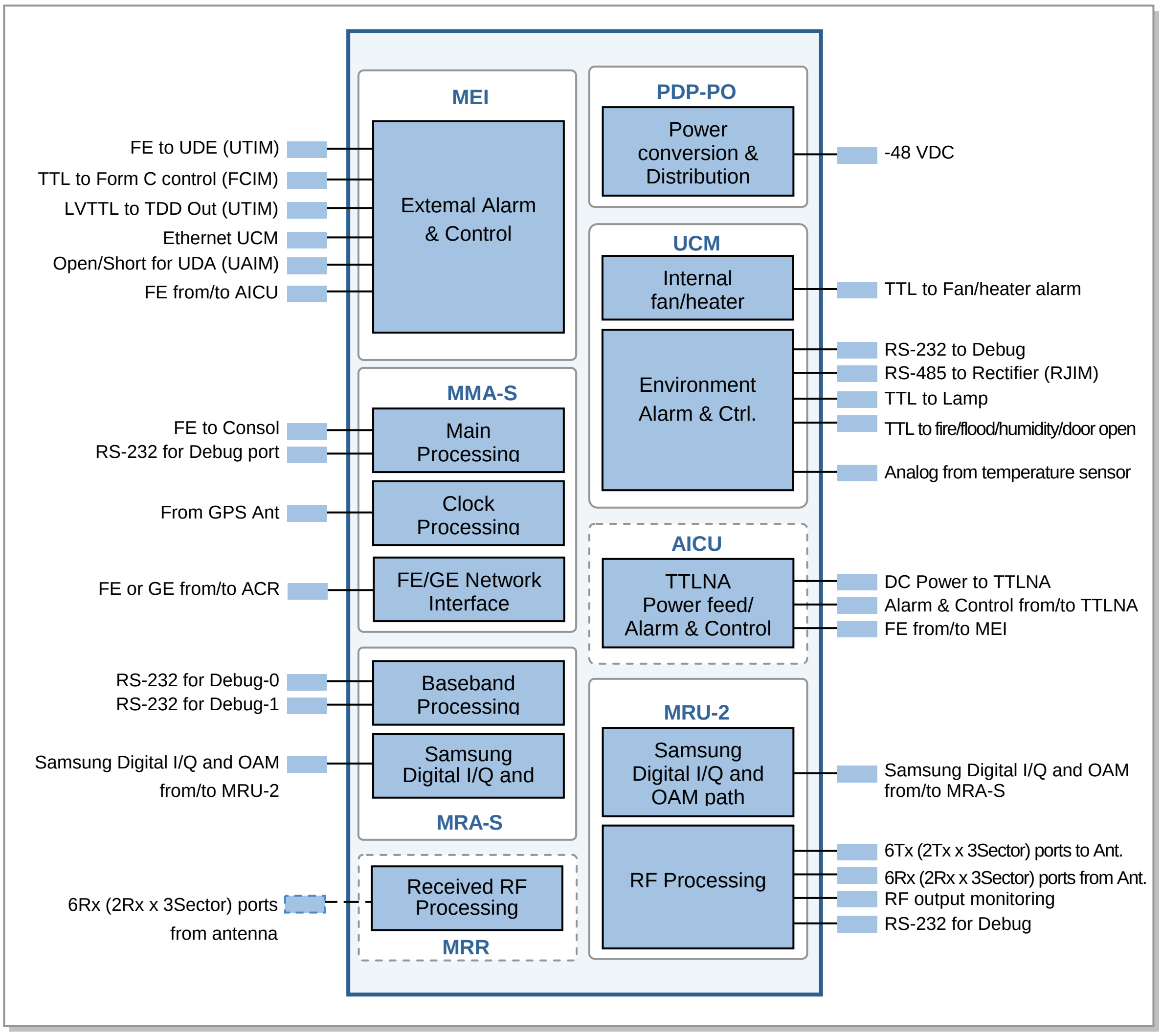


Figure 3.12 External Interfaces of Outdoor SPI-2210

The external interfaces provided in the outdoor SPI-2210 are as listed in the table below:

Category	Interface Type	Port Numbers	Connector Type
Backhaul	Simultaneous operation of 1000Base-X and 100/1000Base-TX	2 2	1000Base-X: SFP (LC) 100/1000Base-Tx: RJ-45
	100/100Base-TX	4	RJ-45
	1000Base-X	2	GBIC (LC)
	100Base-FX	4	SFF (LC)
GPS Antenna	Analog RF	1	N-type
GPS Splitter	Analog RF	1	N-type
UDE	10/100Base-TX	2	RJ-45
Form C	60VDC/5A	4	Terminal Block
TDD	LVTTL (at MEI)	1	SMA
	LVTTL (at UTIM)	1	SMA
UDA (6Tx/24Rx)	Open/Short	1	68Pin Champ
Rectifier Interface	RS-485	1	RJ-45
TTLNA Control	DC power/TDD/Alarm	6	SMA
Antenna Interface	Analog (Main Traffic)	Max. 12	7/16-DIN

3.3 Software Structure

3.3.1 Basic Structure

The components of the outdoor SPI-2210 software is 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 outdoor SPI-2210.

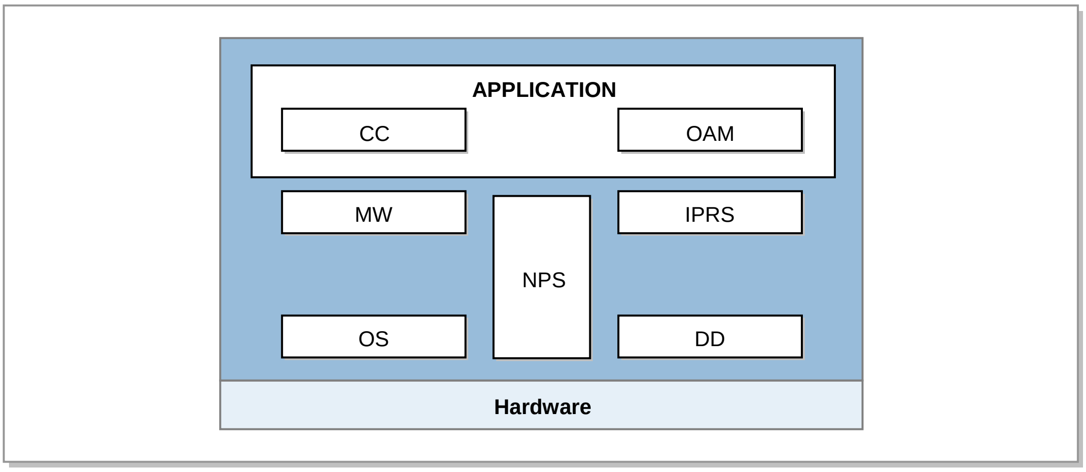


Figure 3.13 Software Structure of Outdoor SPI-2210

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, High Availability (HA) service for duplex managing and data backup, debugging utility services. In addition, the MW provides the systematic and strong management of the account, the authority and the authentication function.

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 outdoor SPI-2210, 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 or SNMPv3, SFTP, HTTPs, SSH) of which the security is strengthened, and 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, processing the call, collecting the statistics for various performance data, managing the system configuration and resources, managing the status of the software resources and the hardware resources, managing the failure and performing the diagnostics for the operation and the management of the outdoor SPI-2210.

3.3.2 Call Control (CC) Block

The CC block caries out the resource management function of the outdoor SPI-2210 and the BS function of ASN Profile-C defined in NWG of Mobile WiMAX forum. The CC block consists of RAS Resource Controller (RRC), RAS Service Controller (RSC) and RAS Traffic Controller (RTC) sub-blocks and the functions of each sub-block are as follow:

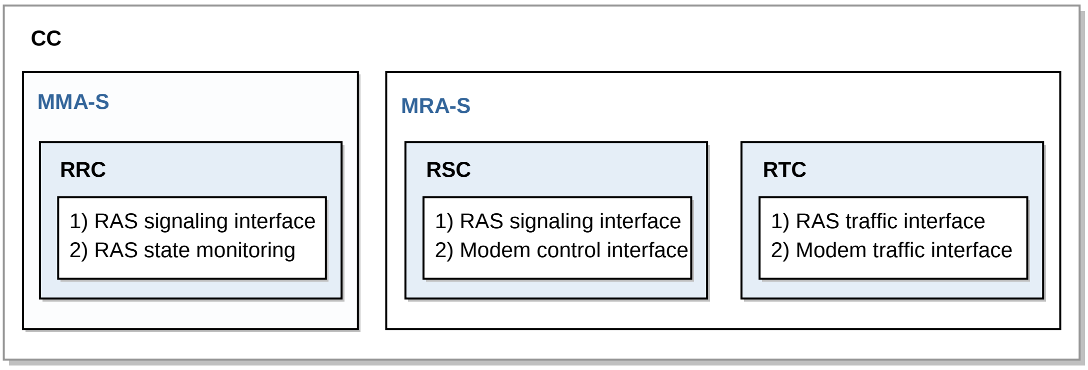


Figure 3.14 CC Block Structure

RRC as the resource manager of the outdoor SPI-2210 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 Admission Control (AC) 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 outdoor SPI-2210.

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.

3.3.2.1 RAS Resource Controller (RRC)

RRC is in charge of the resource management of the outdoor SPI-2210 and is activated on the MMA-S. The RRC interfaces with ACR outside the system and the RSC and OAM blocks inside the system.

RRC's main functions are as follows:

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

3.3.2.2 RAS Service Controller (RSC)

The RSC is in charge of the signaling-concentrated service in the outdoor SPI-2210.
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.

RSC's main functions 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

3.3.2.3 RAS Traffic Controller (RTC)

The RTC is the block to process the traffic of the outdoor SPI-2210. 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-S). 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 outdoor SPI-2210 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.

3.3.3 Operation And Maintenance (OAM) Block

OAM block manages the operation and maintenance of the outdoor SPI-2210, and it is divided as the three shown below: EMS Interface (EMI), Main OAM and Board OAM.

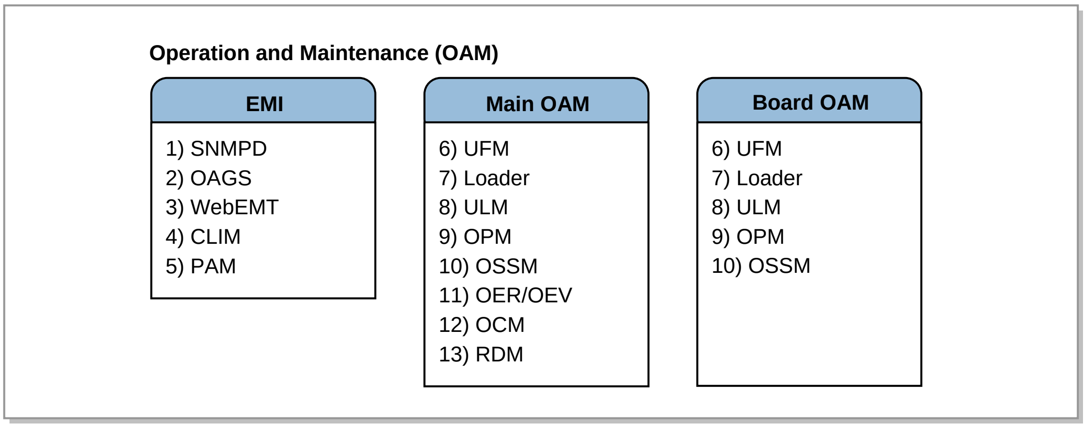


Figure 3.15 OAM Software Structure

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

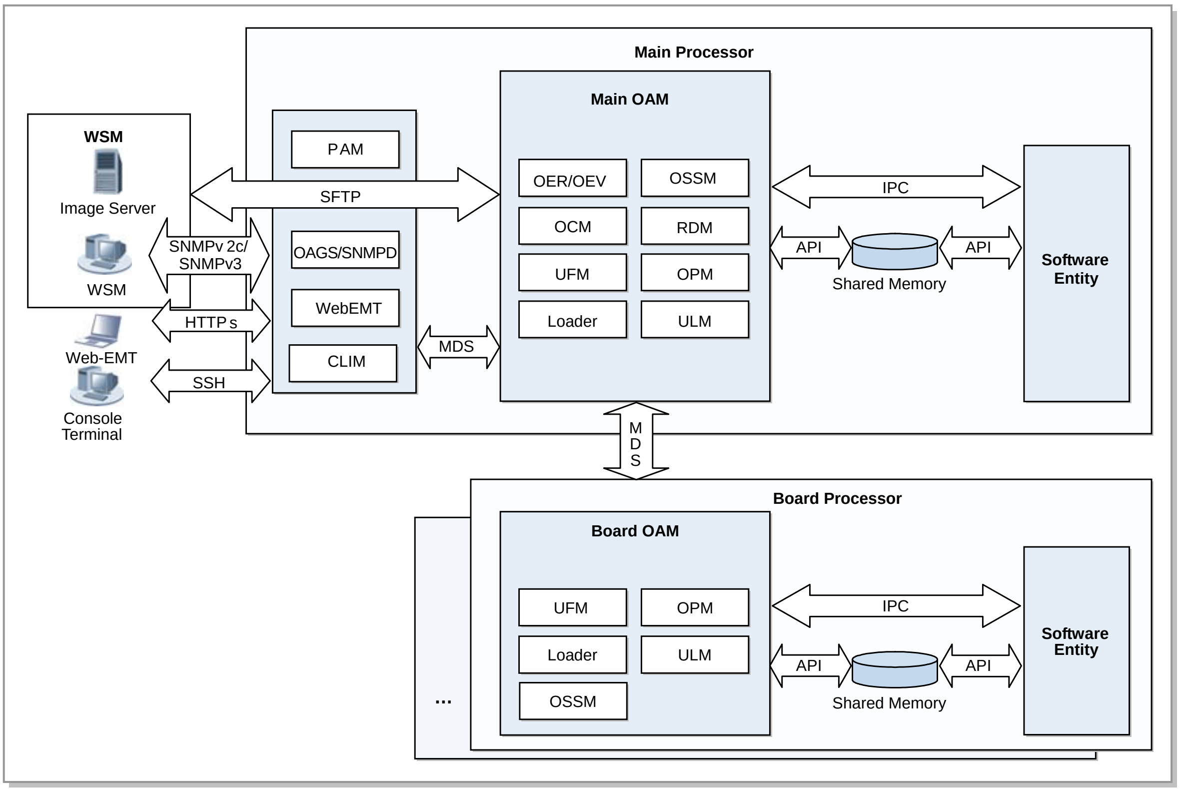


Figure 3.16 Interface between OAM Blocks

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 outdoor SPI-2210 by providing the IMISH. Then, to access the outdoor SPI-2210 directly via the Web-EMT or the console terminal, the process of the operator authentication and the authority allowance via the 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 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.

3.3.3.1 SNMP Daemon (SNMPD)

SNMPD plays the SNMP agent role to support the standard SNMP (SNMPv2c or SNMPv3c) 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.

SNMPD Main Functions

- Standard MIB processing
  If the request for the MIB-II and 802.3ah MIB object 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 Implementation

SNMPD is implemented on the MMA-S as shown below. MMA-S has 1:1 active/standby redundancy.

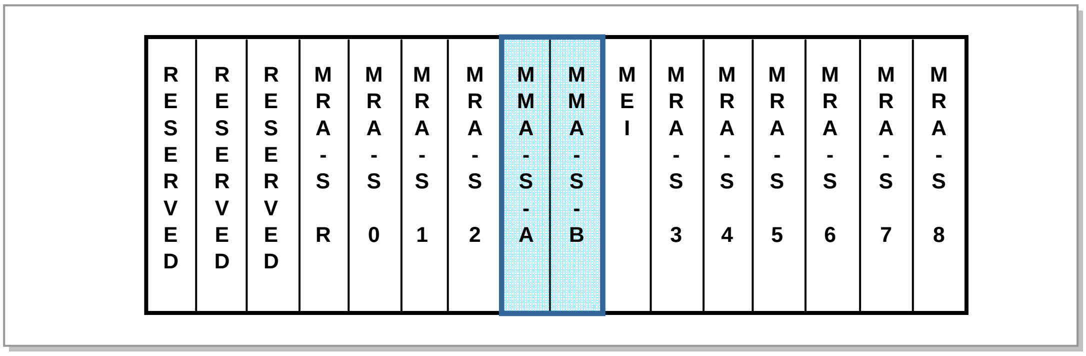


Figure 3.17 SNMPD Block

3.3.3.2 Common SNMP Agent Subagent (OAGS)

OAGS plays the SNMP subagent role to support the standard SNMP (SNMPv2c or SNMPv3c).

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.

OAGS Main Functions

- 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 outdoor SPI-2210 data to the upper management system.

OAGS Implementation

OAGS is implemented on the MMA-S as shown below. MMA-S has 1:1 active/standby redundancy.

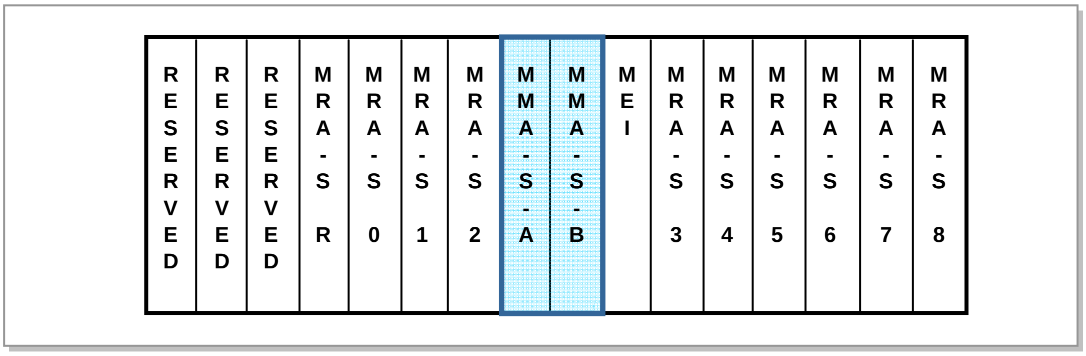


Figure 3.18 OAGS Block

3.3.3.3 Web-based Element Maintenance Terminal (WebEMT)

The 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 outdoor SPI-2210 support the HTTP communications based on the Secure Sockets Layer (SSL).

WebEMT Main Functions

- 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

WebEMT Implementation

WebEMT is implemented on the MMA-S. MMA-S has 1:1 active/standby redundancy.

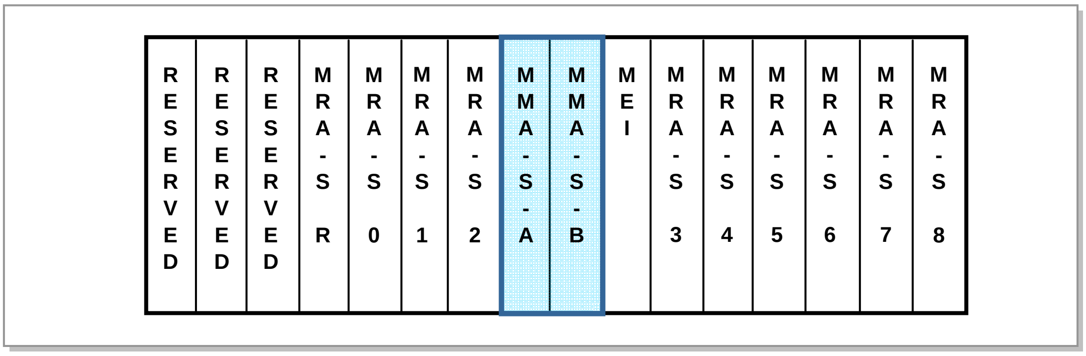


Figure 3.19 Web-EMT Block

3.3.3.4 Command Line Interface Management (CLIM)

The 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.

CLIM Main Functions

- IMISH command processing
  - Setup/change/inquiry of interface and routing functions
  - Setup/change/inquiry of the outdoor SPI-2210 operation & maintenance

CLIM Implementation

CLIM is implemented on the MMA-S as shown below. MMA-S has 1:1 active/standby redundancy.

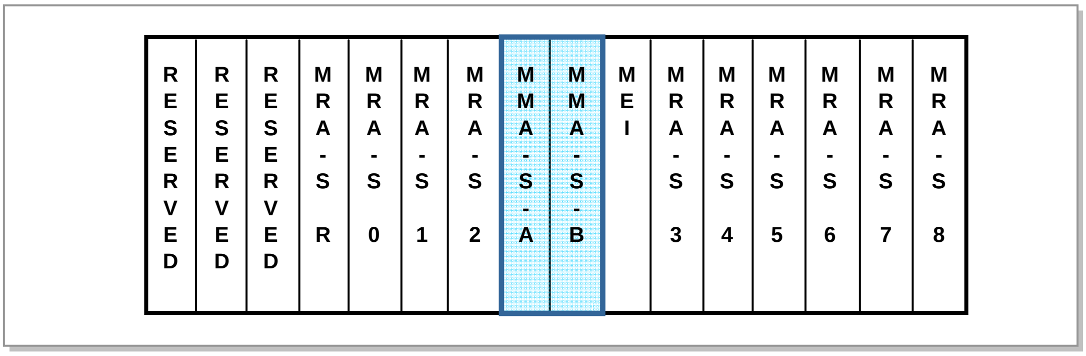


Figure 3.20 CLIM Block

3.3.3.5 Pluggable Authentication Module (PAM)

The PAM receive the account and the password of the operator who uses the console terminal (IMISH, Web-EMT) when logging in, thus performs the operator authentication and the process of allowing the authority.

PAM Main Functions

- Operator's account management and authentication
  The function of managing and authenticating the account of the operator who uses the console terminal (IMISH, 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 Implementation

PAM is implemented on the MMA-S as shown below. MMA-S has 1:1 active/standby redundancy.

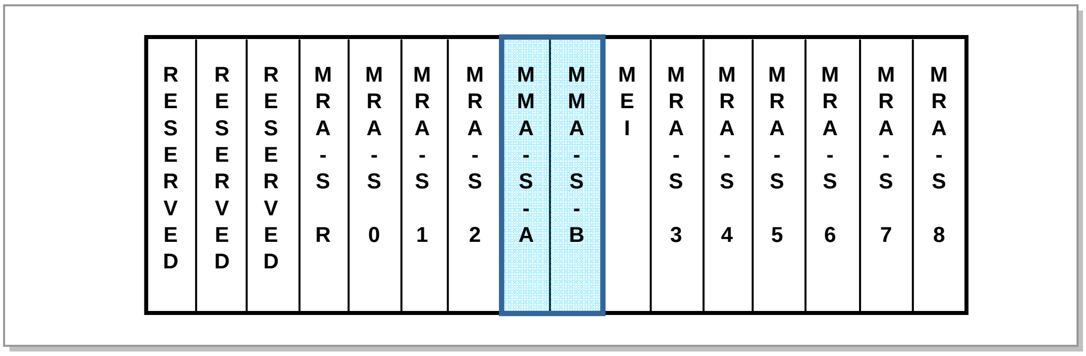


Figure 3.21 PAM Block

3.3.3.6 Universal Fault Management (UFM)

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), distributes the received ToD to CC software for call processing, and manages faults concerned with the ToD.

In addition, the UFM provides the interface function with Device Driver (DD) to support statistics and status management for devices such as Marvel switch 98DX246/98DX166 and Comet PM4358 of MMA-S/MEI. The interfaces for Marvel switch 98DX246/98DX16 and Comet PM4358 are called Marvel Switch Device Driver Interface (MVSDDI) and Comet Device Driver Interface (CMDDI), respectively.

UFM Main Functions

- 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 ACR and the upper management system.
- Failure history information management and save
- Redundancy of the failure information
  Redundancy of the failure information is supported between the active/standby status of the main OAM board which supports the 1:1 active/standby structure.
- 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
  he interface between DD and applications is provided for statistics and status management of devices.

UFM Implementation

UFM is implemented in MMA-S and all lower boards as shown below.

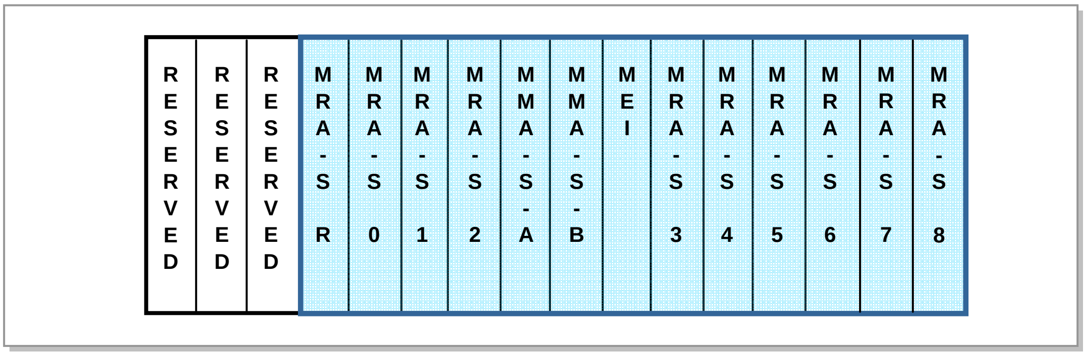


Figure 3.22 UFM Block

3.3.3.7 Loader

Loader manages the entire process from the start of OS to the previous step of ULM running (pre-loading). After that, if ULM is actuated after the initialization script is executed and the registration and loading function is performed, the loader monitors the ULM block.

Loader Main Functions

- System time setting
  Before NTP-based synchronization, the system time is set by receiving the Time of Date (ToD) from a GPS receiver.
- Outdoor SPI-2210 registration and loading
  - Registration of the outdoor SPI-2210 to the Registration Server (RS)
  - Determination of the loading method
    1) Loading of most recent version through version comparison: loading through self non-volatile storage or remote IS
    2) Loading through console port (The process to register the ACR to the RS is skipped.)
- 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, the operator sends a command for backup.)
- ULM monitoring
  Loader monitors whether the ULM block operates normally and if it is abnormal, this restarts it.

Loader Implementation

Loader is implemented on the MMA-S and all lower board as shown below.

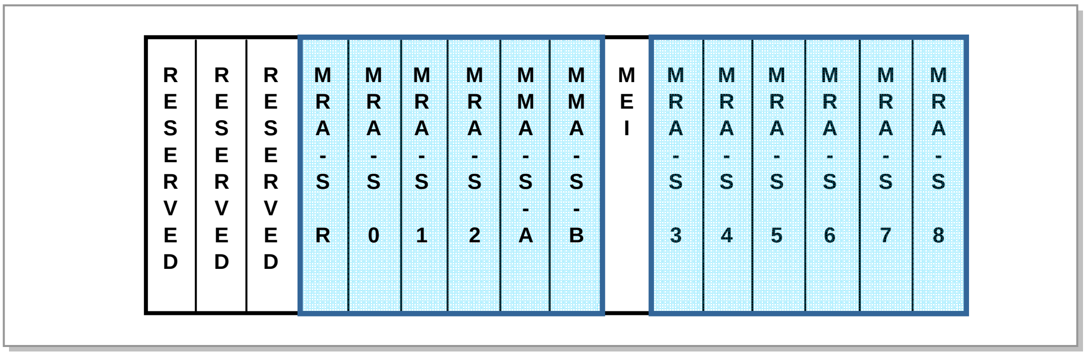


Figure 3.23 Loader Block

3.3.3.8 Universal Loading Management (ULM)

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.

ULM Main Functions

- 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, the serial number and the Common Language Equipment Identifier (CLEI), 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 Implementation

ULM is implemented on the MMA-S and all lower board as shown below.

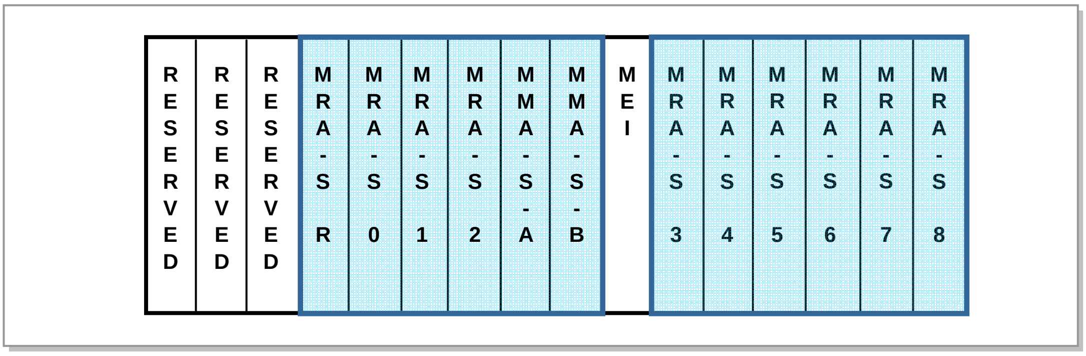


Figure 3.24 ULM Block

3.3.3.9 Common Performance Management (OPM)

OPM collects and provides the performance data for the upper management system operator to know the outdoor SPI-2210 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 SFTP.

OPM Main Functions

- 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 Implementation

OPM is implemented on the MMA-S and all lower board as shown below.

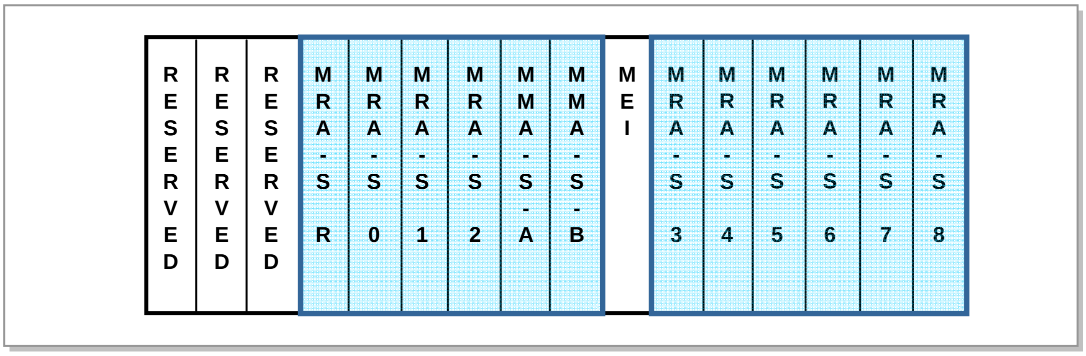


Figure 3.25 OPM Block

3.3.3.10 Common Subscription Service Management (OSSM)

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.

OSSM Major Functions

- 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 outdoor SPI-2210 (between main board and lower boards)

OSSM Implementation

OSSM is implemented on the MMA-S and all lower board.

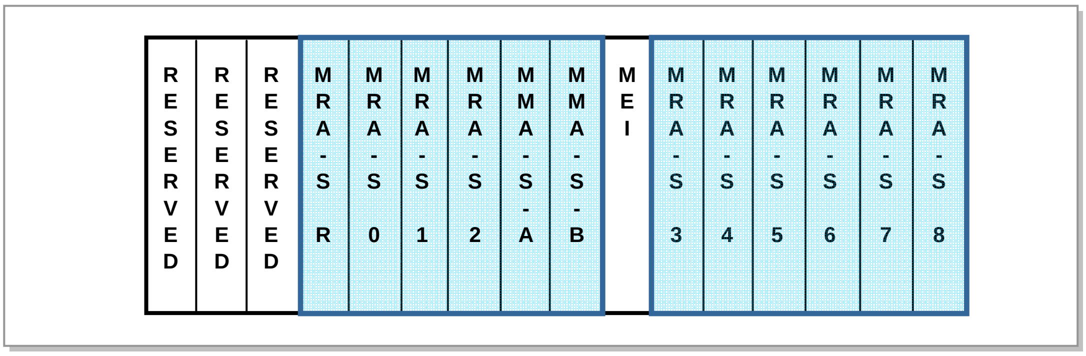


Figure 3.26 OSSM Block

3.3.3.11 Common Event Router (OER)/Common Event Viewer (OEV)

The OER/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.

OER/OEV Major Functions

- 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 outdoor SPI-2210 on the operator window (IMISH) in real time.

OER/OEV Implementation

OER/OEV is implemented on the MMA-S. MMA-S has 1:1 active/standby redundancy.

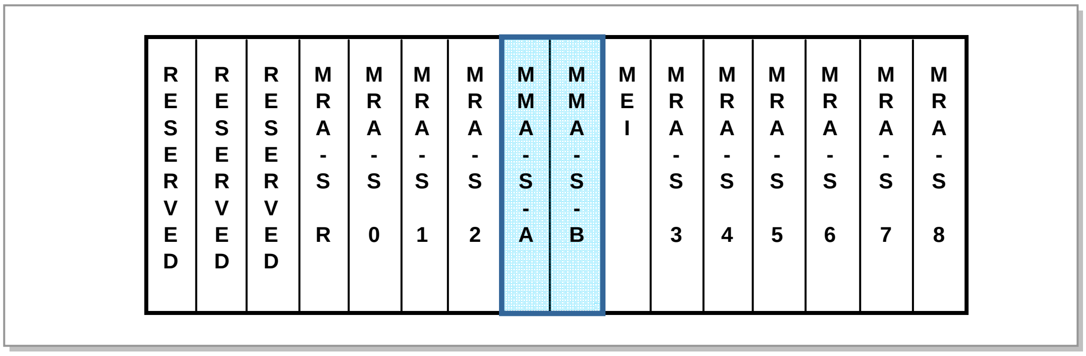


Figure 3.27 OER/OEV Block

3.3.3.12 Common Configuration Management (OCM)

OCM manages the outdoor SPI-2210 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: Outdoor SPI-2210 configuration grow/degrow, inquiry and change of configuration data and operational parameters.

OCM Major Functions

- ACR configuration management
  Manage the outdoor SPI-2210 system configuration with PLD
- PLD inquiry and change
  - Upper management system inquires and changes PLD by command
  - Updating PLD changes to self non-volatile storage with an operator command
- PLD audit
  For the consistent PLD data with the upper management system
- Grow/degrow of resources
  Link, board, carrier, sector, the auxiliary devices in the outdoor SPI-2210

OCM Implementation

OCM is implemented on the MMA-S. MMA-S has 1:1 active/standby redundancy.

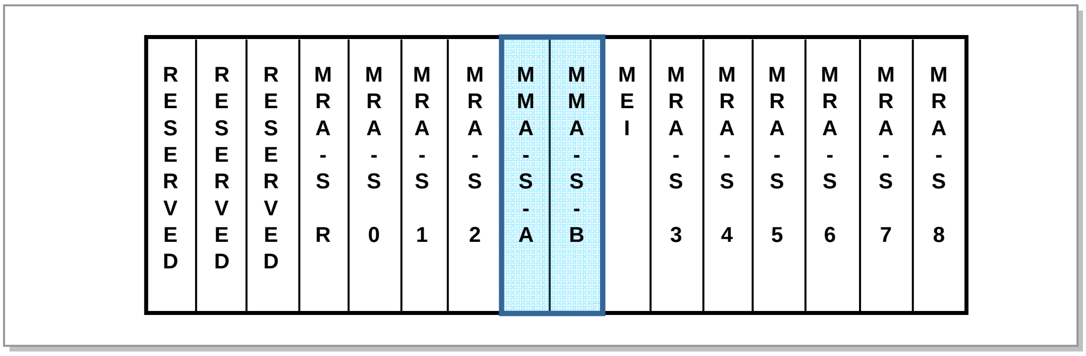


Figure 3.28 OCM Block

3.3.3.13 RAS Diagnosis Management (RDM)

The RDM checks if internal and external connection paths or resources of the outdoor SPI-2210 are normal. The connection paths are roughly divided into the external path between the outdoor SPI-2210 internal IPC path and another NE and the path between ACR and the outdoor SPI-2210. 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.

RDM Functions

- Path Test
  - Internal path test: Ping test for the IPC path of the board level in NE
  - External path test: Traceroute test for external hosts
  - Traffic path test: Test for the UDP message-based bearer path between ACR and the outdoor SPI-2210
- 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
- Loopback Test
  Support of IEEE 802.3ah Ethernet loopback functions
- Backhaul performance monitoring test
  Quality (packet loss, delay and delay variance) measurement for backhaul between ACR and the outdoor SPI-2210
- 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, traffic statistics) to the management system via SNMPD.
- 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, redundancy structure and management of failure/status

RDM Configuration

The RDM is implemented on the MMA-S as shown in the figure below. The MMA-S has 1:1 redundancy (active/standby) structure.

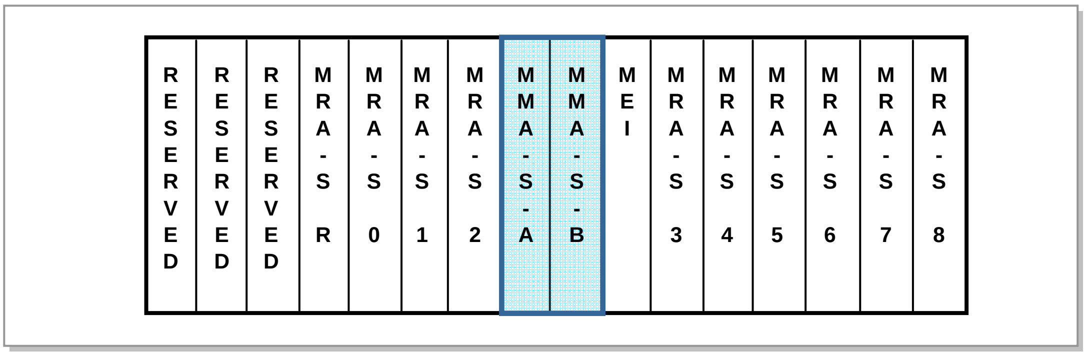


Figure 3.29 RDM Block

3.4 Redundancy Structure

The outdoor SPI-2210 has the redundancy structure for main processors, devices and links to provide persistent and stable service by enhancing the reliability and availability.
In the figure below, '● (Red)' mark indicates the board in service and '○ (White)' mark indicates the board in standby mode.

3.4.1 MMA-S Redundancy Structure

The MMA-S, which is the main processor of the outdoor SPI-2210, supports the redundancy structure for the system reliability. The MMA-S functionally consists of the OAM block and the UCCM for GPS reception and clock distribution and each block has the redundancy structures as follows:

Redundancy Structure of OAM Block

The OAM block of MMA-S is duplicated in active/standby method. The two dual boards sends/receives data required for the duplication in Low Voltage Differential Signaling (LVDS) method.

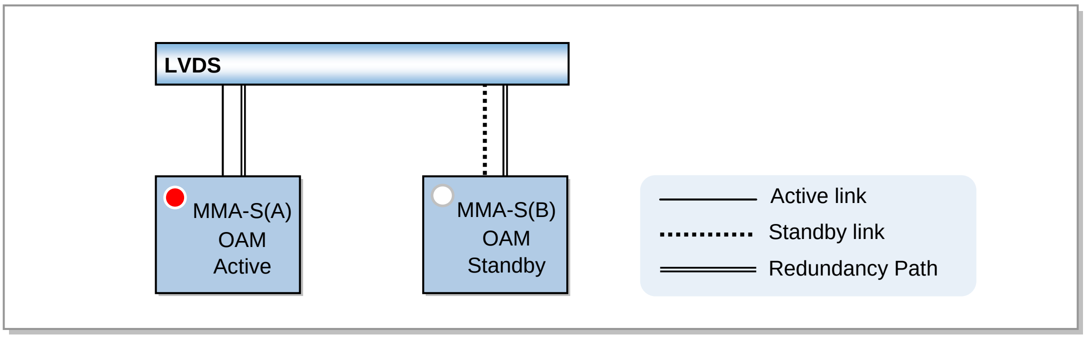


Figure 3.30 Redundancy Structure of OAM Block (MMA-S)

Redundancy Structure of UCCM

The UCCM of MMA-S is duplicated in active/standby method. The two dual boards sends/receives data required for the duplication in LVDS method

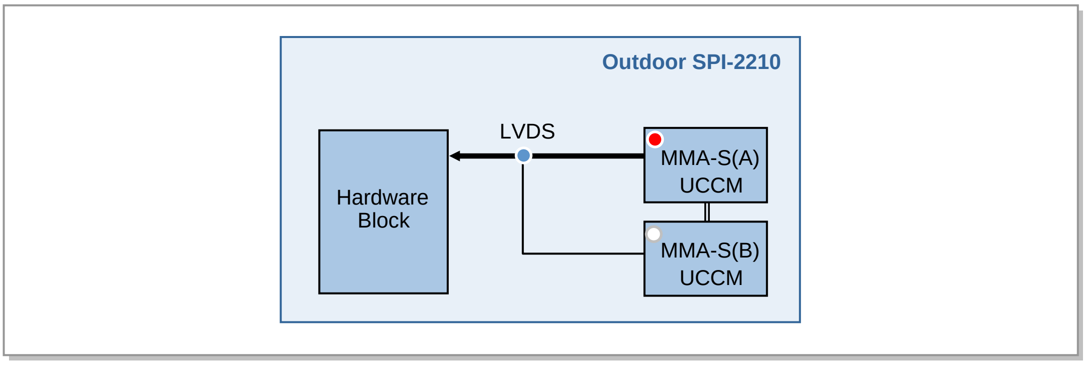


Figure 3.31 Redundancy Structure of UCCM (MMA-S)

3.4.2 MRA-S Redundancy Structure

The MRA-S performs the call processing function in the outdoor SPI-2210 and has N:1 redundancy structure only for 1st carrier. Redundancy structure of MRA-S is provided to service providers optionally.

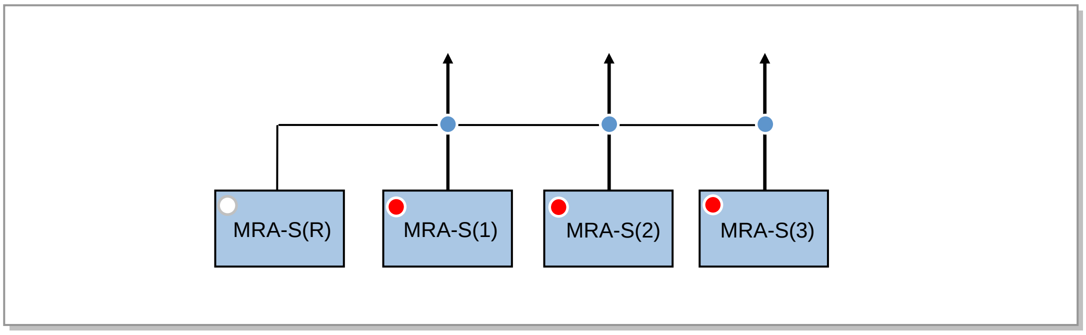


Figure 3.32 MRA-S Redundancy Structure

> **NOTE**
>
> **Switchover of MRA-S**
>
> Active MRA-S doesn't backup the data to redundancy MRA-S on principle that existing service is not kept on in the switchover of MRA-S.

3.4.3 Backhaul Redundancy Structure

The backhaul interface of outdoor SPI-2210 supports static link aggregation (IEEE 802.3ad) based load sharing. The link aggregation (802.3ad) redundancy method ties several ports as an interface group to deal with some or entire traffic in the remain group pertaining to the group even if a fault occurs in some ports.

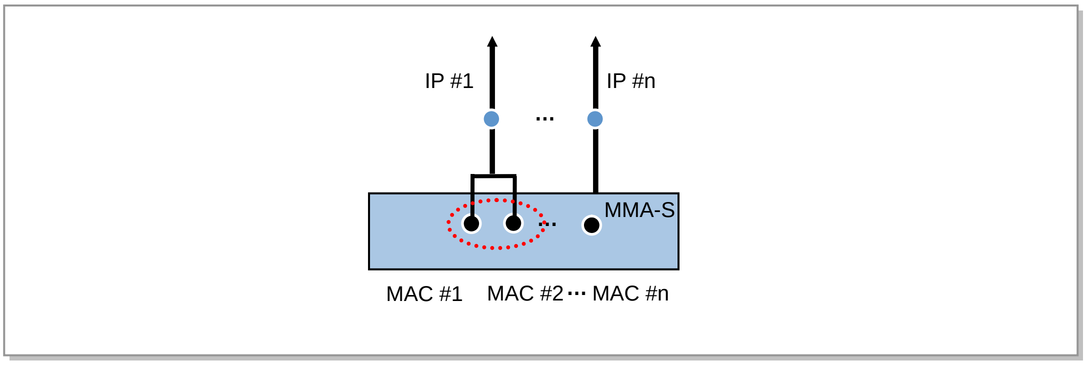


Figure 3.33 Load Sharing Structure of Backhaul

CHAPTER 4. Message Flow

4.1 Call Processing Message Flow

4.1.1 Initial Access

The following is the procedure to set the Provisioned Service Flow (SF) of the network-initiated Dynamic Service Add (DSA) mode in the process of the initial network entry.

An MS periodically receives Downlink Channel Descriptor (DCD), Downlink-MAP (DL-MAP), Uplink Channel Descriptor (UCD) and Uplink-MAP (UL-MAP) messages from the RAS in the initial access, acquires the downlink channel synchronization and the uplink parameter and sets the Provisioned SF connection.

The ACR supports the PMIP and simple IP methods when allocating an IP address to the MS. When the PMIP method is used, the ACR performs the DHCP proxy function. When the simple IP method is used, the ACR performs the DHCP relay agent function.

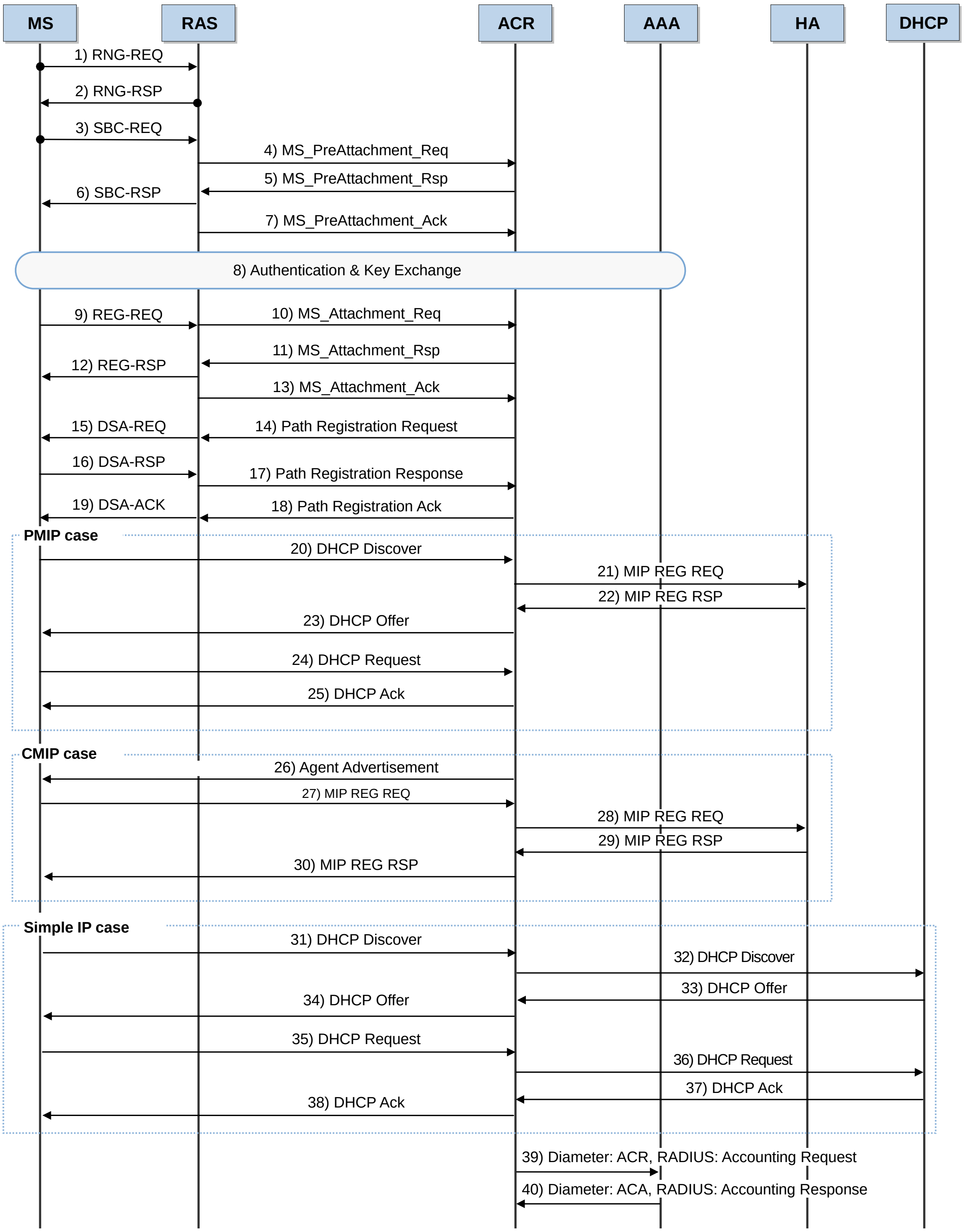


Figure 4.1 Initial Access Process

Classification	Description
(1)~(2)	The MS transmits the RNG-REQ message including its own MAC address and the Ranging Purpose Indication to the RAS, and the RAS allocates the Basic & Primary Management CID and transmits the RNG-RSP message to the MS.
(3)~(4)	The MS transmits the SBC-REQ message to the RAS including the physical parameter and the authorization policy information which it supports. The RAS transmits the MS_PreAttachment_Req message to the ACR including the authorization policy support via the Default IP address and the UDP port number of the ACR.
(5)~(7)	The ACR transmits the MS_PreAttachment_Rsp message to the RAS including the supported authorization policy, and the RAS extracts the information received from the ACR, attaches it to the SBC-RSP message and transmits it to the MS. Then, RAS transmits the MS_PreAttachment_Ack to the ACR, and notifies the start point of the next process (EAP transmission) explicitly.
(8)	The procedure of the subscriber authentication between the MS and the AAA server is performed, and when the authentication is successful, the ACR receives the provisioned policy information for each subscriber from the AAA server. For the detailed information, see '4.1.2 Authentication'.
(9)~(13)	The MS transmits the REG-REQ message to the RAS including the registration information (MS Capabilities, CS Capabilities, HO Support, etc), and the RAS transmits the MS_Attachment_Req message to the ACR to inquire the corresponding MS Capability and the corresponding CS Capability. The ACR transmits the response to the RAS including the result of the requested registration information, and the RAS transmits the REG-RSP message to the MS. The RAS transmits the MS_Attachment_Ack to the ACR, and notifies the start point of the next process explicitly.
(14)~(19)	To request the DSA for the Pre-Provisioned SF, the ACR transmits the RR-Request message to the RAS, including the SFID, the Resource Description field (SF/CS parameter) and the Data Path ID (=GRE Key) field to set the data path with the RAS. The RAS receives this message and performs admission control for this, and then transmits the DSA-REQ message to the MS. The MS attaches the Confirmation Code to the DSA-RSP message as a result of DSA-REQ and transmits the message to the RAS, and the RAS transmits the RR-Response message to the ACR including the Data Path ID to set the data path with the ACR. Then the ACR transmits the RR-Confirm message to the RAS, and the RAS transmits the DSA-ACK message to the MS
(20)~(25)	This is the procedure to allocate the IP address to the MS, which uses the PMIP, if the MS requests the DHCP procedure to acquire the IP address, the ACR performs the PMIP procedure.
(26)~(30)	This is the procedure to allocate the IP address to the MS, which uses the CMIP, if the MS requests the MIP registration directly, the ACR operates as the FA and interworks with the HA and allocates the MIP address to the MS.
(31)~(38)	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 performs the DHCP relay agent function to receive a simple IP address from the external DHCP server and then sends the received IP address to the MS.
(39)~(40)	When the Diameter protocol is used, it is notified that accounting has begun for the service flow using the ACR/ACA message. When the RADIUS protocol is used, the Accounting Request/Accounting Response message is used.

4.1.2 Authentication

At the Time of Initial Access

The MS authentication procedure performed in '4.1.1 Initial Access' is as follows:

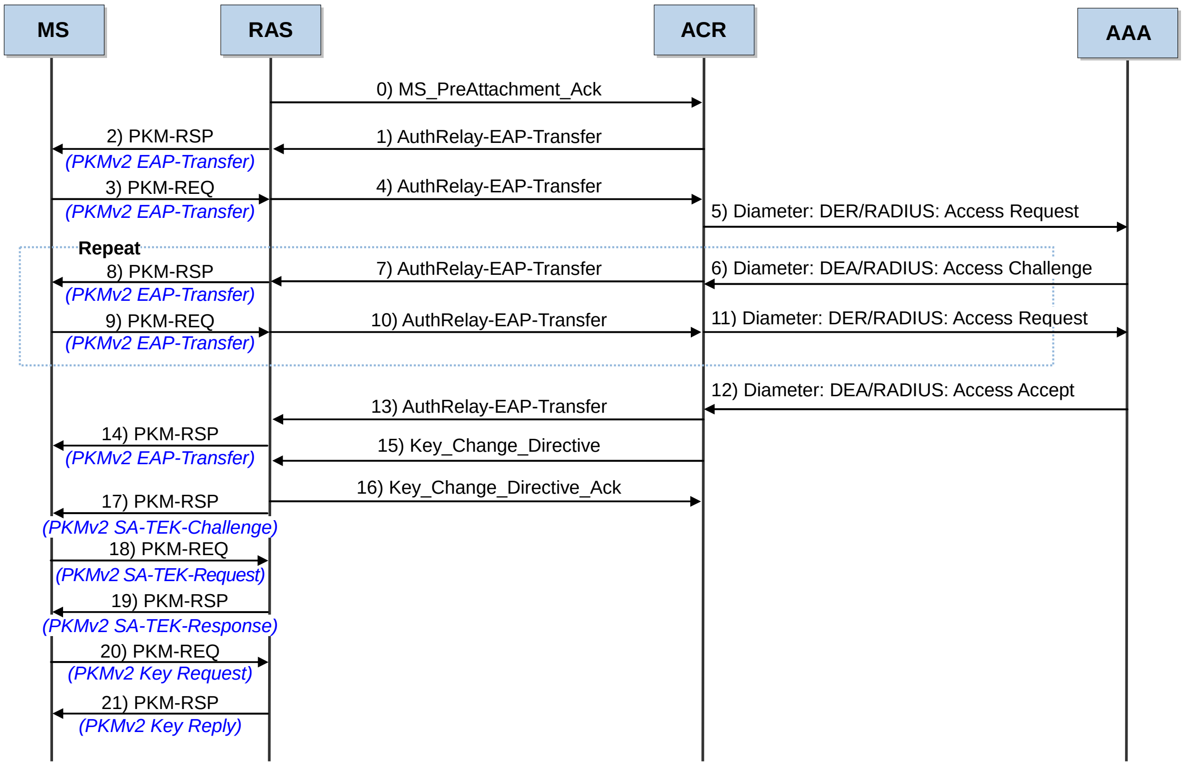


Figure 4.2 Authentication Procedure (At the time of initial access)

Classification	Description
(0)~(2)	When the ACR receives MS_PreAttachment_Req_Ack for SBC-RSP from the RAS, the ACR includes the EAP Request/Identity payload in the AuthRelay-EAP-Transfer message and transmits the message to the RAS to start the EAP authentication. The RAS relays the received EAP payload to the MS by using the PKMv2 EAP-Transfer/PKM-RSP message.
(3)~(5)	The MS sends the RAS a PKMv2 EAP-Transfer/PKM-REQ message with the NAI included in the EAP Response/Identity. The RAS relays it to the ACR using the AuthRelay-EAP-Transfer message. The authenticator of the ACR then analyzes the NAI and sends the MS the Diameter DEAP Request (DER) message (when the Diameter protocol is used) or the Access Request message (when the RADIUS protocol is used).
(6)~(11)	The subscriber authentication procedure is performed between the MS and AAA server using the EAP-method. The authentication procedure is performed using the Diameter EAP Request (DER)/Diameter EAP Answer (DEA) message (when the Diameter protocol is used) or the Access-Challenge/Access-Request message (when the RADIUS protocol is used).

(Continued)

Classification	Description
(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 the Diameter EAP Answer (DEA) message (when the Diameter protocol is used) or the Access-Accept message (when the RADIUS protocol is used). The ACR generates the AK from the MSK and sends the RAS a Key_Change_Directive message including the generated AK Context information and Security Association (SA) information for the MS. In addition, the RAS relays the EAP Success information to the MS using the PKMv2-EAP-Transfer message.
(17)~(19)	After the EAP authentication, the RAS verifies the AK key value which it has with MS, and transmits the SA-TEK-Challenge message to the MS to notify the start of the SA negotiation, and the MS verifies the CMAC of the SA-TEK-Challenge message, checks the AK key value, and transmits the SA negotiation information to the RAS by using SA-TEK-Request. The RAS transmits SA-TEK-Response including the AKID and the SA Descriptor which is the final result of the SA negotiation to the MS.
(20)~(21)	The MS requests the Traffic Encryption Key (TEK) to the RAS by using PKMv2 Key-Request, and the RAS creates the TEK randomly and transmits it to the MS by using the PKMv2 Key-Reply message. Then, the TEK is transmitted by being encrypted via the Key Encryption Key (KEK).

NOTE

Keys and Functions

The functions of the keys are as follows.

- MSK: creates the AK
- AK: creates the CMAC key
- KEK: encrypts the TEK
- CMAC key: provides integrity for the MAC management message
- TEK: encrypts traffics in wireless sections

At the Time of Authenticator Relocation

When the MS performs the CSN-anchored Handover (HO), or the Idle Mode MS moves to another ACR area and performs the location update, the following re-authentication procedure is performed to move the authenticator from the existing Serving ACR to the Target ACR. The Target ACR triggers in order that the MS performs the EAP authentication procedure with the AAA server again, and then, when the result of the authentication result is notified to the Serving ACR, the Authenticator Relocation procedure is completed.

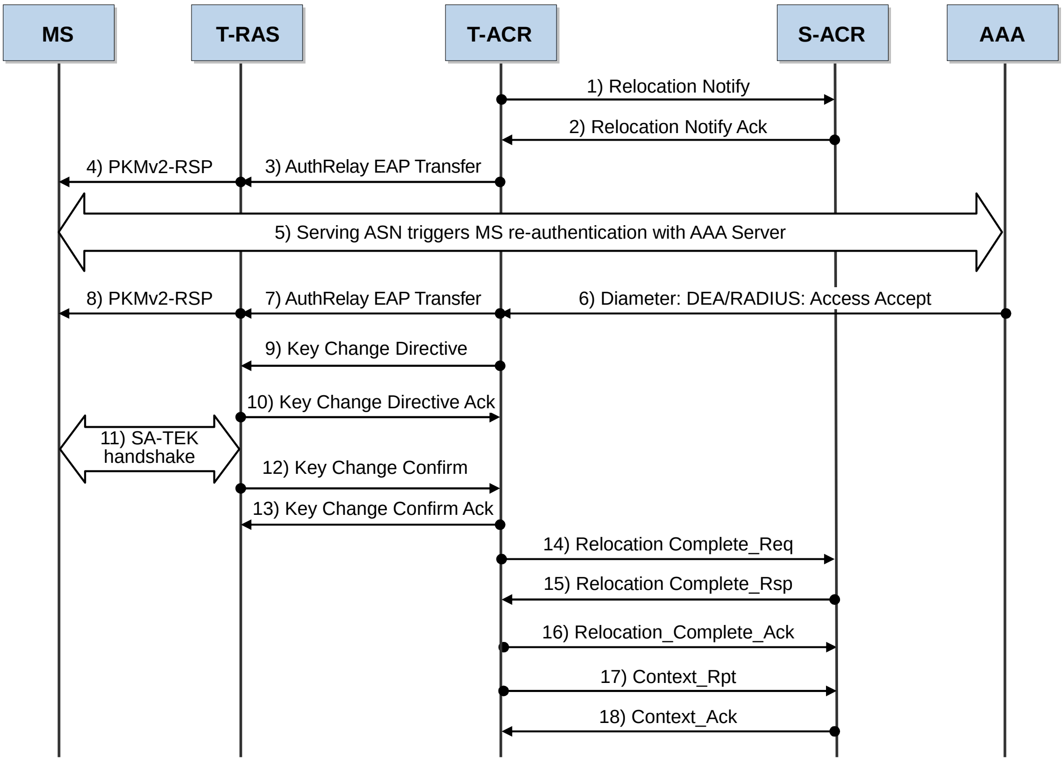


Figure 4.3 Authentication Procedure (At the time of the Authenticator Relocation)

Classification	Description
(1)~(2)	The new authenticator, T-ACR, exchanges the Relocation Notify/Ack message with the previous authenticator, S-ACR, to perform re-authentication and authenticator relocation.
(3)~(11)	The re-authentication procedure is performed in the target area, as the authentication procedure for initial entry. When the Diameter protocol is used, the Diameter EAP Answer (DEA) message is received from the AAA server. When the RADIUS protocol is used, the Access Accept message is received from the AAA server.
(12)~(13)	The RAS sends the Key Change Confirm message to the authenticator (T-ACR) to notify it that re-authentication is complete with the MS.
(14)~(16)	The T-ACR completes the authenticator relocation procedure by exchanging the Relocation Confirm/Ack message with the S-ACR.
(17)~(18)	After the authenticator relocation, the new authenticator notifies the anchor that the authenticator has been changed through the context Rpt procedure.

4.1.3 Status Change

Awake Mode → Idle Mode

If the data traffic is not transmitted/received for a certain time, the status of MS is changed from the Awake Mode to the Idle Mode.

> NOTE
>
> **Sleep Mode → Idle Mode Change**
>
> The MS of the Sleep Mode is not changed into the Idle Mode, immediately. Before being changed from the Sleep Mode into the Idle Mode, the MS is changed to the Awake Mode, first, and then, after requesting DREG, it is changed into the Idle Mode.

The deregistration procedure to be changed into the Idle Mode is divided into the MS-initiated Idle Mode change and the Network-initiated Idle Mode change, and the following indicates the procedure of the MS-initiated Idle Mode change.

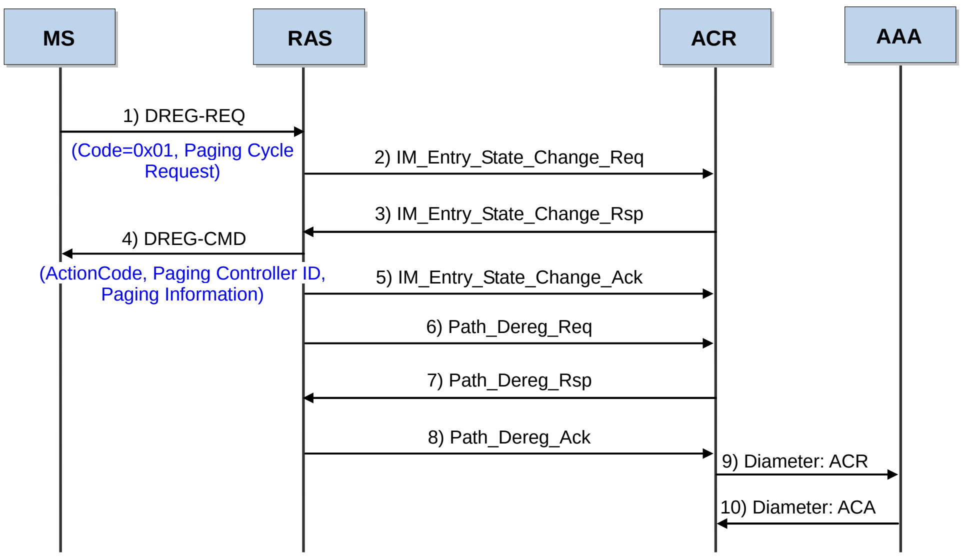


Figure 4.4 Awake Mode → Idle Mode Status Change Procedure

Classification	Description
(1)	When the MS is changed into the Idle Mode, it creates the DREG-REQ message and transmits it to the RAS, and the value of the De-Registration Request Code field is set as 0x01.
(2)~(5)	The RAS creates the IM_Entry_State_Change_Req message including the context information of the MS and transmits it to the ACR (Paging Controller), and the ACR creates the IM_Entry_State_Change_Rsp message including the Action Code (0 x 05), the paging information (PAGING_CYCLE, PAGING_OFFSET) and the Idle Mode Retain Flag and transmits the message to the RAS. The RAS transmits the DREG-CMD including the received information to the MS.

(Continued)

Classification	Description
(6)~(8)	If the Network re-entry from the MS is not transmitted until the Idle Resource Retain timer expires, the RAS performs the Data Path (DP) Release procedure with the ACR.
(9)~(10)	As the MS has been transited to Idle mode, an accounting end message is sent to the AAA server to update the accounting information using the ACR/ACA message (if the Diameter protocol is used). If the RADIUS protocol is used, no accounting report is made when the MS has been transited to Idle mode. Then when the MS is returned to Awake mode, the accounting information is updated at the specified interim interval using the Accounting Request interim message.

Awake Mode → Sleep Mode

The Awake Mode and the Sleep Mode of the MS can be classified only by the RAS, and the ACR does not classified the two kinds of status, and recognizes and manages both of them as the Awake Mode.

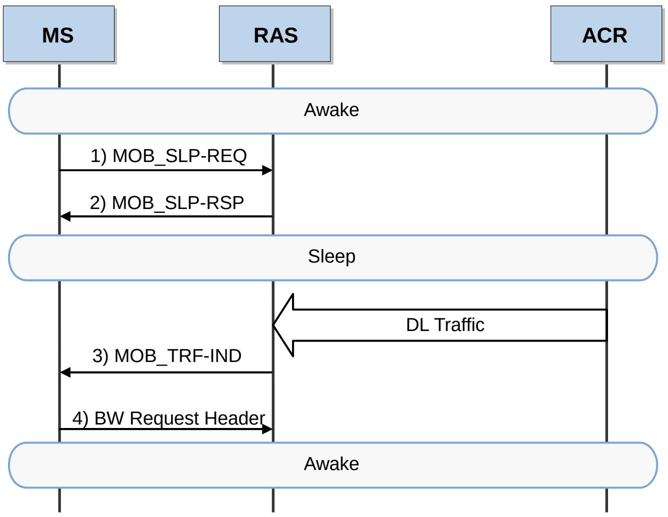


Figure 4.5 Awake Mode ⇔ Sleep Mode Status Change Procedure

Classification	Description
(1)~(2)	If the MS does not transmit/receive the data for a certain time (set by the MS/RAS as the parameter), timeout is generated in its own timer, thus the mode is changed from the Awake Mode to the Sleep Mode. Then, the MS transmits the MOB_SLP-REQ message to the RAS, and the RAS transmits the MOB_SLP-RSP message for this, and the status of MS is changed into the Sleep Mode.
(3)~(4)	If the terminating traffic exists in the Sleep Mode MS, the RAS transmits the MOB_TRF-IND message in the listening period of the corresponding MS, and the MS which receives this, sets the BW value as 0 in the UL BW Request and transmits it to the RAS. The RAS receives this message and recognizes that the status of MS has been changed into the Awake Mode, and transmits the traffic to the MS.

Idle Mode → Awake Mode (QCS)

When an MS in Idle Mode responds for the paging because of incoming traffic or sends the traffic, the status of MS is changed from the Idle Mode into Awake Mode. In both cases, the MS should perform the network re-entry procedure to change the status into the Awake Mode and the Mobile WiMAX system of Samsung basically takes account of the QCS procedure as the network re-entry method.
The following is the case where the mode is changed from the Idle Mode to the Awake Mode at the time of the Network re-entry (QCS).

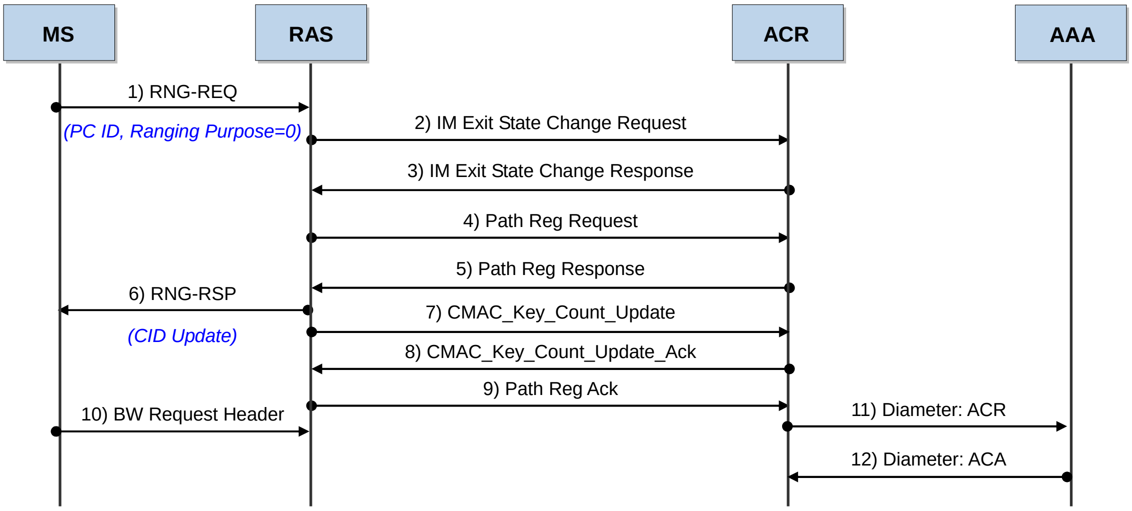


Figure 4.6 Idle Mode → Awake Mode (QCS) Procedure

Classification	Description
(1)	If the Idle Mode MS is changed into the Awake Mode, the MS creates the RNG-REQ message including the MAC address and the Paging Controller ID value and transmits the message to the RAS. Then, the value of the Ranging Purpose Indication field is set as 0x00 (=Network Re-entry).
(2)~(3)	The RAS creates the IM Exit State Change Request message including the parameter of the received RNG-REQ message and transmits the message to the ACR. The ACR checks the status information of the Idle Mode of the MS, creates the IM Exit State Change Response message including the Idle Mode Retain information to perform the QCS procedure and the AK Context information for the CMAC authentication and transmits the message to the RAS.
(4)~(5)	The RAS transmits the Path Registration Request message including the data path information such as the (UL) GRE Key to the ACR to set the data path with the ACR. The ACR responds to the RAS as the Path Registration Response message including the data path information such as the (DL) GRE Key for this.
(6)	The RAS replies with the RNG-RSP message along with HO Optimization Flag for the QCS and relevant CID_Update and SA-TEK_Update information.
(7)~(8)	The RAS notifies the new CMAC_KEY_COUNT value updated by the MS to the ACR, which is an authenticator.

(Continued)

Classification	Description
(9)	The ACR receives the Path Registration Ack message and is notified of data path set results.
(10)	If an MS receives RNG-RSP, the MS transmits BW Request Header to notify the system that the status is changed into the Awake Mode.
(11)~(12)	If the Diameter protocol is used, as the MS has transited to Awake mode and a new transport CID has been allocated, it sends a new accounting start message to the AAA server to update the AAA server's accounting information. If the RADIUS protocol is used, no accounting report is made when the MS has been transited to Awake mode and the accounting information is updated at the specified interim interval using the Accounting Request interim message.

NOTE

Changing from Idle Mode to Awake Mode

For the procedure that the MS status is changed from Idle Mode to Awake Mode due to paging, refer to '4.1.5'.

4.1.4 Location Update

Inter-RAS Location Update

The following is the location update procedure when the MS moves to other paging group in the same ACR.

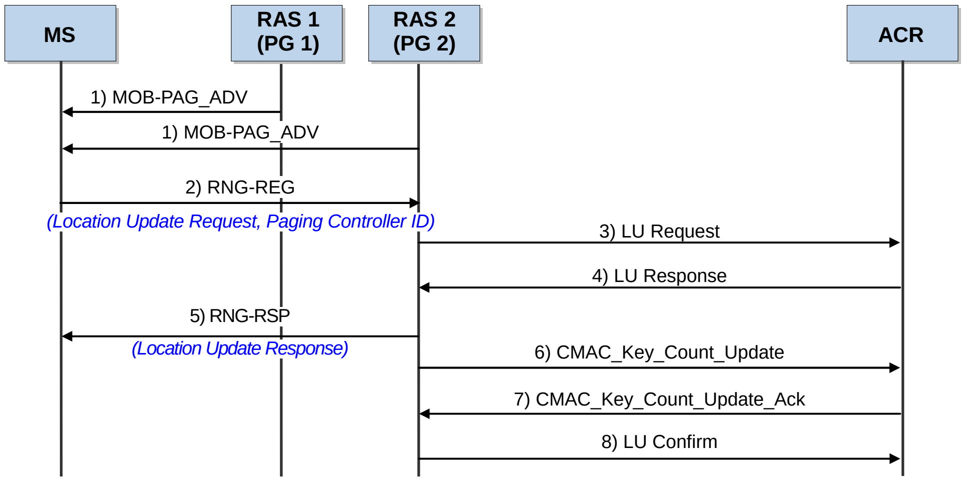


Figure 4.7 Inter-RAS Location Update Procedure

Classification	Description
(1)	When the Idle Mode MS in the paging group 1 moves to the paging group 2, it receives the PAG-ADV message and recognizes that the location has been changed.
(2)~(3)	The MS transmits the RNG-REQ message to a new RAS (RAS 2) including the MAC address, the Location Update Request, and the Paging Controller ID and the RAS 2 transmits the Location Update Request message to the ACR.
(4)~(5)	The ACR transmits the Location Update Response message including the paging information and the AK Context information to the RAS 2. The RAS 2 checks the CMAC validation and transmits the RNG-RSP message including the LU Response to the MS, and notifies that the location update procedure has been completed by transmitting the LU Confirm to the ACR.
(6)~(7)	The RAS notifies the new CMAC_KEY_COUNT value updated by MS to the ACR, which is an authenticator.
(8)	The ACR sends the LU Confirm message and is notified that the location update procedure is completed.

Inter-ACR Location Update (Anchor Relocation)

When the MS in the Idle mode moves to other ACR area, the Inter-ACR Location Update (LU) procedure is performed. At this time, the procedure is different depending on whether the MIP-based CMIP/PMIP method or the simple IP method is used.

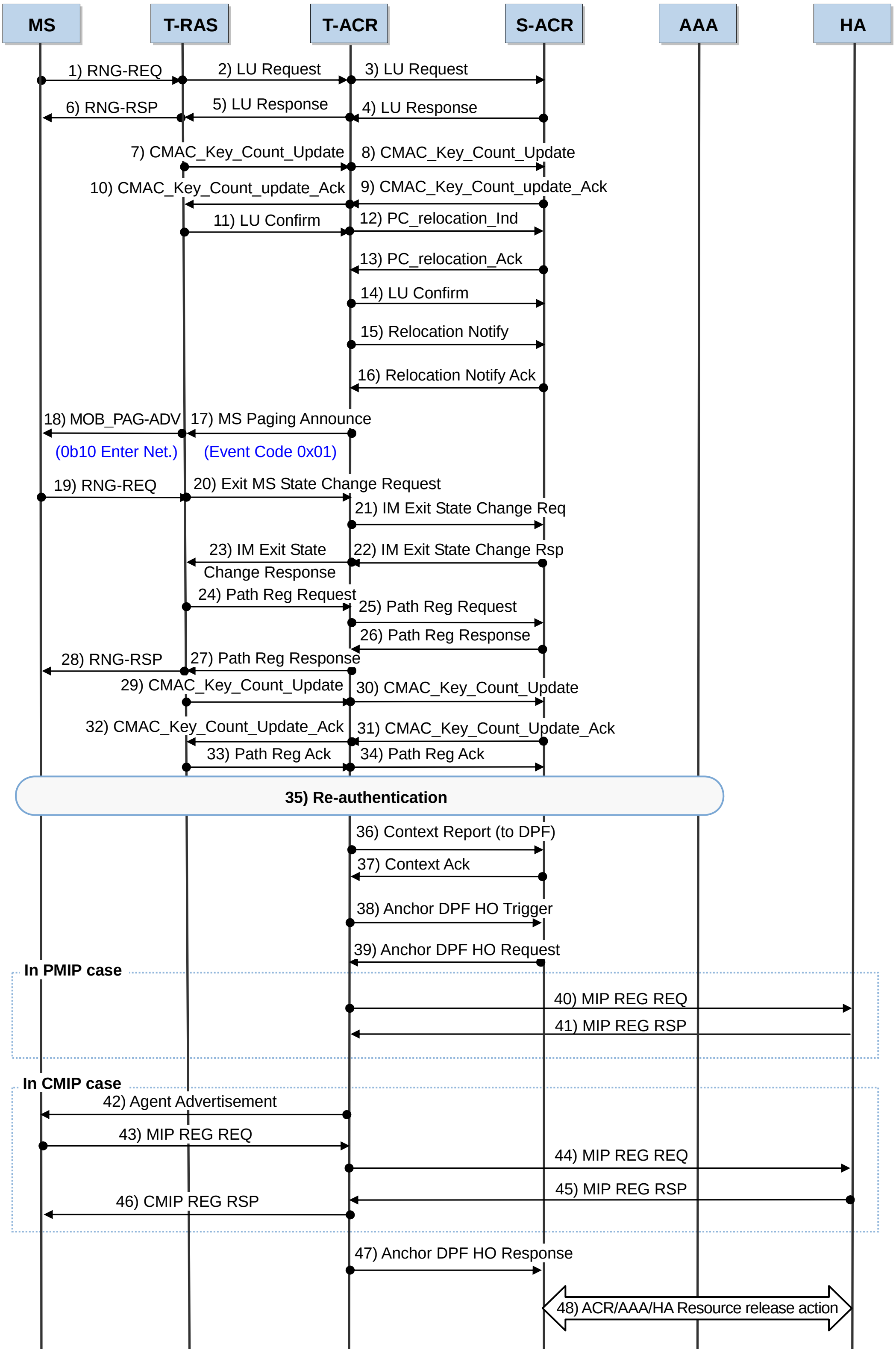


Figure 4.8 Inter-ACR Location Update Procedure (CMIP/PMIP Case)

Classification	Description
(1)~(2)	If the paging group is changed, the MS transmits the RNG-REQ message including the MAC address, the Location Update Request and the Paging Controller ID to a new T-RAS (Target RAS). The T-RAS transmits the Location Update Request message including the Paging Controller ID to its own default ACR.
(3)~(5)	When the received Paging Controller ID does not belong to the Target ACR (T-ACR), the T-ACR transmits the Location Update Request message of which the APC Relocation Destination is set as its own Paging Controller ID to the previous Serving ACR (S-ACR) via the R4 interface to change the Paging Controller. The S-ACR responds by using the Location Update Response message including the information on whether to allow the Paging Controller Relocation and the Context information of the corresponding MS.
(6)	When the T-RAS receives the Location Update Response message, it sets as 'LU Response=Success', transmits the RNG-RSP message to the MS, and checks if the paging controller is changed into the T-ACR by transmitting the LU Confirm message.
(7)~(10)	The T-RAS notifies the new CMAC_KEY_COUNT value updated by the MS to the S-ACR, which is an authenticator.
(11)	The LU Confirm message is sent to confirm that the T-ACR is now the paging controller.
(12)~(14)	The T-ACR, after Location Update Confirm, notifies the FA and the Authenticator which are still located in the S-ACR of that the Paging Controller has been changed.
(15)	The T-ACR requests the FA Relocation for the MS to the S-ACR.
(16)~(18)	The S-ACR which receives the request of the FA/DPF Relocation from the T-ACR allows the relocation in the T-ACR, then, the T-ACR/RAS requests paging to the corresponding MS to trigger the relocation.
(19)~(34)	The MS which receives the MOB_PAG-ADV message performs the QCS which is the Network Re-Entry procedure with the network.
(35)~(37)	This is the procedure to relocate the Authenticator from the S-ACR to the T-ACR, the T-ACR triggers in order that the MS performs the EAP authentication procedure with the AAA server, and notifies the S-ACR of the authentication result, then completes the Authenticator Relocation procedure.
(38)~(39)	The T-ACR requests the Anchor DPF Relocation for the MS to the S-ACR.
(40)~(41)	If the MS uses the PMIP, the T-ACR instead of the MS registers the MIP to the HA.
(42)~(46)	If the MS uses the CMIP, the ACR operates only as the FA, and the MS registers the MIP in the HA directly.
(47)~(48)	When the anchor DPF relocation is completed successfully, S-ACR releases the existing connection with AAA and HA.

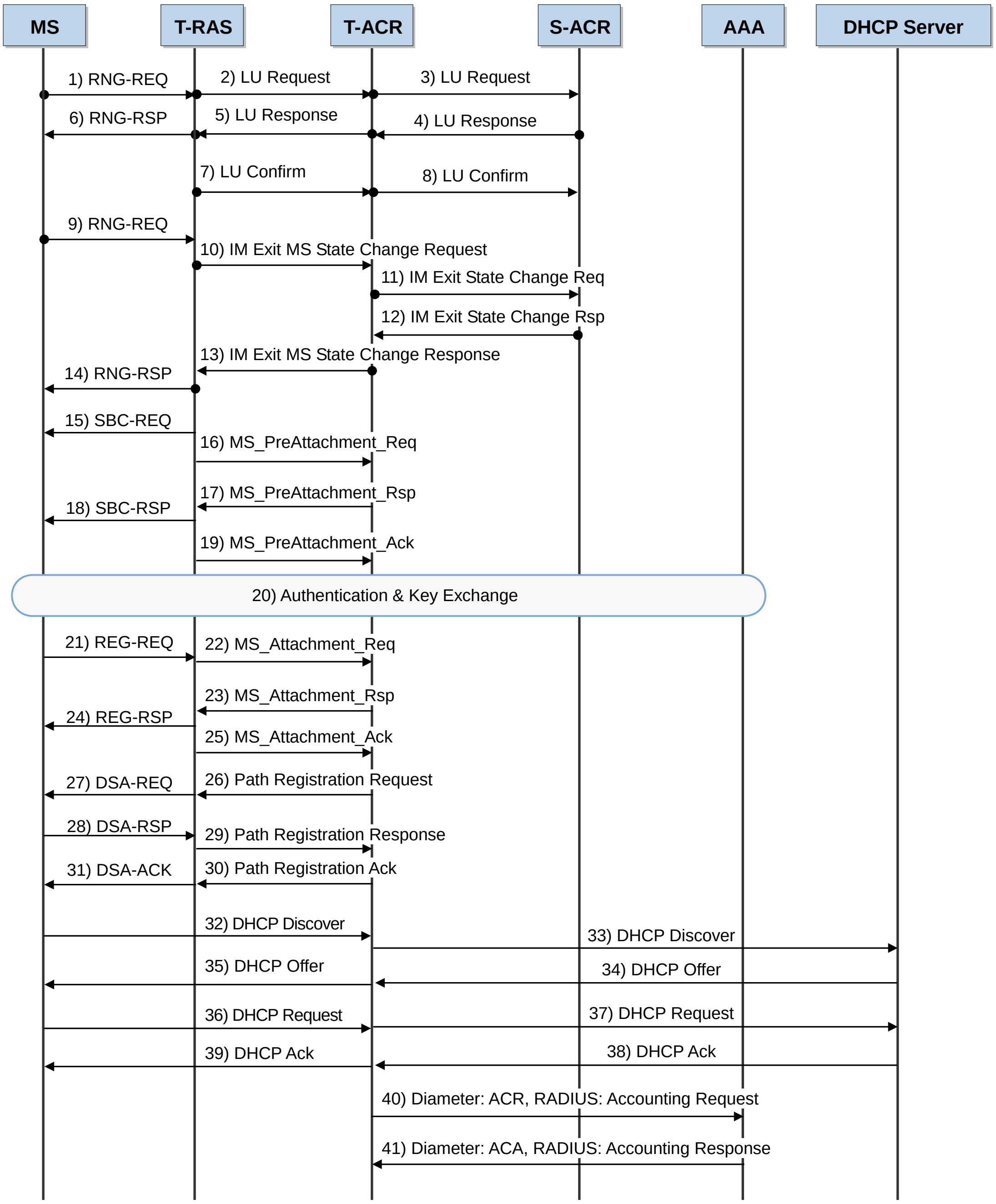


Figure 4.9 Inter-ACR Location Update Procedure (Simple IP Case)

Classification	Description
(1)~(2)	At this time, the procedure is different depending on whether the MIP-based CMIP/PMIP method or the simple IP method is used. When the paging group is changed, the MS sends the new T-RAS (Target RAS) an RNG-REQ message including the MAC address, Location Update Request and Paging Controller ID in order to request a location update. The T-RAS sends its default ACR a Location Update Request message including the Paging Controller ID.
(3)~(5)	If the received Paging Controller ID does not belong to the T-ACR (Target ACR), it sends a Location Update Request message to the S-ACR (Serving ACR) through the R4 interface in order to change the paging controller. At this point, the APC Relocation Destination of the Location Update Request message is set to the Paging Controller ID of the T-ACR. The S-ACR responds with a Location Update Response message including confirmation of whether the paging controller relocation is allowed or not 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 that allocates an IP address to the MS that uses the simple IP method. When the DHCP procedure is requested to allocate an IP address to the MS, the ACR receives a simple IP address from the DHCP server and sends it to the MS (DHCP Relay Agent mode).
(40)~(41)	The T-ACR notifies the AAA server that accounting has begun for the service flow newly generated in the network entry. When the Diameter protocol is used, it is notified that accounting has begun for the service flow using the ACR/ACA message. When the RADIUS protocol is used, the Accounting Request/Accounting Response message is used.

Inter-ASN Location Update

The Inter-ASN location update procedure is the same with the Inter-ACR location update procedure.

4.1.5 Paging

Paging can be classified into the following two types.

- The RAS broadcasts the MOB_PAG-ADV message periodically and notifies the MS of the corresponding paging group. The MS is changed into the Idle Mode and checks if the paging group of the MS is changed by checking the MOB_PAG-ADV message periodically based on the paging information (Paging Cycle, Paging Offset, PGID) received from the system.
- If the traffic to be transmitted to the Idle Mode MS exists in the ACR, the ACR triggers the MOB_PAG-ADV message to the RAS to change the corresponding MS into the Awake Mode.

The following figure is the procedure to perform paging on the Idle Mode MS.

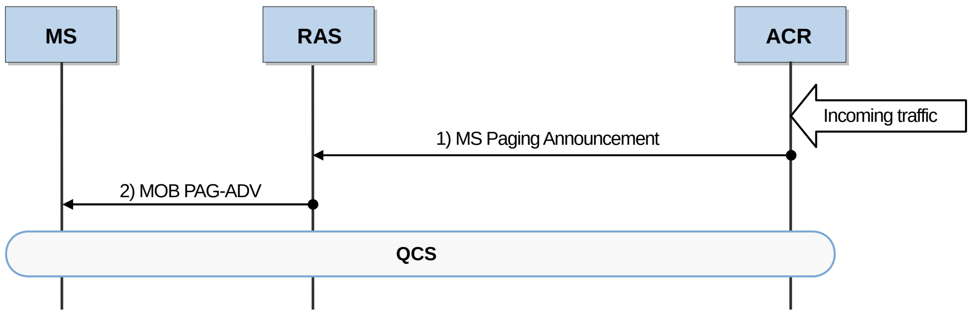


Figure 4.10 Paging Procedure

Classification	Description
(1)~(2)	When receiving the packet to be transmitted to the specific MS, the ACR transmits the MS Paging Announce message including the MAC address, the Paging Group ID and the Action Code (0x10) of the MS when the corresponding MS is the Idle Mode to the RAS. The RAS transmits the MOB_PAG-ADV message including the information received from the ACR to the MS.

After this, the MS performs the QCS procedure with the network. For the information on the QCS procedure, see the procedure of 'Idle Mode → Awake Mode' in '4.1.3'.

4.1.6 Handover

Inter-RAS Handover

The following is the inter-RAS handover procedure.

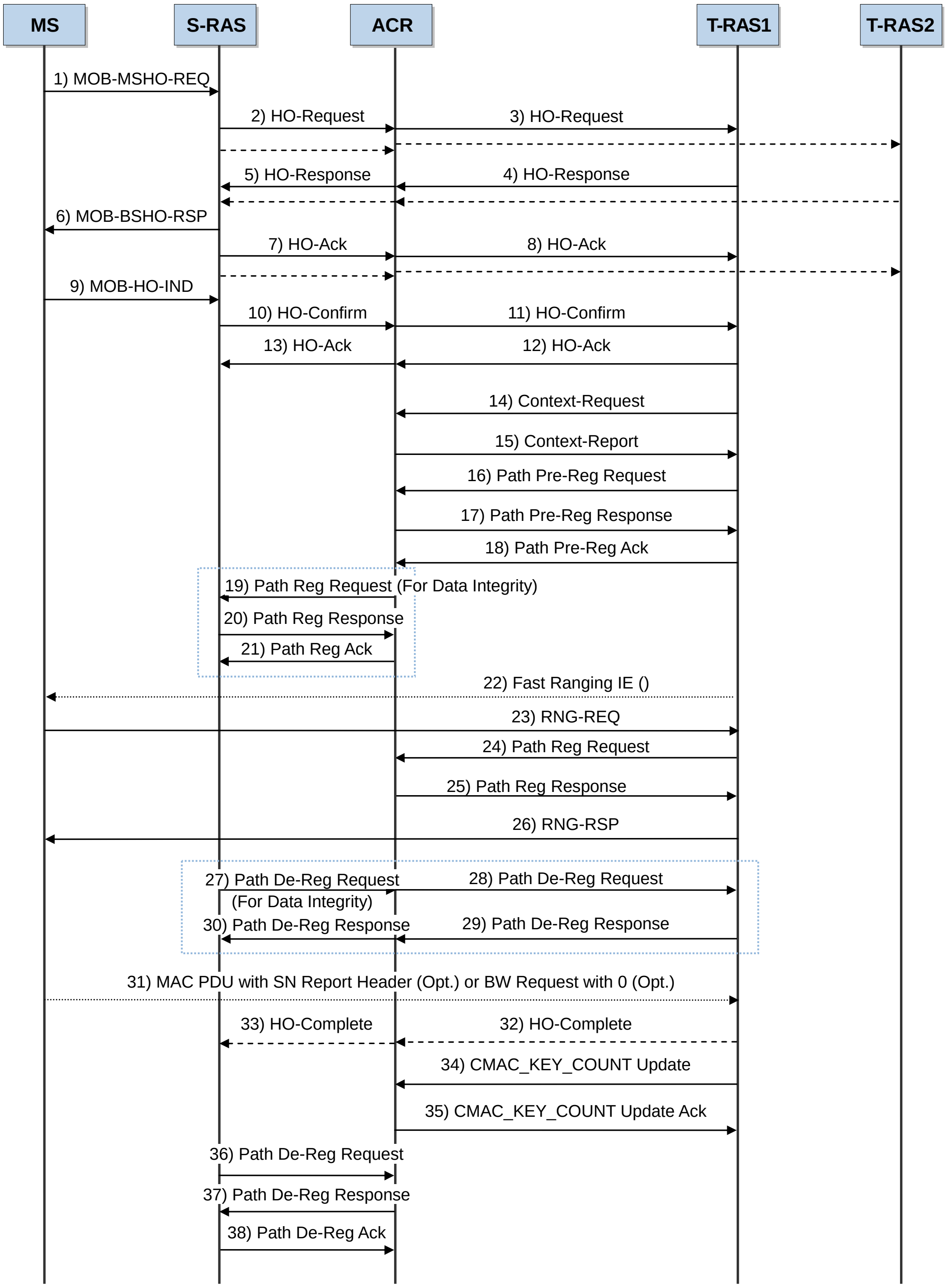


Figure 4.11 Inter-RAS Handover Procedure

Classification	Description
(1)~(3)	The MS transmits the MOB_MSHO-REQ message including the Neighbor BS (RAS) ID and the parameter related to handover to the current Serving RAS (S-RAS) to request handover. The S-RAS transmits the HO-Request message including the received MOB_MSHO-REQ parameter and the context information to the ACR, and the ACR forwards the HO-Request message to the Target RAS (T-RAS).
(4)~(8)	The T-RAS transmits the HO-Response message including its own capability information to the ACR, and the S-RAS transmits the MOB_BSHO-RSP message including the Recommended Neighbor BS-IDs, the HO-ID and the parameter result value to the MS.
(9)~(13)	The MS transmits the MOB_HO-IND message including the HO-IND Type and the Target BS-ID to the S-RAS to notify handover finally, and the S-RAS transmits the HO-Confirm message including the context information and the Data Integrity information (e.g., Buffered SDU SN) of the MS to the T-RAS.
(14)~(15)	The T-RAS transmits the Context-Request message to the ACR (Authenticator) to request the AK Context information, and the ACR responds by using the Context-Response message including the AK context information.
(16)~(21)	The path pre-registration is executed to set a new data path between the ACR and the T-RAS. In addition, a forwarding path is set to send to the T-RAS the traffics that the S-RAS has not yet transmitted to the MS, and the traffics are sent to the T-RAS.
(22)	If T-RAS allows the request of an MS, the T-RAS notifies UL_MAP IE to enable the MS to transmit HO Ranging Request via uplink.
(23)	The MS transmits to the T-RAS the RNG-REQ message that contains the MAC address, Serving BS-ID and HO indication.
(24)~(25)	The path registration procedure is executed to exchange the SF information that is mapped with the data path created between the ACR and the T-RAS through the steps (16)~(18).
(26)	The T-RAS replies with the RNG-RSP message along with HO Optimization Flag, CID_Update, and SA-TEK_Update.
(27)~(30)	If the S-RAS transmits all the traffic to the T-RAS, the forwarding path is removed.
(31)	If an MS successfully receives the RNG-RAS message, the MS transmits Bandwidth Request (BR) MAC PDU to RAS to inform the reception of the message.
(32)~(33)	The T-RAS transmits the HO-Complete message to S-RAS to notify the completion of handover.
(34)~(35)	The RAS notifies the new CMAC_KEY_COUNT value updated by MS to the ACR, which is an authenticator.
(36)~(38)	When the handover procedure is completed, the old path between the S-RAS and the ACR is removed.

Inter-ACR Handover

Inter-ACR handover within the same ASN considers the path extension via the R6 interface. The inter-ACR handover procedure is the same with the inter-RAS handover procedure.

Inter-ASN Handover: ASN-Anchored Mobility

Inter-ASN handover is divided into the ASN-anchored mobility method via the R4 interface and the CSN-anchored mobility method via the R3/R4 interface. The following figure indicates the inter-ASN handover procedure of the ASN-anchored mobility method, the Serving ACR (S-ACR) performs the anchor function.

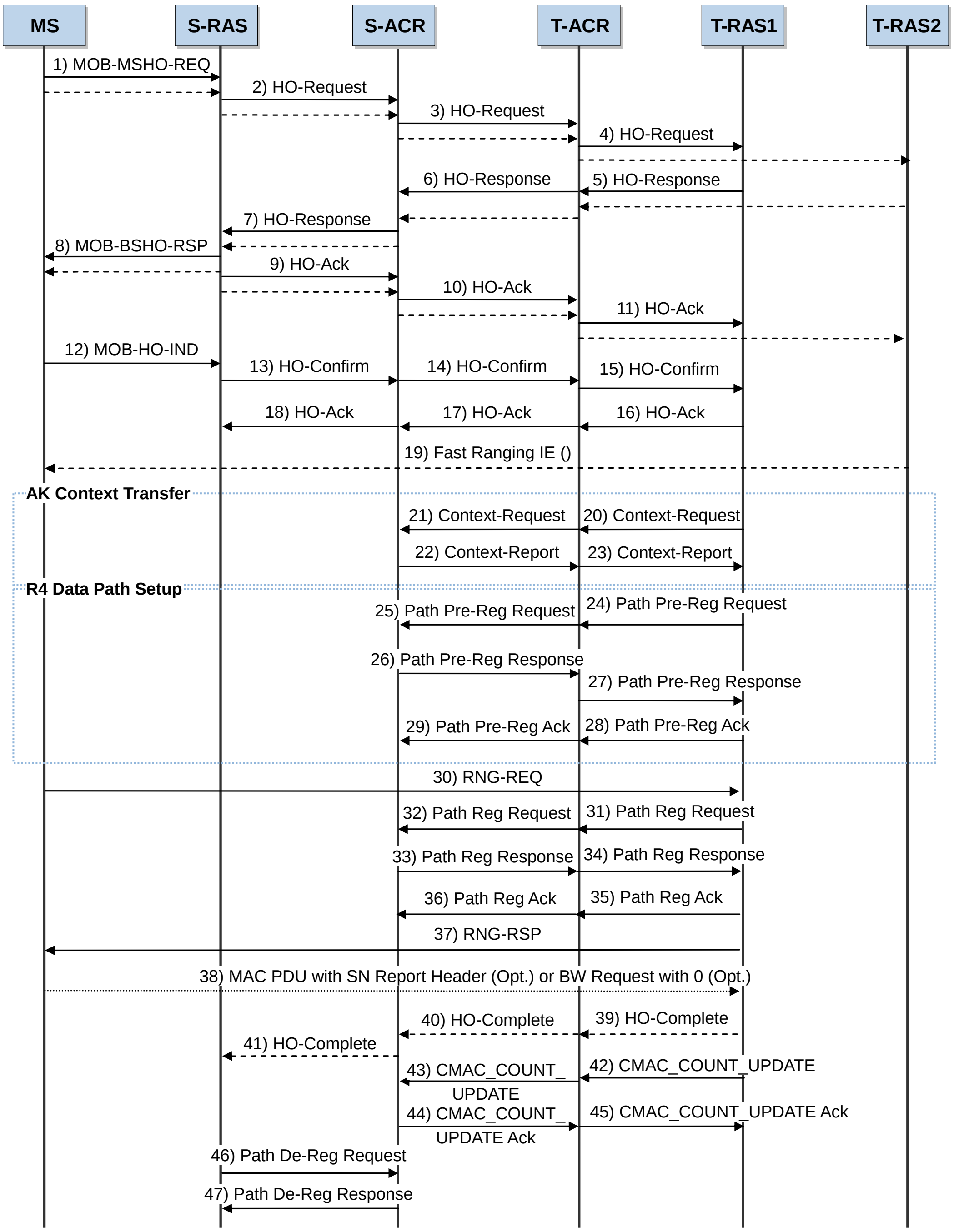


Figure 4.12 Inter-ASN Handover (ASN-Anchored Mobility)

The HO signaling procedure is the same with the inter-RAS handover procedure, however in the HO signaling procedure, the procedure of exchanging the HO signaling message via the R4 interface is added between the S-ACR and the Target ACR (T-ACR).

Classification	Description
(1)~(4)	The MS, in order to request a handover, sends the S-RAS (Serving RAS) an MOB_MSHO-REQ message including the neighbor BS (RAS) ID and handover-related parameters. The S-RAS sends the ACR an HO-Request message including the received MOB_MSHO-REQ parameters and context information. The ACR forwards the HO-Request message to the T-RAS (Target RAS).
(5)~(11)	The T-RAS sends the ACR an HO-Response message including its own capability information. The S-RAS sends the MS an MOB_BSHO-RSP message including the Recommended Neighbor BS-IDs, HO-ID, and parameter results.
(12)~(18)	The MS, in order to notify the final execution of the handover, sends the S-RAS an MOB_HO-IND message including the HO-IND Type and Target BS-ID. The S-RAS sends the T-RAS an HO-Confirm message including the context information and data integrity information (e.g., the Buffered SDU SN) of the MS.
(19)~(22)	The T-RAS sends a Context-Request message to the ACR (authenticator) to obtain the AK Context information. The ACR responds with a Context-Response message including the AK context information.
(23)~(28)	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 to transmit the traffic that the S-RAS has not yet transmitted to the MS is set up to the T-RAS, and is used to send that traffic to the T-RAS.
(29)	In the event that the T-RAS requests an HO for the MS, it notifies the MS of the UL_MAP IE so that the MS can send an HO Ranging Request message via the uplink.
(30)	The MS sends the T-RAS an RNG-REQ message including the MAC address, Serving BS-ID, and HO Indication.
(31)~(36)	The Path Registration procedure is performed to exchange the service flow (SF) information to be mapped to the data path generated between the ACR and T-RAS in steps (23)~(28).
(37)	The T-RAS responds with an RNG-RSP message including the HO Optimization flag and the CID_Update and SA-TEK_Update information.
(38)	Once it has received the RNG-RSP message successfully, the MS sends a bandwidth request (BR) MAC PDU to the RAS to notify it.
(39)~(41)	The T-RAS sends an HO-Complete message to the S-RAS to notify the handover is completed.
(42)~(45)	The RAS sends the new CMAC_KEY_COUNT updated value for the MS to the ACR which is the authenticator.
(46)~(47)	When the handover procedure is completed, the previous path, i.e. the existing path between the S-RAS and ACR, is released.

Inter-ASN Handover: CSN-Anchored Mobility

The following is handover of the CSN-anchored mobility method among the types of inter-ASN handover, the anchor function is relocated from the Serving ACR (S-ACR) to the Target ACR (T-ACR).

CSN-anchored mobility is composed of the process that Authenticator/DPF Anchor is relocated to the target ACR after ASN-anchored mobility handover is performed.

For convenience, the case that T-ACR triggers the relocation is defined in pull mode and the other case that S-ACR triggers is in push mode. Samsung's Mobile WiMAX system supports both pull mode and push mode.

The CSN-anchored mobility method follows the MIP standard, and the NWG defines the PMIP and the CMIP for the MIP method. The first part of the CSN-anchored handover signaling process is the same as the procedure of ASN-anchored mobility handover and the procedure after the ASN-anchored handover is as follows:

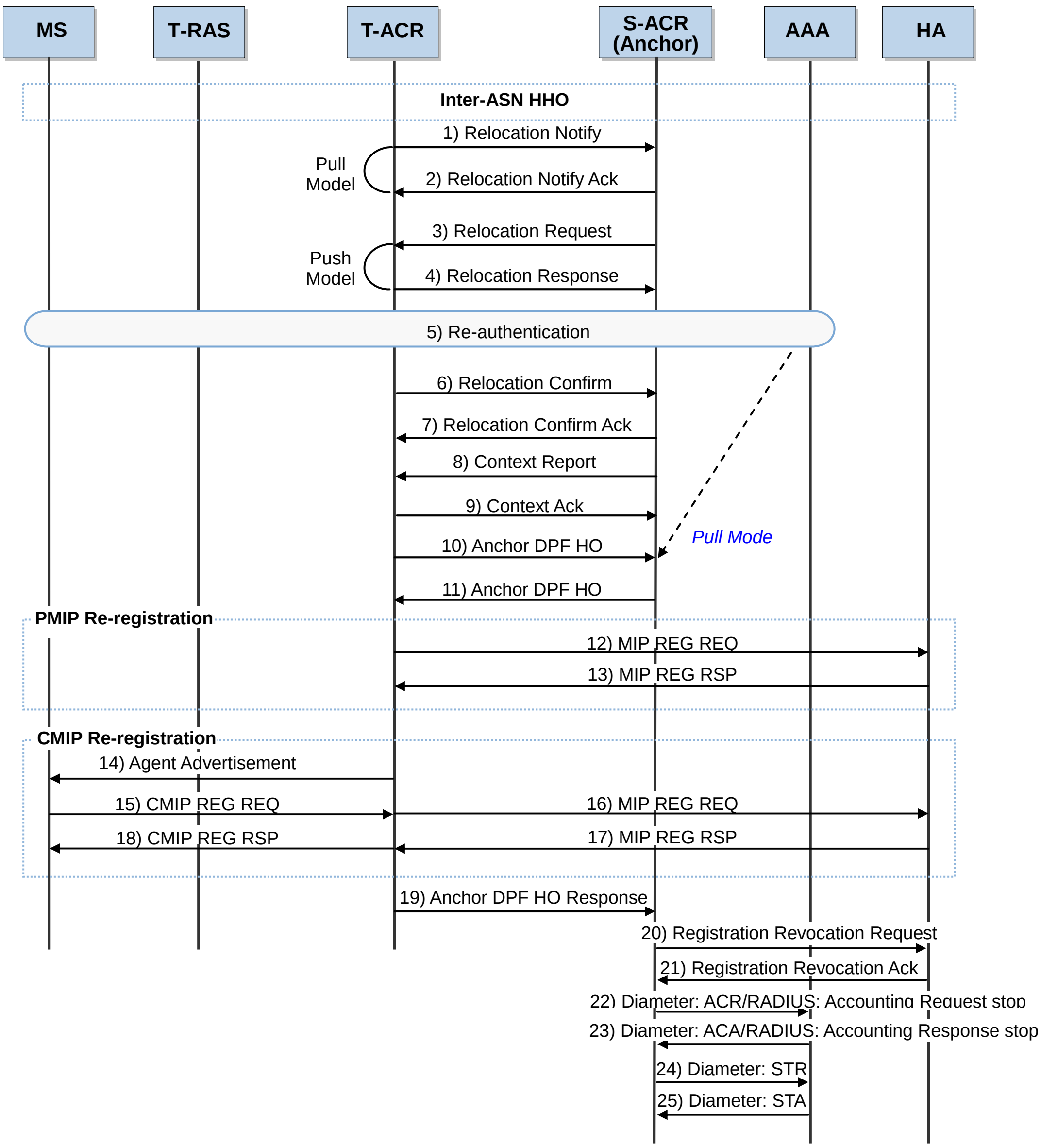


Figure 4.13 Inter-ASN Handover (CSN-Anchored Mobility)

Classification	Description
(1)~(7)	This is the procedure to relocate the Authenticator from the S-ACR to the T-ACR, the T-ACR triggers in order that the MS performs the EAP authentication procedure with the AAA server again. The T-ACR completes the Authenticator Relocation procedure by notifying the S-RAS of the authentication result.
(8)~(9)	S_ACR sends MS context information to T_ACR.
(10)~(19)	FA relocation and authenticator are triggered, and the registration of the PMIP or the CMIP is processed.
(20)~(21)	The S-ACR cancels the S-ACR registration of the MS in the HA.
(22)~(25)	The S-ACR, in interoperation with the AAA server, updates the final accounting information for the MS. If the Diameter is used as the AAA protocol, the S-ACR performs the session release procedure from the AAA server. However, when the RADIUS protocol is used, only the Accounting Request stop procedure and the Accounting Response stop procedure are processed and the STR/STA procedure is omitted.

4.1.7 Access Termination

Access Termination (Awake Mode)

The following is the procedure that the access is terminated because the power of the Awake Mode MS is turned off.

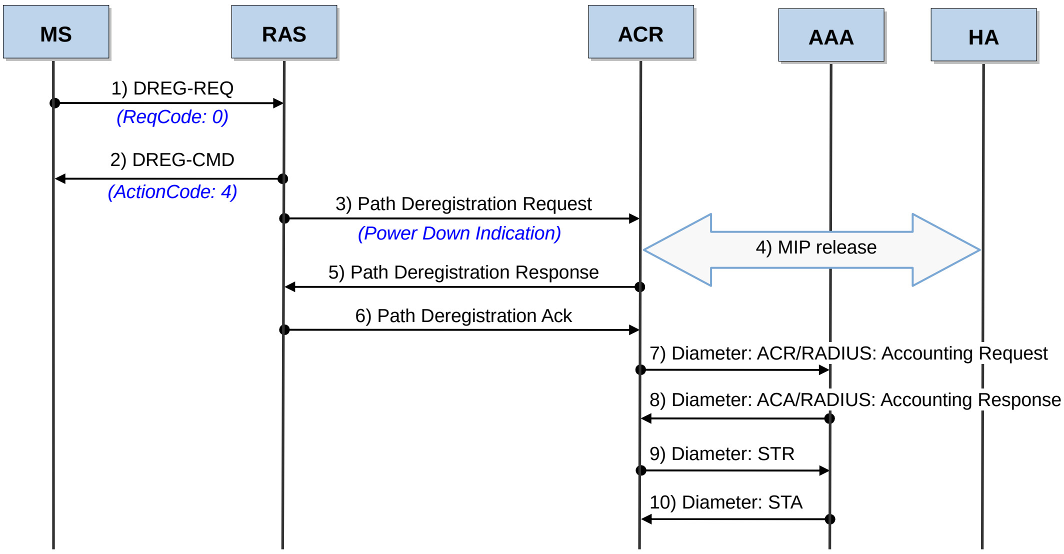


Figure 4.14 Access Termination (Awake Mode)

Classification	Description
(1)~(3)	If the power of the Awake Mode MS is turned off, the MS transmits the DREG-REQ message including 'Deregistration code=0' to the RAS, and the RAS notifies the ACR of this.
(4)	ACR release the MIP related information with HA.
(5)~(6)	The ACR notifies the RAS of the result of power down processing, and release the data path.
(7)~(10)	The S-ACR updates the information on interworking with the AAA server and the final accounting information of MS. Diameter is applied to AAA protocol, S-ACR performs the session termination procedure. However, when the RADIUS protocol is used, only the Accounting Request stop and Accounting Response stop operations are performed, and the STR/STA procedure is omitted.

Access Termination (Idle Mode)

The following is the procedure that the access is terminated because the power of the Idle Mode MS is turned off.

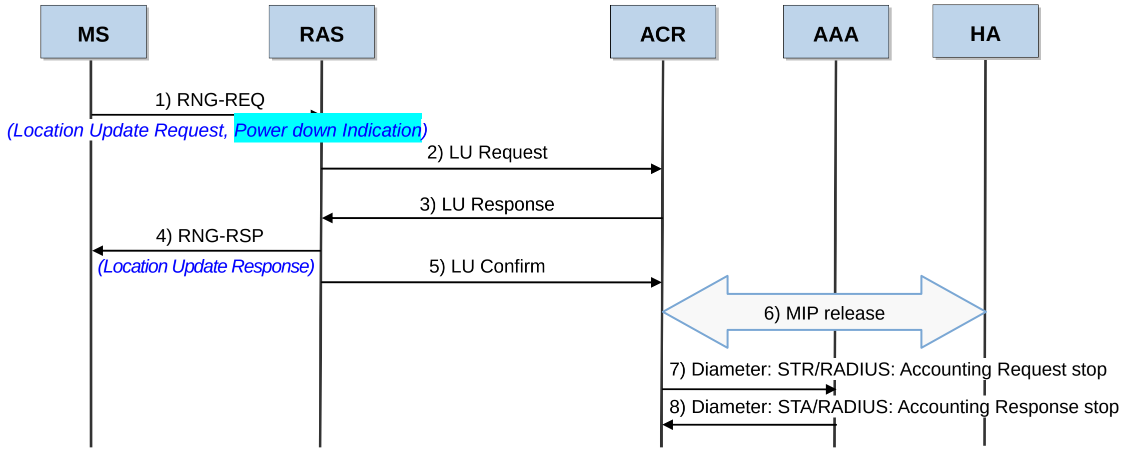


Figure 4.15 Access Termination (Idle Mode)

Classification	Description
(1)~(5)	If the power of the Idle Mode MS is turned off, the MS transmits the RNG-REQ message including the Power Down Indicator to the RAS, and the RAS notifies the ACR of this. The ACR deletes the information of the MS.
(6)	ACR release the MIP related information with HA.
(7)~(8)	Diameter is applied to AAA protocol, S-ACR performs the session termination procedure. However, when the RADIUS protocol is used, only the Accounting Request stop and Accounting Response stop operations are performed, instead of the STR/STA process.

4.2 Network Synchronization Message Flow

The outdoor SPI-2210 uses GPS for the system synchronization. The UCCM of the MMA-S, 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 outdoor SPI-2210.

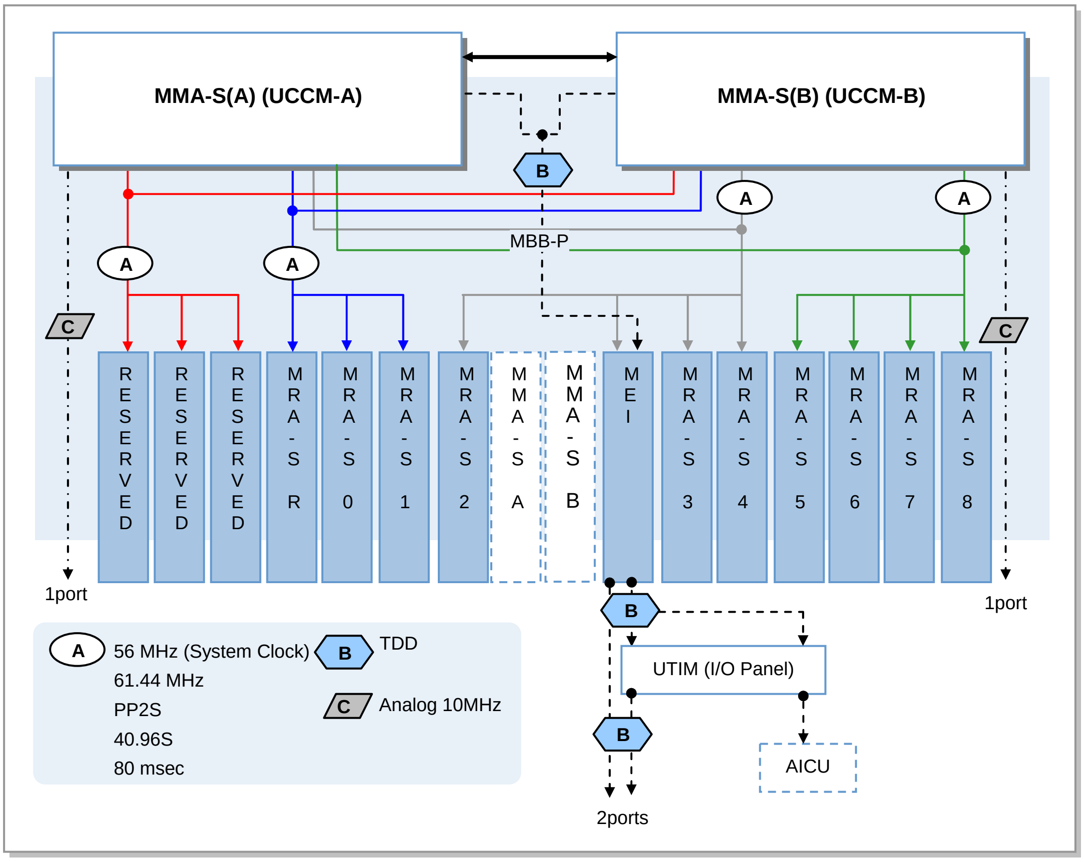


Figure 4.16 Network Synchronization Flow of Outdoor SPI-2210

4.3 Alarm Signal Flow

The detection of failures in the outdoor SPI-2210 can be implemented by hardware interrupt or software polling method. The failures generated in the outdoor SPI-2210 are reported to the management system via the SNMP trap message.

Failure Alarm Types

- System Failure Alarms
  Time Sync Fail, Fan Fail, Temperature High, etc.
- Board Failure Alarms
  - Hardware Failure Alarms: BOARD DELETION, FUNCTION FAIL, etc.
  - Software Failure Alarms: COMMUNICATION FAIL, PORT DOWN, CPU OVERLOAD, OVER POWER, etc.
- UDA
  24 UDAs are supported.
- Environmental alarm via UCM

Failure Report Message Flow

The main OAM (UFM) collects the failures detected from each board and UDA interface of the outdoor SPI-2210 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:

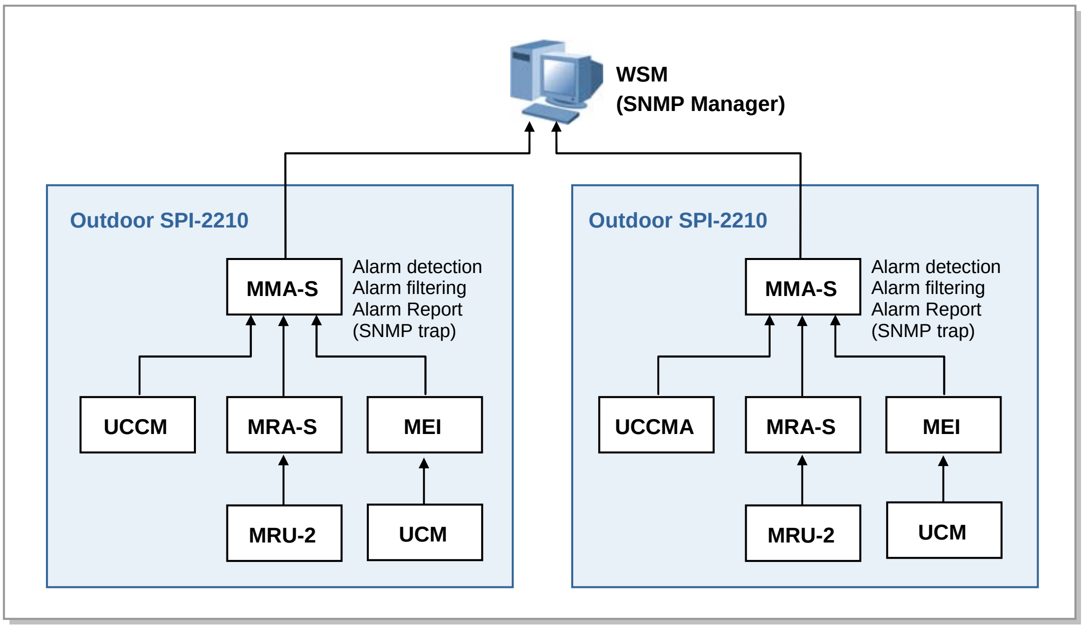


Figure 4.17 Alarm Signal Flow of Outdoor SPI-2210

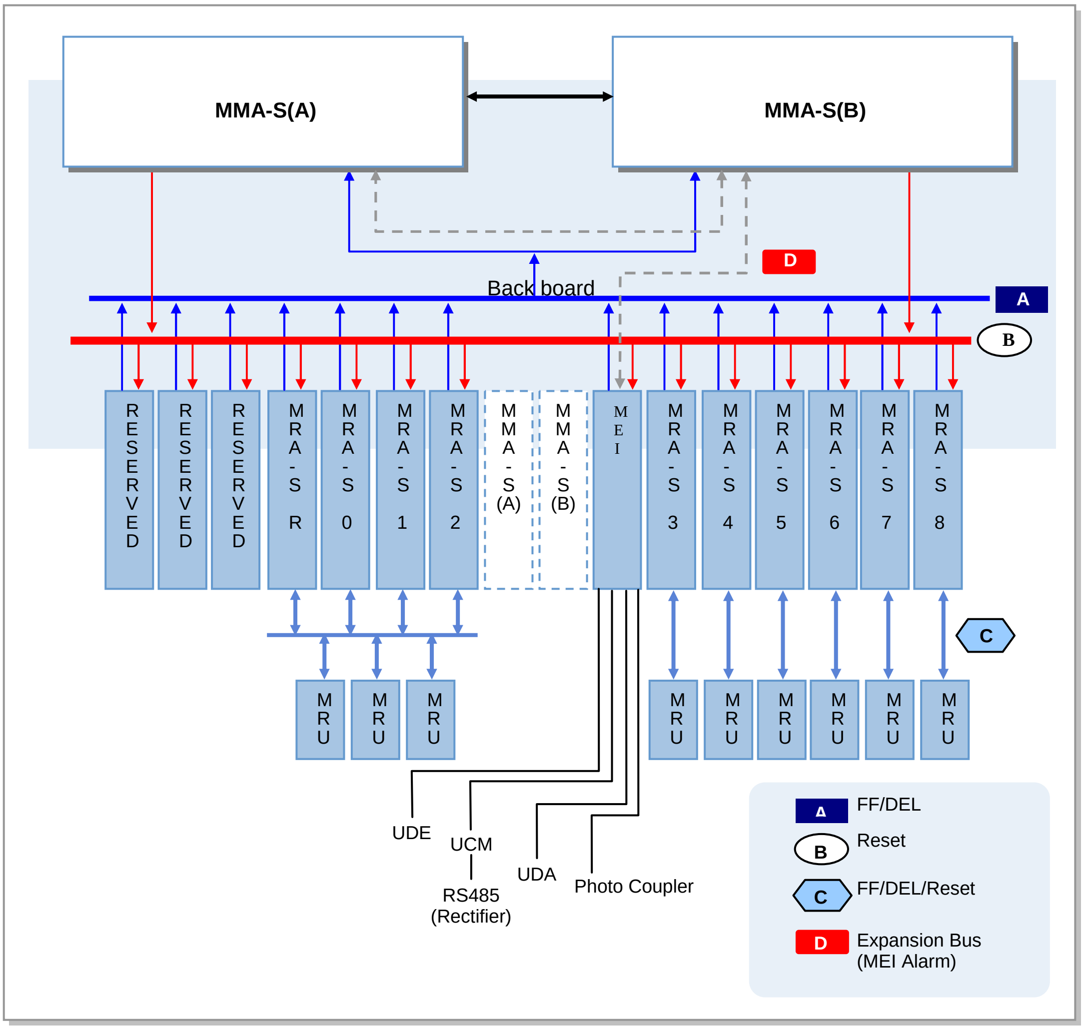


Figure 4.18 Alarm and Control Structure of Outdoor SPI-2210

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 outdoor SPI-2210. Loading the outdoor SPI-2210 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 nonvolatile storage and the other is loading by using the remote IS. When the system is initialized for the first time, the outdoor SPI-2210 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 outdoor SPI-2210 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 outdoor SPI-2210 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 outdoor SPI-2210, 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. The DPSA, which uses the Intel CPU, loads the kernel and the RFS from the Disk On Chip (DOC) to the RAM Disk via ROM BIOS booting and performs the kernel.
- IP configuration: The IP address information is obtained and configured from the flash ROM to allow it to communicate with the first upper management system.
  For automatic initialization, the outdoor SPI-2210 automatically obtains the L3 information needed for communication, such as the IP address, subnet mask, and gateway IP address from DHCP. At this time, it also receives the IP address of the additional information server, and asks for its ID and the IP address of the RS to which its ID is registered.
- 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-S which performs the operation and the maintenance of the entire Outdoor SPI-2210 performs loading by using the SFTP to the corresponding IS (remote IS 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 outdoor SPI-2210 can be checked in the upper management system.

The loading message flow is as the following figure:

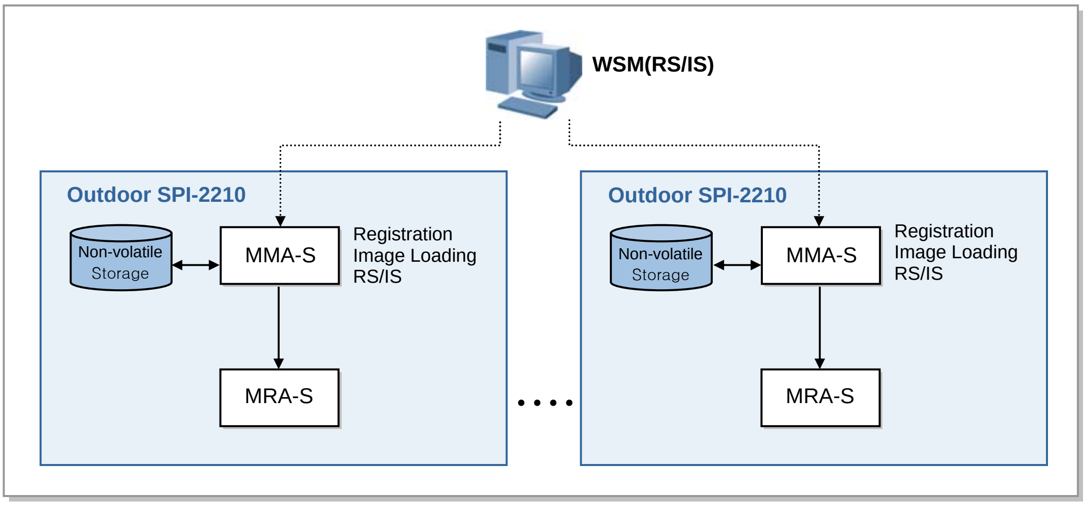


Figure 4.19 Loading Message Flow

4.5 Operation and Maintenance Message Flow

An operator can check and change the status of the outdoor SPI-2210 by means of the management system. To this end, the outdoor SPI-2210 provides the SNMP agent function. The function enables the WSM operator to perform the operation and maintenance function of the outdoor SPI-2210 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 outdoor SPI-2210 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 outdoor SPI-2210 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 outdoor SPI-2210 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 Bucket Interval(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:

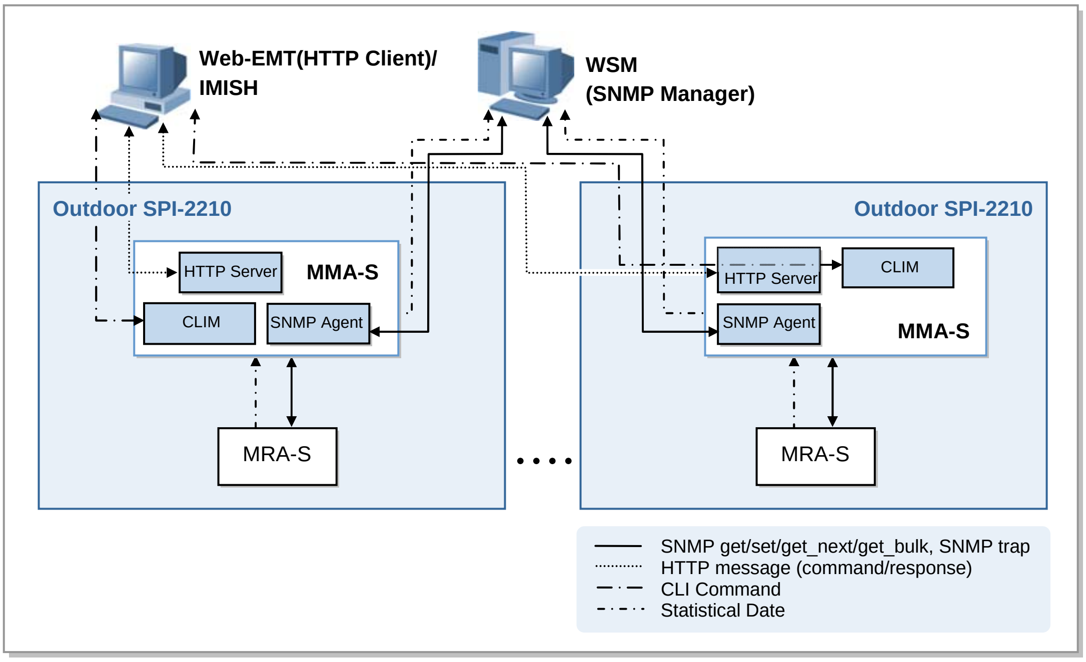


Figure 4.20 Operation and Maintenance Signal Flow

CHAPTER 5. Additional Functions and Tools

5.1 TTLNA/RET

The outdoor SPI-2210 can support Tower Top Low Noise Amplifier (TTLNA) and Remote Electrical Tilting (RET) when the AICU, 3rd party device, is mounted on the system.

TTLNA has the structure that an antenna and LNA is integrated, and service provider can select and use TTLNA to enhance the reception noise performance. At this time, the AICU can supply the power to maximal 12 TTLNAs, and perform the alarm and control function for the TTLNA.

The outdoor SPI-2210 exchange with the alarm and control message for the TTLNA with WSM through AICU (AISG interface), MEI (Ethernet port) and MMA-S, and the WSM can carry out RET function that control the vertical direction of the antenna beam at a remote site via such path.

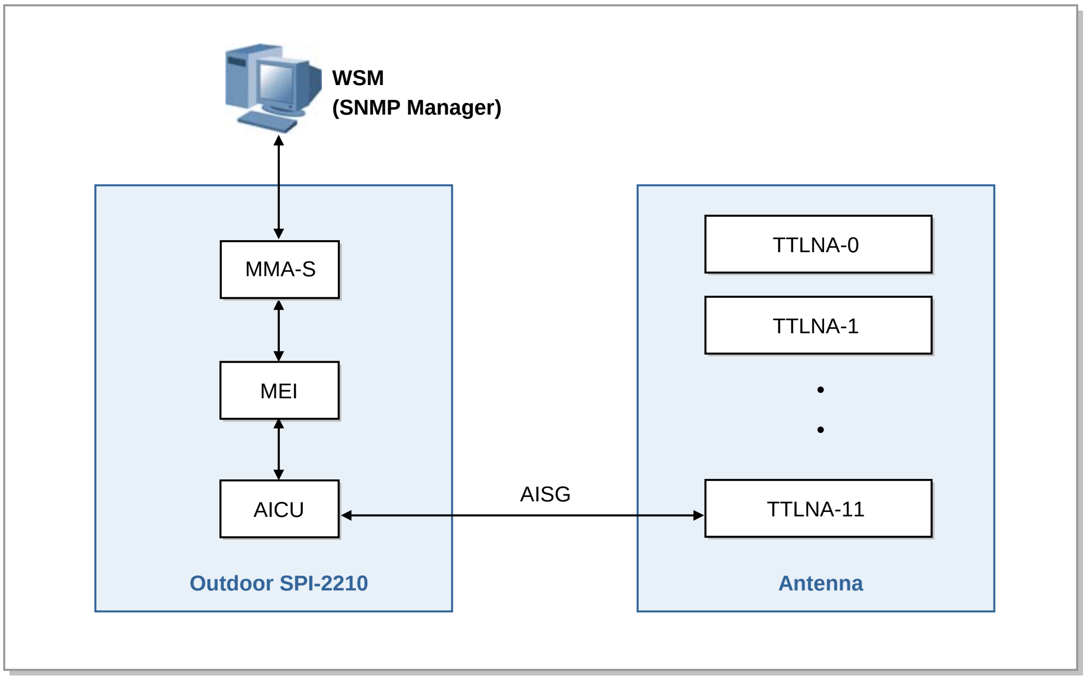


Figure 5.1 TTLNA/RET Interface

5.2 Web-EMT

The Web-EMT is a type of GUI-based consol terminals and the tool to access the outdoor SPI-2210 directly, monitor the device status and perform operation and maintenance.
An operator can execute the Web-EMT only with Internet Explorer and the installation of additional software is not necessary. In addition, GUI is provided in HTTPs protocol type internally.

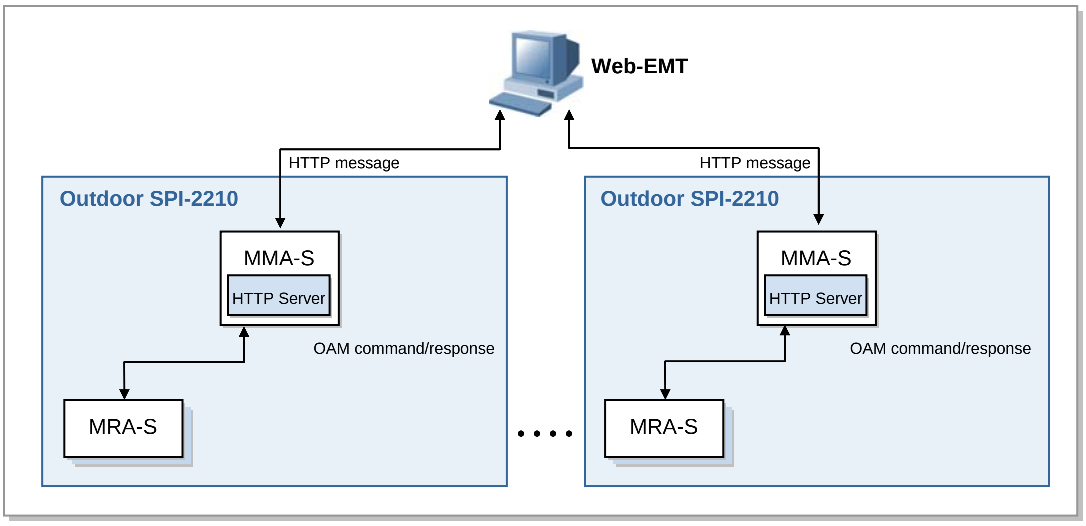


Figure 5.2 Web-EMT Interface

The Web-EMT enables the operator to restart the outdoor SPI-2210 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

AA	Access Accept
AAA	Authentication, Authorization and Accounting
AC	Admission Control
ACR	Access Control Router
ADC	Analog to Digital Conversion
AGC	Automatic Gain Control
AICU	Antenna Interface Control Unit
AISG	Antenna Interface Standards Group
AMC	Adaptive Modulation and Coding
API	Application Programming Interface
AR	Access Request
ARQ	Automatic Repeat request
ASN	Access Service Network

B

BI	Bucket Interval
BP	Board Processor

C

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

DACS	Direct Air Cooling System
DD	Device Driver
DHCP	Dynamic Host Configuration Protocol
DL	Downlink
DMB	Digital Main Block
DST	Daylight Saving Time

E

EAP	Extensible Authentication Protocol
EMI	Electro-Magnetic Interference
EMI	EMS Interface
EMS	Element Management System

F

FA	Foreign Agent
FA	Frequency Allocation
FAN-POD	FAN module-Premium Outdoor DMB
FAN-POR	FAN module-Premium Outdoor RFB
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

L

LTE	Long Term Evolution
LVDS	Low Voltage Differential Signaling

M

MAC	Medium Access Control
MBB-P	Mobile WiMAX base station Backplane Board-Premium
MCU	Mobile WiMAX base station RF Combiner Unit
MEI	Mobile WiMAX base station External Interface board assembly
MIMO	Multiple Input Multiple Output
MIP	Mobile IP
MLPPP	Multi Link Point to Point Protocol
MMA-S	Mobile WiMAX base station Main control board Assembly-Standard
MRA-S	Mobile WiMAX base station RAS board Assembly-Standard
MRR	Mobile WiMAX base station RF Receiver
MRU-2	Mobile WiMAX base station RF Unit-20 MHz
MS	Mobile Station
MW	Middleware

N

NE	Network Element
NP	Network Processor
NPS	Network Processor Software
NWG	Network Working Group

O

OAGS	Common SNMP Agent Subagent
OAM	Operation and Maintenance
OCM	Common Configuration Management
OER	Common Event Router
OEV	Common Event Viewer
OFDMA	Orthogonal Frequency Division Multiple Access
OPM	Common Performance Management
OS	Operating System
OSSM	Common Subscription Service Management

P

PAM	Pluggable Authentication Module
PBA	Panel Board Assembly
PCB	Printed Circuit Board
PCRF	Policy & Charging Rules Function
PDP-PO	Power Distribution Panel-Premium Outdoor
PDP-PA	Power Distribution Panel-Premium Auxiliary
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
RFB	RF Block
RFS	Root File System
RRC	RAS Resource Controller
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
SFP	Small Form Factor Pluggable
SFTP	SSH File Transfer Protocol
SM	Spatial Multiplexing
SMOR	Samsung Mobile WiMAX base station Outdoor Rack
SNMP	Simple Network Management Protocol
SNMPD	SNMP Daemon
SSH	Secure Shell
SSL	Secure Sockets Layer
SSR	Solid State Relay
STC	Space Time Coding

T

TCA	Threshold Cross Alert
TDD	Time Division Duplex
TTLNA	Tower Top Low Noise Amplifier

U

UCCM	Universal Core Clock Module
UCM	Universal Control Module
UDA	User Defined Alarm
UDE	User Define Ethernet
UDP	User Datagram Protocol
UFM	Common Fault Management
UL	Uplink
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

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Mobile WiMAX Outdoor RAS SPI-2210

System Description

SAMSUNG ELECTRONICS

MPE Information

	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.