ATTACHMENT E.

- USER MANUAL -

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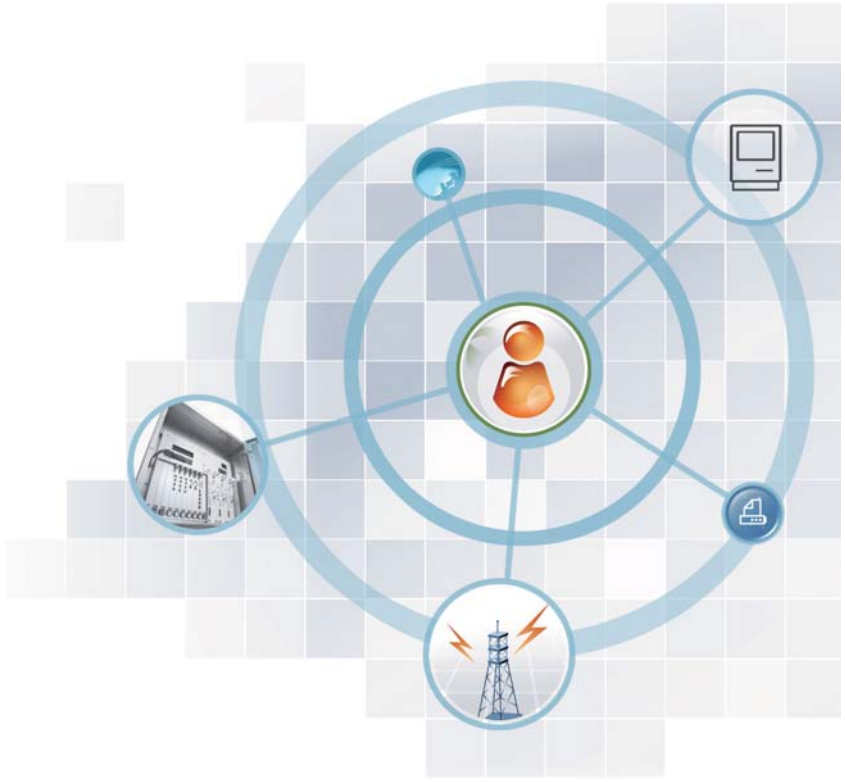
Mobile WiMAX RAS SPI-2C21

System Description



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INTRODUCTION

Purpose

This description describes the characteristics, functions and structures of the SPI-2C21, which is the inbuilding RAS of Mobile WiMAX and 1588 Grand Master (GM), which is IEEE 1588 master equipment.

Who Should Read This Manual

This manual is intended for engineers who want to know the functions and architecture of the SPI-2C21 and the GM and the Mobile WiMAX equipment operators.

Document Content and Organization

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

CHAPTER 1. Overview of Mobile WiMAX System

- Mobile WiMAX System Introduction
- Components of Mobile WiMAX Network

CHAPTER 2. Overview of System

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

CHAPTER 3. System Structure

- Hardware Structure
- Software Structure

CHAPTER 4. Message Flow

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

CHAPTER 5. GM

- GM Introduction
- GM Specifications
- External Interface of GM

ABBREVIATION

Describes the acronyms used in this description.

Conventions

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

NOTE
Indicates additional information as a reference.

Revision History

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

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CHAPTER 1. Samsung Mobile WiMAX Network

1.1 Introduction to Samsung Mobile WiMAX

The Samsung Mobile WiMAX system is the wireless network system that supports IEEE 802.16 base service. The IEEE 802.16 standard is the basis of Samsung Mobile WiMAX, and includes IEEE Std 802.16-2004 defining fixed wireless internet access service and IEEE Std 802.16, P802.16-2004/Cor/D3 defining the technologies supporting mobility, which include handover, paging.

NOTE

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

The wireless LAN (WLAN, Wireless Local Area Network) can provide high speed data services, but its radio wave is short and covers only small areas, and also gives limited user mobility. It is difficult for WLAN to ensure Quality of Service (QoS) for data service.
On the contrary, the present mobile communication networks support the mobility of the users, but the service charge and the cost of system operations are high due to the limited wireless resources. To provide faster service in the existing mobile communication networks, it requires a separate wireless communication technology such as High Speed Downlink Packet Access (HSDPA) for the data services.
Samsung Mobile WiMAX can, therefore, overcome the limitations of the WLAN and present mobile communication networks, and accommodate only the advantages of the system.
Samsung Mobile WiMAX can ultimately provide the high speed wireless internet services with low cost at any time and in anyplace.

Characteristics of the Samsung Mobile WiMAX System

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

- High Compatibility and Cross-Interworking
  The Samsung Mobile WiMAX system is based on IEEE 802.16-2005 standard and complies with Wave 2 Profile and ASN Profile C of the Mobile WiMAX Forum. Therefore, the Samsung Mobile WiMAX system provides high compatibility and excellent cross-interworking.
- High Performance Module Structure

The Samsung Mobile WiMAX system has high performance by using high-performance processor and provides the module structure that it is easy to upgrade hardware and software.
- High System Stability
  The Samsung Mobile WiMAX system provides the redundancy structure for main modules to ensure higher stability.
- Advance RF and Antenna Solution Support
  The Samsung Mobile WiMAX system supports Multiple Input Multiple Output (MIMO) and applies the power amplifier to support wideband operation bandwidth.
- Evolution Possibility into Next Generation Networking
  The Samsung Mobile WiMAX system complies with the structure of the Mobile WiMAX ASN Profile C network and the ASN Profile C network composition is similar to the network structure considered in 3GPP Long Term Evolution (LTE)/Service Architecture Evolution (SAE). Therefore, the Samsung Mobile WiMAX system can easily evolve into the next generation network.
- Maintenance Function with Strengthened Security
  The Samsung Mobile WiMAX system can provides the security function (SNMPv3, SSH, SFTP and HTTPs) to all channels for operation and maintenance. The Samsung Mobile WiMAX system provides the operator Authentication, Authorization and Accounting (AAA) function to authenticate the operator and assign the right for system access and stores the operation history in a log.

Samsung Mobile WiMAX System(ACR and RAS) Functions

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

NOTE

System Support Standards
Network Working Group (NWG) of Mobile WiMAX Forum defines the Mobile WiMAX network as Access Service Network (ASN) and Connectivity Service Network (CSN). RAS of Samsung is Base Station (BS) and ACR is ASN-GW (Gateway) of ASN, respectively.
RAS and ACR are based on ASN Profile C and Wave 2 Profile defined in the Mobile WiMAX Forum and the Wave 2 Profile contains Wave 1 Profile.

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

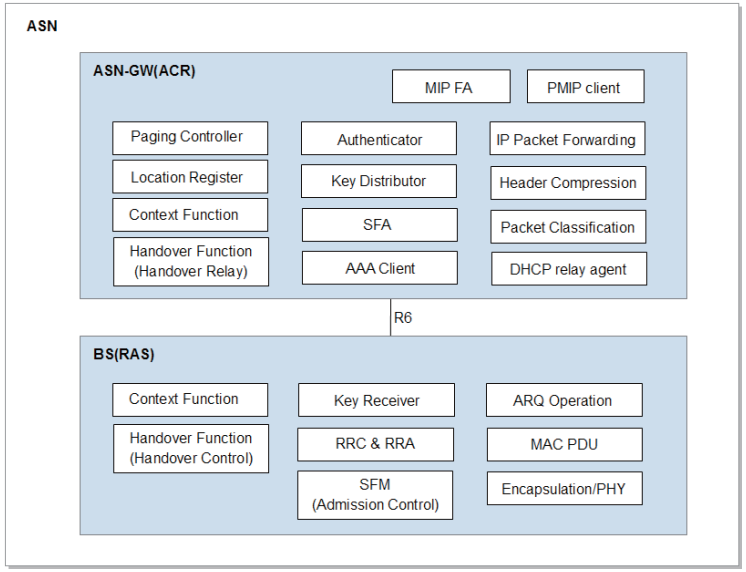

Figure 1.1 Configuration of Mobile WiMAX System Functions (Based on Profile C)

The ACR supports the Convergence Sublayer (CS) and performs the packet classification and Packet Header Suppression (PHS) functions. When the ACR carries out the header compression function, it supports Robust Header Compression (ROHC) defined in the NWG standard.
In addition, the ACR performs the paging controller and location register functions for an MS in Idle Mode.
In authentication, the ACR performs the authenticator function and carries out the key distributor function to manage the higher security key by interworking with the AAA server as an AAA client. At this time, RAS performs the key receiver function to receive the security key from the key distributor and manage it.
The ACR interworks with the AAA server of CSN for authentication and charging services and with the HA of CSN for Mobile IP (MIP) service. The ACR as FA of MIP supports both Proxy MIP (PMIP) and Client MIP (CMIP).
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 both Proxy MIP (PMIP) and Client MIP (CMIP).
The RAS performs the Service Flow Management (SFM) function to create/change/release connections for each Service Flow (SF) and the admission control function while creating/changing connections. In regard to the SFM function of the RAS, the ACR carries out the SF Authentication (SFA) and SFID management functions. The ACR carries out the SFA function to obtain the QoS information from Policy Function (PF) and apply it in the

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

NOTE

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

1.2 Samsung Mobile WiMAX Network Configuration

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, DHCP and PCRF server. ASN is connected with CSN by router and switch.

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

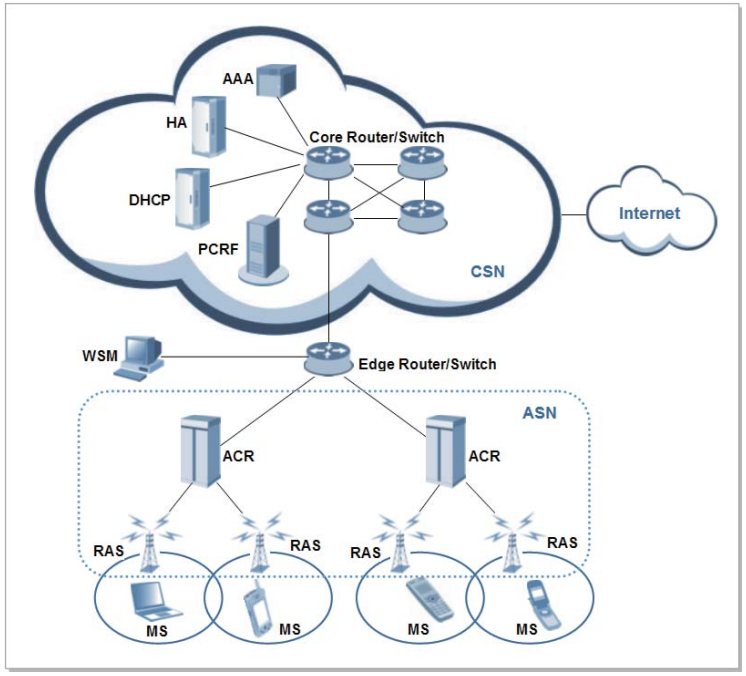

Figure 1.2 Samsung Mobile WiMAX Network Configuration

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. In this way, the ACR provides interfaces for the NEs of the CSN.

Radio Access Station (RAS)

RAS as the system between ACR and MS has the interface with ACR and provides the wireless connection to MS under IEEE 802.16 standards to support wireless communication service for subscribers.

RAS carries out wireless signal exchange with MS, modulation/demodulation signal processing for packet traffic signal, efficient use of wireless resources, packet scheduling for Quality of Service (QoS) assurance, assignment of wireless bandwidth, Automatic Repeat request (ARQ) processing and ranging function. In addition, RAS controls the connection for packet calls and handover.

Samsung Mobile WiMAX System Manager (WSM)

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

Home Agent (HA)

HA accesses other networks or private networks and enables Mobile IP (MIP) users to access internet. HA interworks with ACR that performs Foreign Agent (FA) function for Mobile IPv4 and interworks with MS to exchange data for Mobile IPv6.

Authorization, Authentication and Accounting (AAA) Server

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

Dynamic Host Configuration Protocol (DHCP) Server

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

Policy & Charging Rules Function (PCRF) Server

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

CHAPTER 2. Overview of System

2.1 System Introduction

The SPI-2C21, RAS of Mobile WiMAX, is controlled by ACR and connects Mobile WiMAX calls to MS.
The SPI-2C21 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 SPI-2C21 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 SPI-2C21 and set/hold/disconnect the packet call connection, handover control and ACR interface function and system operation management function.
The SPI-2C21 is a one-box type system that the digital and RF blocks are integrated into and can be installed on a wall or ceiling in indoor environments.
Basically, the SPI-2C21 can support 1Carrier/Omni capacity per system and also 2x2 Multiple Input Multiple Output (MIMO) or 4T/4R with CDD (matrix A/B + CDD) mode.

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 MIMO

Basically the SPI-2C21 supports the 2x2 MIMO mode that is applied with the Cyclic Delay Diversity (CDD) method, and below are the types of supported MIMO.

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

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Support of Cyclic Delay Diversity (CDD)

The CDD repeatedly sends the data stream, which is the same as another data stream using frequency diversity. Therefore, the air performance of the Mobile WiMAX system can be improved using CDD.

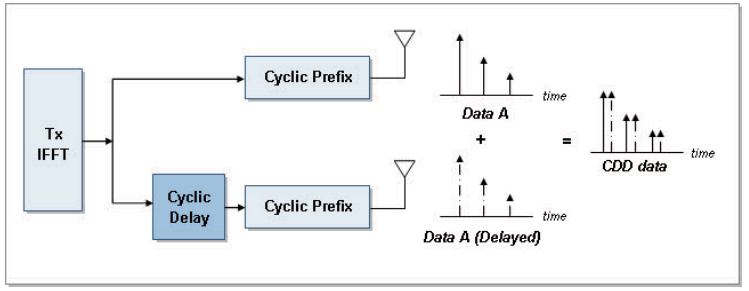

Figure 2.1 FFT Spectrum Plot of CDD

IEEE 1588 Support

The SPI-2C21 generates the clocks needed in the system and is not only equipped with a GPS reception module but also supports the IEEE 1588 protocol to obtain the clock signals for system synchronization.

POE Support

The SPI-2C21 basically supports the Power over Ethernet (POE) function besides an external AC power supply, and the power supply method can be selected according to the installation environment.

Low Power Consumption and Small Footprint

The SPI-2C21 has a highly integrated architecture optimized for the 1Carrier/Omni system and has achieved low power consumption and a small footprint by adapting the System on Chip (SoC) and Radio Frequency Integrated Circuit (RFIC).

Convenience of Installation and Work

The SPI-2C21 is an ultra-small, one-box system that can be conveniently installed on a wall or ceiling with minimum effort and installation space required.

Protection of Software

The SPI-2C21 protects software and its configuration information using non-volatile memory within the system.

Monitoring Port

The operator can monitor the information for the system using its debug port when needed.

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System Feature Availability

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

2.2 Main Functions

The main functions of the SPI-2C21 are as follows:

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 SPI-2C21 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 SPI-2C21 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 SPI-2C21 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 SPI-2C21 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 SPI-2C21 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 SPI-2C21 performs the subchannelization to mitigate the interference between cells.
The SPI-2C21 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 SPI-2C21 transmits the column of the QAM symbol structure to the MS via the sub-carriers pertained to each subchannel.

DL/UL MAP Construction

The SPI-2C21 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 SPI-2C21 and includes various control information for the MS.

Power Control

The SPI-2C21 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 SPI-2C21 transmits the power correction command to each MS and then makes the MS power intensity be the level required in the SPI-2C21 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 SPI-2C21 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 SPI-2C21 provides the MIMO function as follows according to Mobile WiMAX Wave 2 Profile:

- Downlink
  - Matrix A (STC): Transmission ratio of the Matrix A or STC is 1 and equal to that of Single Input Single Output (SISO). However The Matrix A or the STC reduces the error of the signal received from the MS by raising the stability of the signal received from the MS by means of the Tx diversity. This technology is, also, effective in low Signal to Noise Ratio (SNR) and provides excellent performance even when the MS moves in high speed.
  - Matrix B (SM, vertical encoding): Matrix B or SM method raises the effectiveness of the frequency by raising the transmission ratio in proportion to the number of antenna in comparison with SISO. This technology is effective when the reception SNR is high.
- Uplink
  - Collaborative SM: Collaborative SM is the technology that doubles the frequency efficiency in view of the SPI-2C21 as two MSs with each individual antenna send data simultaneously by using the same channel.

The SPI-2C21 provides the adaptive MIMO switching function, which dynamically selects the SM or STC method for the downlink MIMO function. The SPI-2C21 performs switching based on a value calculated by reflecting the Carrier to Interference and Noise Ratio (CINR) and transmission success rate sent by an MS.

4T4R with CDD

The SPI-2C21 provides the 4T4R with CDD for which the frequency diversity is applied to the downlink by providing the 4Tx/4Rx RF path. The benefit of 4T4R with CDD is

that the CDD function is added to the MIMO function. It is divided into the following two modes according to the MIMO mode.

- Matrix A (STC) + CDD
- Matrix B (SM) + CDD

The SPI-2C21 dynamically switches to the two 4T4R with CDD modes given above, depending on the CINR and transmission success rate reported by an MS. At this time, the Collaborative SM (CSM) is applied to the uplink.

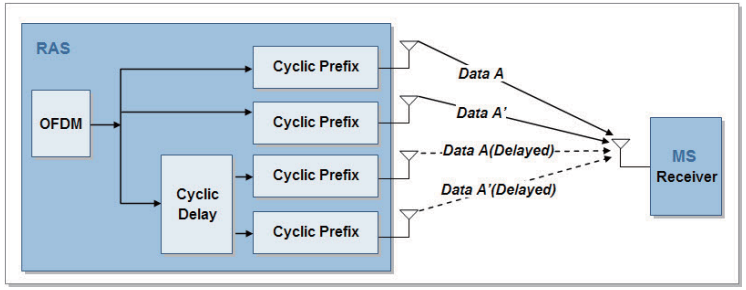

Figure 2.2 4T4R with CDD (Matrix A + CDD mode)

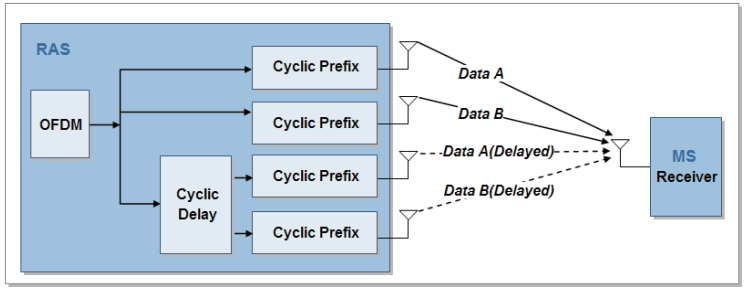

Figure 2.3 4T4R with CDD (Matrix B + CDD mode)

2.2.2 Call Processing Function

Cell Initialization Function

The SPI-2C21 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 SPI-2C21 enables an MS to enter to or exit from the network. When an MS enters to or exit from the network, the SPI-2C21 transmits/receives the signaling message required for call processing via R1 interface with the MS or R6 interface with ACR.
The SPI-2C21 allocates various management/transport Connection Identifier (CID) required for the network entry and service to an MS. When the MS exit from the network, the SPI-2C21 collects and release the allocated CID.

Handover

The SPI-2C21 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 SPI-2C21 performs the data switching function. In handover, the SPI-2C21 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.

Handover Procedure
For the detailed handover procedure, refer to 'Handover'.

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 SPI-2C21 carries out the related call processing function by receiving/sending the signaling message required for the status transition into Sleep Mode of MS and the return from the Sleep Mode to Awake Mode of MS.

Admission Control (AC) Function

If the SPI-2C21 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 SPI-2C21 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 SPI-2C21 checks if the air resources of the requested subcell exceed the threshold and determines the creation of the service

MAC ARQ Function

The SPI-2C21 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 SPI-2C21 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 SPI-2C21 is delivered to the modem in the SPI-2C21. At this time, the SPI-2C21 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 SPI-2C21 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 and Backhaul Operating Functions

IP QoS Function

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 SPI-2C21 supports the mapping between Differentiated Services Code Point (DSCP) and 802.3 Ethernet MAC service class.

IP Routing Function

Since the SPI-2C21 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 SPI-2C21 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 SPI-2C21 supports the static routing configuration only and not the router function for the traffic received from the outside. When the SPI-2C21 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 SPI-2C21 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 SPI-2C21 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 Maintenance Function

The SPI-2C21 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 SPI-2C21 interworks with this WSM. In addition, ACR interworks with the console terminal for directly accessing the NE as well as WSM by operator to perform the operation and maintenance function.
For operator's convenience and working purpose, the operator can select graphic-based console interface (Web-based Element Maintenance Terminal, Web-EMT) or text-based console interface (Integrated Management Interface Shell, IMISH).
The operator can access the console interface with no separate software and log in to Web-EMT through Internet Explore and IMISH through Secure Shell (SSH) on the command window.
The operator can carry out the retrieval and setup of the configuration and the operation information and monitoring about faults, status and statistics via console terminal. However, the operator can carry out grow/degrow of resources and setting of the neighbor list and paging group which have correlation between several NEs only via the WSM.

Operator Authentication Function

The SPI-2C21 provides the authentication and the permission management functions for the operator who manages the Mobile WiMAX system. The operator accesses the SPI-2C21 by using the operator's ID and password via Web-EMT or IMISH and the SPI-2C21 assigns the operation right in accordance with the operator's level.

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The SPI-2C21 carries out the logging function for successful access, access failure and login history.

Maintenance Function with Enhanced Security Function

For the security, the SPI-2C21 supports Simple Network Management Protocol version 2c (SNMPv2c) Simple Network Management Protocol version 3 (SNMPv3) and File Transfer Protocol (FTP) 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 SPI-2C21 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 SPI-2C21 updates the package stored in a non-volatile storage.
In addition, the SPI-2C21 can re-perform the 'Change to New package' stage to roll back into the previous package before upgrade.

Call Trace Function

The SPI-2C21 supports the call trace function for a specific MS. The SPI-2C21 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 SPI-2C21, also, sends the RF environment information, such as 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 SPI-2C21 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 SPI-2C21, and the SPI-2C21 creates and stores a file for each period.

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Threshold Cross Alert (TCA) Control

The SPI-2C21 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 SPI-2C21 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 SPI-2C21 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 SPI-2C21 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 SPI-2C21 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 SPI-2C21 provides a throughput test for the backhaul to the ACR. The SPI-2C21 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 SPI-2C21 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 SPI-2C21 is running may affect the system performance.

Disabling Zero Code Suppression (ZCS)

The SPI-2C21 collects statistics data and generates statistics files periodically.
The WSM collects these statistics files. A statistics file is composed of the header used to indicate a statistics group and its detailed index (for example, a specific carrier, sector, CPU, port, etc.) and the statistics data for that index.
In a statistics period, the statistics data for a specific index can become zero in a statistics file in the following cases:

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

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

2.3 Specifications

Capacity

The capacity of the SPI-2C21 is as follows:

Category	System Capacity
Channel Bandwidth	10 MHz
Frequency	2,496~2,690 MHz
Maximum Number of Carriers/Sectors	1 Carrier/Omni
Backhaul Interface	100Base-T 1 port
FFT size	1,024
Multiple Antenna	– 2x2 MIMO – 4T4R with CDD(Matrix A/B + CDD)
Output	100mW/path – When operating 4T(4 path): Total 400mW – When operating 2T(2 path): Total 200mW

Input Power

The table below lists the power standard for the SPI-2C21. The SPI-2C21 satisfies the UL60950 electrical safety requirements.

Category	Standard
System Input Voltage	– External AC/DC Adapter (100~240V) – PoE

Unit Size and Weight

The table below lists the size and weight of the SPI-2C21.

Category	Standard
Size(mm)	210(W) × 210(D) × 50(H), About 2.2L
Weight(kg)	2 or less

Environmental Condition

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

Category	Range
Temperature Condition[a)]	0~50°C(32~122°F)
Humidity Condition [a)]	5~90%, but not to exceed 0.024 kg water/kg of dry air
Altitude	–60~1,800 m(-200~6,000 ft)

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Category	Range
Vibration	GR-63-CORE Sec.4.4 Earthquake Office Vibration Transportation Vibration
Sound Pressure Level	60 dBA or less on the position where is 0.6 m away from the surface of system(front/rear/left/right) and in the height of 1.5m on the bottom.
EMI	FCC Title47 Part 15 Class B GR-1089-CORE Sec. 3.2 Emission Criteria

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

GPSR Specification

The table below lists the characteristics of the GPS Receiver (GPSR) that is used when the SPI-2C21 receives the synchronization signals directly from a GPS.

Category	Description
Output from GPSR	PP2S, TOD, 44.8MHz
Frequency Accuracy	± 0.02 ppm
Time Accuracy	± 1 μs

RF Specification

The table below lists the RF characteristics of the SPI-2C21.

Category	Description
Total Tx Output Power	– When operating 2T: 200mW @avg power – When operating 4T: 400mW @avg power
Tx Constellation error	In accordance with the 802.16e standard
RX Sensitivity	In accordance with the 802.16e standard

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2.4 Interface between Systems

Interface Structure

The SPI-2C21 interfaces with another RAS and ACR as shown in the figure below:

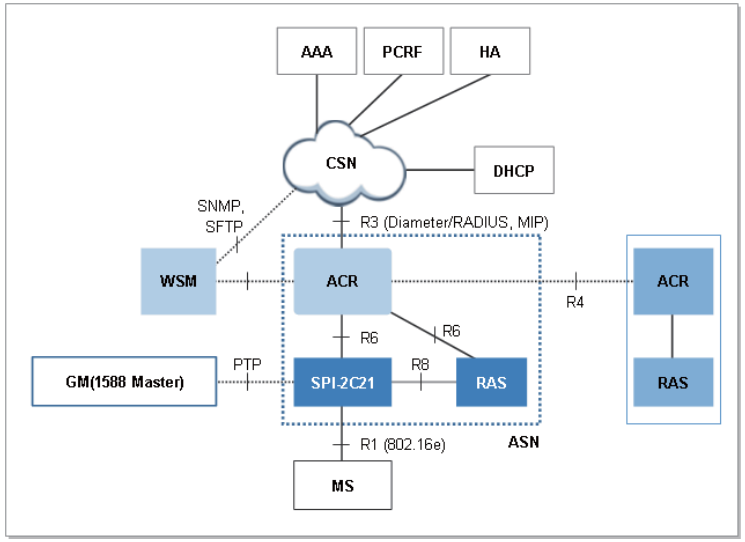

Figure 2.4 Structure of SPI-2C21 Interface

- Interface between SPI-2C21 and MS
  The SPI-2C21 interfaces with an MS according to the IEEE 802.16 radio access standard to exchange the control signal and the subscriber traffic.
- Interface between SPI-2C21 and GM
  The SPI-2C21 and GM interface using the IEEE 1588 protocol (PTP), and its physical connection method is FE. The system's synchronization-related data and control signals are sent/received through the interface between the SPI-2C21 and GM.
- Interface between SPI-2C21 and ACR
  The interface between an ACR and the SPI-2C21 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 SPI-2C21 and WSM
  The interface between the SPI-2C21 and the WSM complies with SNMPv2c or SNMPv2c/SNMPv3c of IETF standard, FTP/SFTP and proprietary standard of Samsung and its physical access method is GE/FE.

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Protocol Stack

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

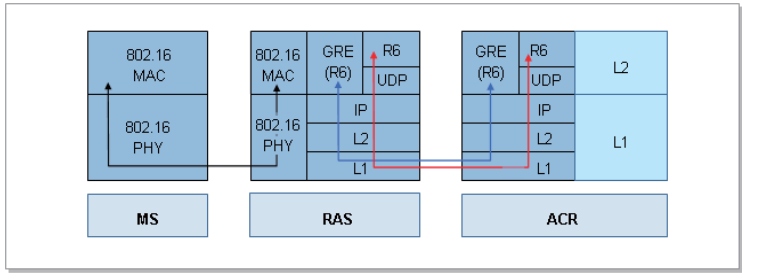

Figure 2.5 Protocol Stack between NEs

The SPI-2C21 interworks with MSs via R1 interface according to IEEE 802.16 standard and the interface between the SPI-2C21 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

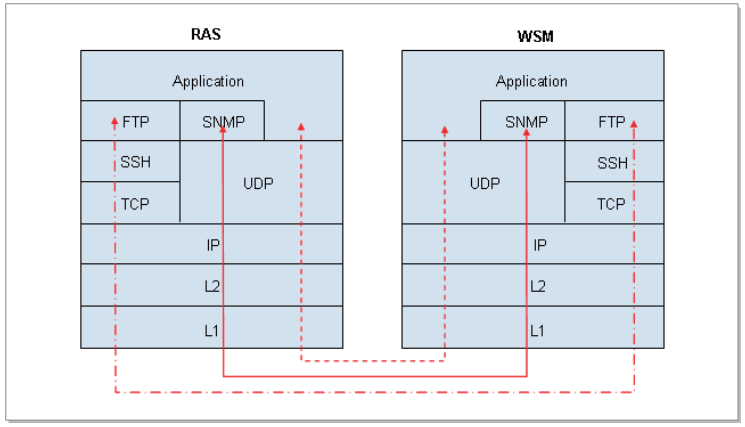

Figure 2.6 Protocol Stack between SPI-2C21 and WSM

The ACR interworks with WSM in IP/UDP-based SNMP method to carry out the operation and maintenance functions. In particular, the SPI-2C21 interworks with WSM in IP/TCP-based FTP/SFTP (FTP over SSH) method to collect the statistical data periodically, initialize & restart the system and download software.

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CHAPTER 3. System Structure

3.1 Hardware Structure

The SPI-2C21 has a highly integrated architecture optimized for the 1Carrier/Omni capacity and has low power consumption and a small footprint by adapting SoC and RFIC.
The SPI-2C21 is configured as follows, and it can be installed on a wall or ceiling.

Figure 3.1 SPI-2C21 System Configuration

Below are the internal configuration diagrams of the SPI-2C21.

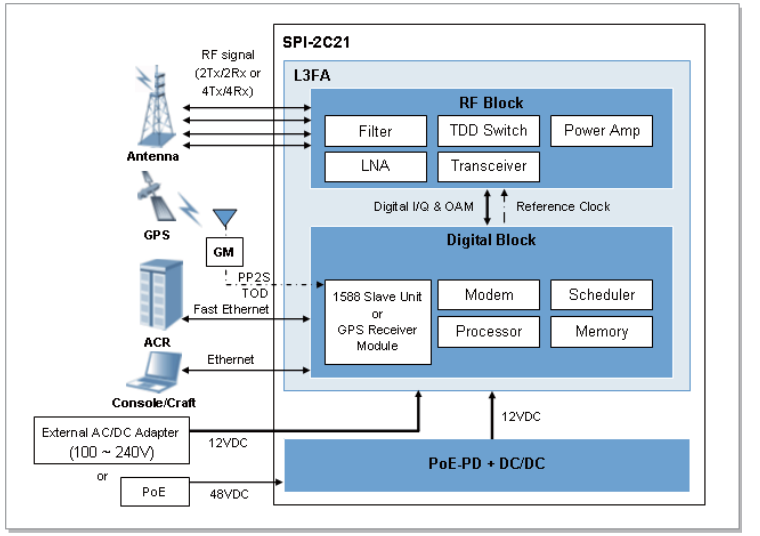

Figure 3.2 SPI-2C21 Internal Configuration

3.1.1 L3FA(Digital Block, RF Block)

U-RAS Light Series 3 Four-path main board Assembly (L3FA) is the board here the digital block and RF block of the SPI-2C21 are integrated. The L3FA interfaces with the relevant networks, controls the system, processes digital baseband and RF signals, and carries out the RF signal sending/receiving function.

Board	Quantity (EA)	Function
L3FA	1	Digital Block Functions – System's main processor (control, bearer, and O&M) – Processes OFDMA channels – Supports 2x2 MIMO or selectively supports 4T4R with CDD – Provides 100Base-T 1 port for Backhaul interface – Supports IEEE 1588 or GPS – Provides one port for debugging (HDMI) – Provides LED (Backhaul, Alarm, and CPU) – PD (PoE+) function
		RF block function – Performs the transceiver (upconverting/downconverting frequency, DAC/ADC) functions – RF Up/Down conversion function

Board	Quantity (EA)	Function
		– RF signal amplification – TDD switch function: Classifying sending/receiving signals and filtering out-of-band signals – Amplifies low level noise from the received RF signals

From a functional standpoint, L3FA consists of the following.

Network Interface Part

The network interface part performs the ACR matching via 100BASE-T copper 1port in Fast Ethernet method. In addition, the SPI-2C21 can send/receive synchronization-related information with the GM via the network interface part.

Control Part

The control part is equipped with the main processor and performs the top-level operations in the SPI-2C21 system. The main processor of the SPI-2C21 sets up a communication path between the MS and ACR and carries out the ethernet switch function within the system and the system operation and maintenance functions.
The control part downloads the software in the system, manages the status of all hardware/software, and reports it to the WSM via the ACR. In addition, the Control Part assigns the trunk lines and channel resources within the system and performs call processing, system operation and maintenance, and TDD signal control.

Signal Processing Part

The signal processing part is equipped with the modem that supports the IEEE 802.16/16e Mobile WiMAX standard physical layer (PHY). This modem processes OFDMA signals under control of the control part.
That is, the signal processing part modulates the packet data received from the ACR and sends them to the RF processing part in the format of digital baseband I/Q signals. In the other direction, the signal processing part carries out the Automatic Gain Control (AGC) function on the data received from the RF processing part then demodulates the data, converts them to the format defined in the specifications of the IEEE 802.16/16e Mobile WiMAX standard physical layer, and sends to the ACR via the ethernet interface.
The signal processing part can selectively support 4T4R CDD or 2Tx/2Rx SM/STC-MIMO of 1Carrier/Omni. And the part operates in MIMO or SIMO mode once two or more RF path failures have occurred in 4T4R with CDD mode.

GPS Reception and Clock Distribution Part

In L3FA, a U-RAS Light series-3 Clock Board (ULCB) is mounted to directly receive GPS signals. Or a 1588 Slave unit [Top Slave clock without TCXO Mezzanine board assembly (TSTM) or GPS/1588 Slave Clock Mezzanine board assembly (GSCM)] can be mounted to receive the 1588 packets transferred through the GM. The ULCB or 1588 slave unit

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generates reference clocks by using received signals to enable the operation of each block of the SPI-2C21 in a synchronized clock structure then distributes them to each block of the L3FA. These clocks are used to maintain internal synchronization in the SPI-2C21 and to operate the system.

RF Processing Part

The RF processing part of the L3FA consists of transceiver, power amplifier (PA), TDD switch, and filter. The RF processing part can support 1 carrier that has a 10 MHz channel bandwidth and RF path of 4Tx/4Rx or 2Tx/2Rx that supports 4T4R with CDD or MIMO.

- Downlink (Tx) Signal Processing
  The RF processing part of the L3FA restricts the baseband I/Q signals received from the signal processing part in bandwidth by filtering them using the digital filter and converts them into analog signals through Digital to Analog Conversion (DAC). These converted analog signals are upconverted into the RF bandwidth signals and then sent to the PA. These signals are high-power amplified through PA and then sent to the filter. The filter suppresses spurious radiation, except the RF signals within the RF signal bandwidth, and then sends those RF signals through the antenna.
  At this time, the strength of the RF signals sent per Tx path is 100 mW at the RF output port.
- Uplink (Rx) Signal Processing
  For the RF signals received through the antenna, the filter suppresses spurious radiation, except the RF signals within the RF signal bandwidth. Then the signals that have passed through the filter are low noise amplified by the Low Noise Amplifier (LNA) and then frequency downconverted into analog signals. These converted analog signals are converted into digital baseband signals through analog to digital conversion (ADC) and then sent to the signal processing part of the L3FA via the filter.

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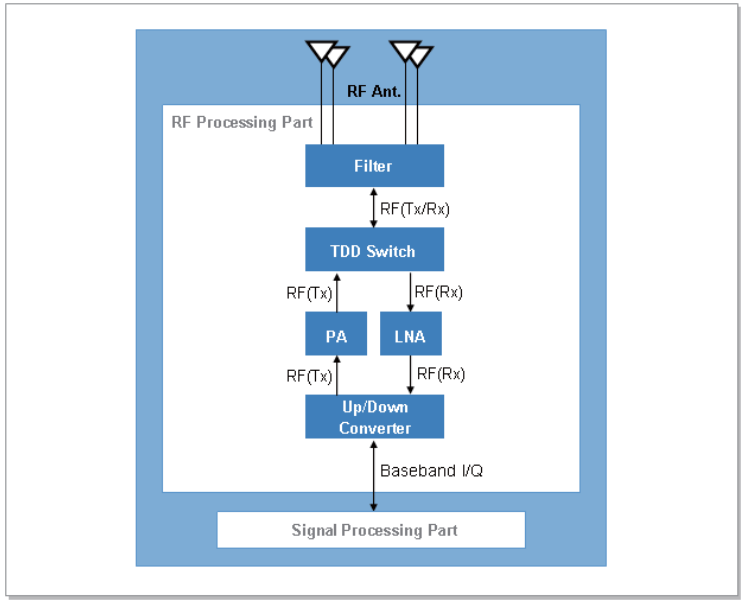

Figure 3.3 RF Processing Part of L3FA

3.1.2 Power Structure

PoE and external AC/DC adapter is the external power supplying device of the SPI-2C21. When using the PoE, the SPI-2C21 performs the DC/DC conversion for the input power from an external Power Sourcing Equipment (PSE) into 12 VDC then supplies the power to the L3FA. When using the external AC/DC adapter, the SPI-2C21 supplies 12VDC to the L3FA directly.

L3FA performs the DC/DC conversion for 12VDC into the power used in the system.

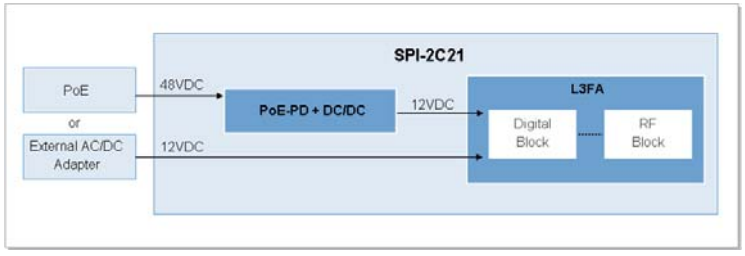

Figure 3.4 Power Structure of SPI-2C21

3.1.3 External Interface Structure

The external interfaces of the SPI-2C21 are shown below.

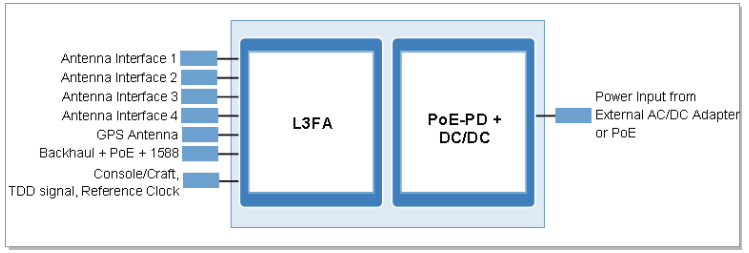

Figure 3.5 External Interface Structure of SPI-2C21

Category	Interface	Number of Ports	Connector	Description
Antenna Interface	Analog RF	4	SMA	Connected to the RF antenna
GPS Antenna	Analog RF	1	SMA	Connected to the GPS antenna to receive GPS signals
Backhaul	100BASE-T	1	RJ-45	– Connected to the ACR – IEEE 1588 Packet – Power is supplied to the system through an external PSE (DC -48 V)
Console/ Craft, TDD Signal, Reference Clock	100BASE-T	1	HDMI	– Connector for debugging – TDD signal: Connected to an external measuring instrument to provide reference signals during RF output testing – Reference clock: Connected to an external measuring instrument to provide reference clock during RF output testing
AC Power Input	AC 100~240V	1	Conn. Housing	Connected to an external power source directly to supply power to the system

3.2 Software Structure

3.2.1 Software Basic Structure

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

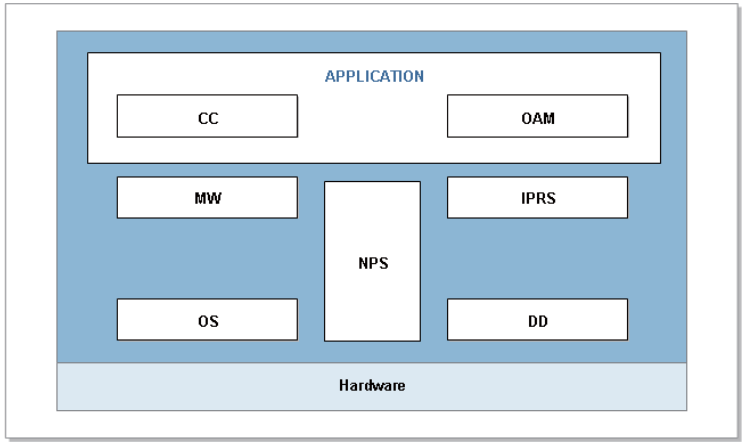

Figure 3.6 Software Structure of System

Operating System (OS)

OS initializes and controls the hardware device, and runs the software operation in the hardware. To operate the software, OS uses the embedded Linux OS, and manages the dual software processes. Then, OS provides various functions efficiently with limited resources.

Middleware (MW)

MW helps the smooth operation between OS and application under various types of hardware environment, and to achieve this, MW provides various services: message delivery service between applications, event notification service, debugging utility services. 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 system, and CC interfaces with MS and ACR. CC supports data exchange function to support wireless data service such as the MAC scheduling, air link control, ARQ processing and IEEE 802.16 message processing.

Operation And Maintenance (OAM)

The OAM provides the interface (SNMPv2c/SNMPv3, FTP/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, collecting the statistics for processing the call and various performance data, managing the system configuration and resources, managing the status of the software resources and the hardware resources, managing the failure and performing the diagnostics for the operation and the management of the system.

3.2.2 CC Block

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

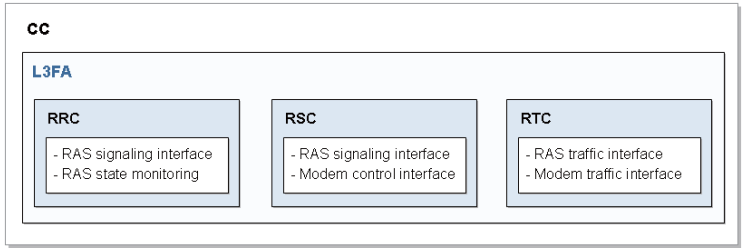

Figure 3.7 CC Block Structure

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

RRC

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

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

RSC

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

Main functions of RSC are as follows:

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

RTC

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

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

3.2.3 OAM Block

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

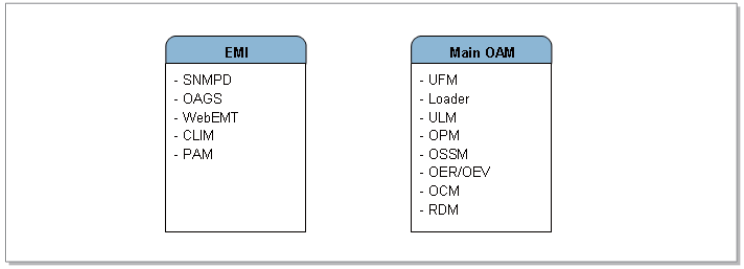

Figure 3.8 OAM Software Structure

EMI and Main OAM are implemented on the L3FA.
The EMI carries out SNMP agent and web server function, and provides the OAM interface between the management system (WSM, Web-EMT and CLI Terminal) and the system by providing the IMISH. Then, to access the system directly via the Web-EMT or the console terminal, the process of the operator authentication and the authority allowance via the WebEMT or Pluggable Authentication Module (PAM) block should be done.
The Main OAM 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.
Functional details of each block are as follows.

SNMPD

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

- Standard MIB processing
  If the request for the MIB-II 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.

OAGS

Common SNMP Agent Subagent (OAGS) plays the SNMP subagent role to support the standard SNMP (SNMPv2c/SNMPv3).

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

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

WebEMT

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

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

CLIM

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

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

PAM

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

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

UFM

Universal Fault Management (UFM) manages the ACR faults and the status of software and hardware. UFM informs the detected failures to the upper management system by the filtering function, and applies the severity changes and the threshold to the fault management system. In particular, the UFM receives ToD from a Global Positioning System (GPS) signal receiver, distributes the received ToD to CC software for call processing, and manages faults concerned with the ToD.
UFM provides the interface with Device Driver (DD) and supports statistics and status management of Ethernet switch devices.
Main Functions are as follows:

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

  In case of the call fault, the related information (call status, error code, MS information, etc.) is collected and reported to the management system.
- DD Interface
  The interface between DD and applications is provided for statistics and status management of devices.

Loader

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

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

ULM

Universal Loading Management (ULM) downloads and executes the packages that are identified in the file list downloaded by loader during pre-loading process. Also, ULM monitors the executed software and provides the running software information, and supports the restart and the software upgrade by the command. In addition, in the initialization stage, ULM sets the system time by using the Time of Date information obtained from a GPS receiver/IEEE 1588 GM and periodically performs the synchronization with the NTP server by actuating as an NTP client after the loading is completed.
Main Functions are as follows:

- System initialization and reset
  - System reset by command
  - Act as internal RS & IS of lower board
- Software management
  - Monitor the operation of software block and restart the software block in abnormal state

  - Software restart by command
  - Provide information on software block and the status
- Inventory Management
  - ULM provides the information such as the software version for the components, the PBA ID, the PBA version and the serial number, etc.
  - Function of reporting the inventory information when performing the initialization, adding and extending the components
- Online upgrade and version management for the software
  ULM provides the functions of updating the software and the firmware, upgrading the package and managing the version.
- System time information synchronization
  Synchronize system time information with NTP server as a NTP client and transmit the time information to the lower boards
- Time Zone setup
  Setup Time Zone and Daylight Saving Time (DST)
- Mortem time update
  Setup mortem time after system time information synchronization

OPM

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

- Record and collect statistics data
  Record statistics data to the memory and generate the statistics file by regularly collecting data per each board
- 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

OSSM

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

Main Functions are as follows:

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

OER/OEV

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

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

OCM

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

- System configuration management
  Manage the system configuration with PLD
- PLD inquiry and change
  - Upper management system inquires and changes PLD by command
  - PLD changes are updated in its own nonvolatile storage by operator's command.
- PLD audit
  For the consistent PLD data with the upper management system

RDM

The RAS Diagnosis Management (RDM) checks if internal and external connection paths or resources of the system are normal. The connection paths are roughly divided into the

external path between the system internal IPC path and another NE and the path between ACR and the system.
In addition, it supports the on-demand test at the request of an operator and the periodical test according to the schedule defined by the operator.
Main Functions are as follows:

- Path Test
  - Internal path test: Ping test for the IPC path of the board level in NE
  - External path test: Traceroute test for external hosts
  - Traffic path test: Test for the UDP message-based bearer path between ACR and the system
  - Signal path test: Test for the UDP message-based signaling path
- 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
- Backhaul performance monitoring test
  Quality (packet loss, delay and delay variance) measurement for backhaul between ACR and the system
- Periodical online test by the operator setting
- Change of the Diagnosis Schedule
  Schedule setup, such as diagnosis period, start time and end time of periodical online test
- Support of Call Trace Function
  It reports the call trace information (signaling message of a specific MS, RF parameter, and traffic statistics) to the management system via SNMPD.
- RF Module Setup and Control
  Transmission of the setup information required for the RF module, redundancy structure and management of failure/status

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CHAPTER 4. Message Flow

4.1 Call Processing Message Flow

4.1.1 Initial Entry

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

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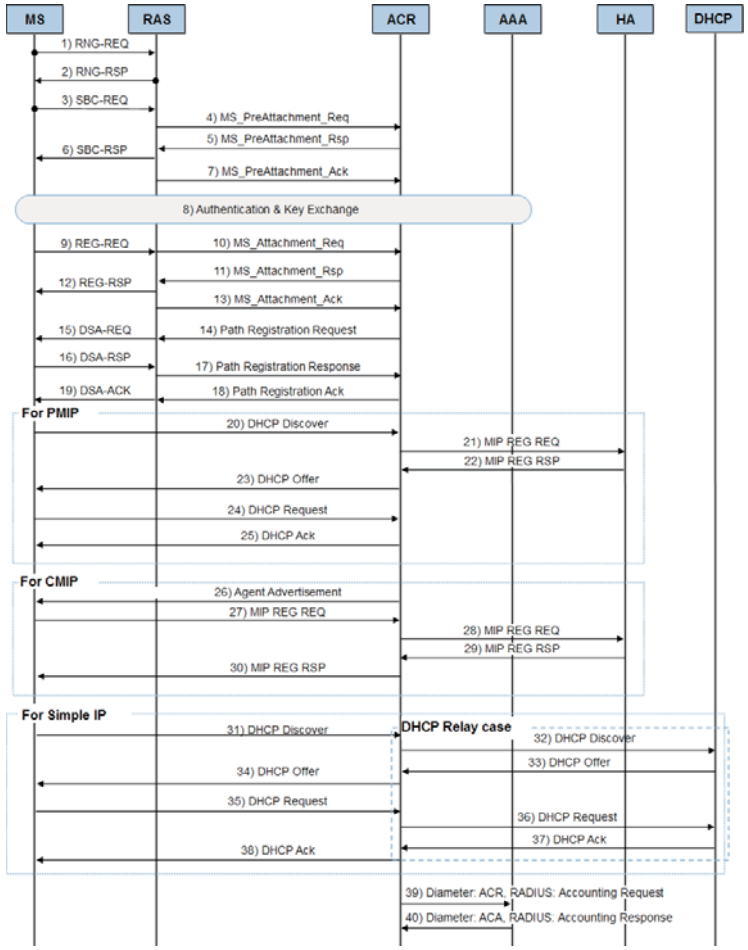

Figure 4.1 Initial Entry Procedure

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

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

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4.1.2 Authentication

During Initial Entry

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

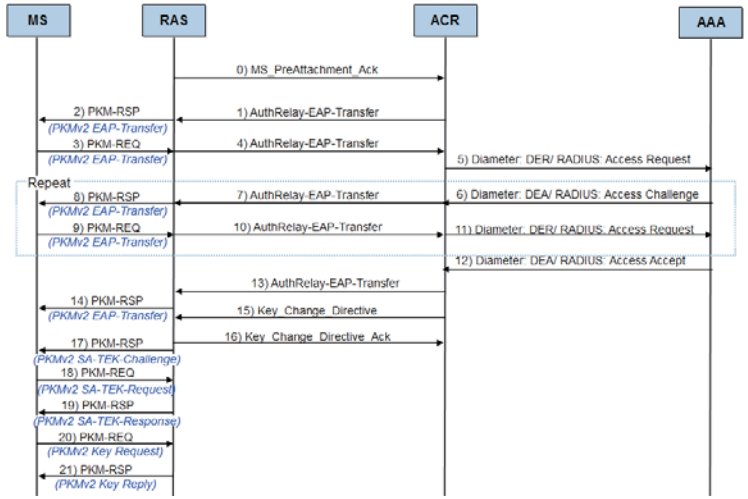

Figure 4.2 Authentication Procedure (During Initial Entry)

Category	Description
(0)~(2)	When receiving the MS_PreAttachment_Ack message from the RAS as a response to the SBC-RSP message, the ACR sends the RAS the AuthRelay-EAP-Transfer message containing the EAP Request/Identity payload to begin EAP authentication. The RAS relays the received EAP payload to the MS using the PKMv2 EAP-Transfer/PKM-RSP message.
(3)~(5)	The MS includes the NAI in the EAP Response/Identity and sends the RAS the PKMv2 EAP-Transfer/PKM-REQ message. The RAS relays the received information to the ACR using the AuthRelay-EAP-Transfer message. The authenticator of the ACR analyzes the NAI and transmits the Diameter EAP Request (DER) message (when using the Diameter protocol) or the Access Request (AR) message (when using the RADIUS protocol) to the home AAA server of the MS.
(6)~(11)	In accordance with the EAP method, the subscriber authentication procedure is performed between the MS and AAA server. 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).

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

NOTE

Types and Uses of Keys

The types and uses of keys are as follows:

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

During Authenticator Relocation

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

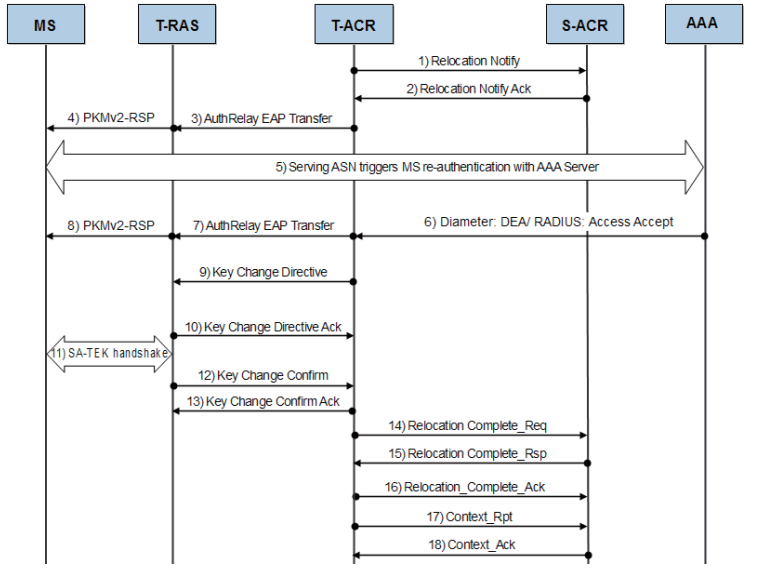

Figure 4.3 Authentication Procedure (During Authenticator Relocation)

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

4.1.3 State Transition

Awake Mode → Idle Mode (MS-Initiated)

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

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

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

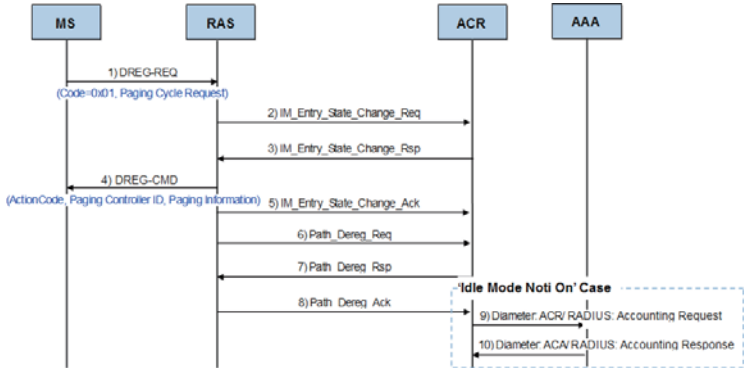

Figure 4.4 Awake Mode → Idle Mode State Transition Procedure (MS-Initiated)

Category	Description
(1)	When the MS transits to Idle mode, it creates the DREG-REQ message and sends it to the RAS. The De-Registration Request Code field value is set to 0x01.
(2)~(5)	The RAS creates the IM_Entry_State_Change_Req message containing the context information of the MS and sends it to the ACR (paging controller). The ACR creates the IM_Entry_State_Change_Rsp message containing Action Code (0 × 05), paging information (PAGING_CYCLE, PAGING_OFFSET), and Idle Mode Retain flag and sends it to the RAS. The RAS sends the MS the DREG-CMD message containing the information received.

Category	Description
(6)~(8)	If no network reentry request is received from the MS until the Idle Resource Retain timer expires, the RAS performs the Data Path (DP) Release procedure with the ACR.
(9)~(10)	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. When the Diameter/RADIUS protocols are used, they are operated according to the Idle Mode Notification on/off. If it is on, the accounting information is updated using the Diameter ACR/RADIUS Accounting Request message.

Awake Mode → Idle Mode (Network-Initiated)

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

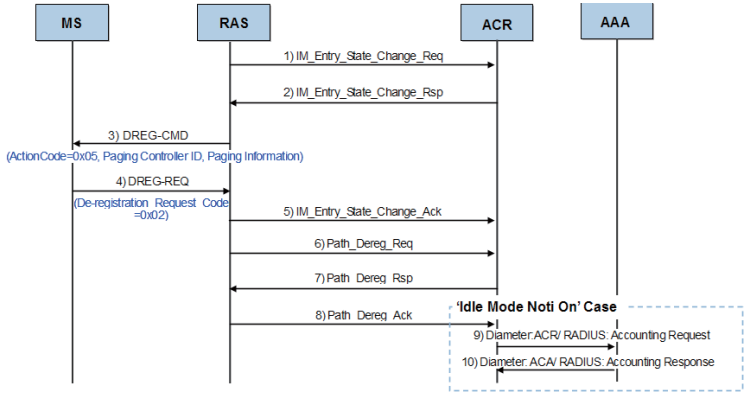

Figure 4.5 Awake Mode → Idle Mode State Transition Procedure (Network-Initiated)

Category	Description
(1)~(3)	If the Dormant timer expires, the RAS creates the IM_Entry_State_Change_Req message containing the context information for the MS and sends it to the ACR (Paging Controller). The ACR creates the IM_Entry_State_Change_Rsp message containing paging information (PAGING_CYCLE, PAGING_OFFSET) and Idle Mode Retain and sends it to the RAS. At this time, the Idle Mode Retain info is set to 0x7F. The RAS sends the MS the DREG-CMD message containing the information received.
(4)	The MS sends the BS the DREG-REQ message and sets the De-Registration_Request_Code field value to 0x02.
(6)~(8)	If no network re-entry request is received from the MS until the Idle Resource Retain timer expires, the RAS performs the Data Path (DP) Release procedure with the ACR.
(9)~(10)	Now the MS has transited to Idle mode. When the Diameter/RADIUS protocols are used, they are operated according to the Idle Mode Notification on/off. If it is on, the accounting information is updated using the Diameter ACR/RADIUS Accounting Request message.

If an error occurs during the procedure of changing the MS-initiated Idle Mode or network-initiated Idle Mode, the RAS can start the BS-initiated network exit procedure. Below are the cases in which the RAS starts the network exit procedure.

- Time out has occurred due to no response from the ACR or the fail indication is notified from the ACR when the MS asked for the Idle Mode transition.
- Time out has occurred due to no response from the ACR or the fail indication is notified from the ACR when the RAS asked for the Idle Mode transition.

Awake Mode → Sleep Mode

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

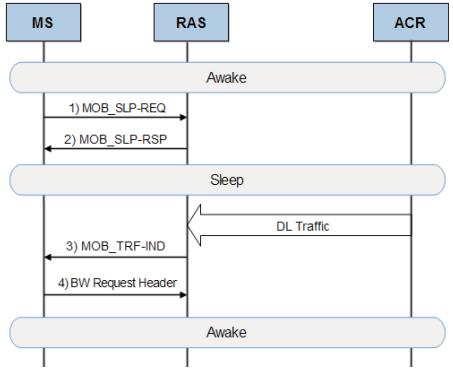

Figure 4.6 Awake Mode → Sleep Mode State Transition Procedure

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

Idle Mode → Awake Mode(QCS)

When the MS in Idle mode responds to a paging caused by incoming traffic or when the MS in Idle mode sends traffic, it transits from Idle mode to Awake mode.

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For both cases, the MS has to perform a network re-entry procedure to enter Awake Mode. The Mobile WiMAX system should consider the QCS procedure as a network re-entry method by default.
The figure below shows the procedure (QCS) in which Idle mode is changed to Awake mode during network re-entry.

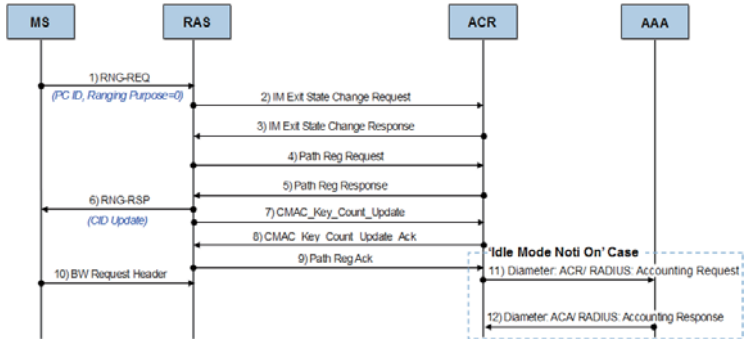

Figure 4.7 Idle Mode → Awake Mode State Transition Procedure (QCS)

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

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Category	Description
(10)	When receiving the RNG-RSP message, the MS sends the BW Request Header to notify the system that it has transited to Awake mode.
(11)~(12)	Now the MS has transited to Awake mode and a new Transport CID has been assigned. When the Diameter/RADIUS protocols are used, they are operated according to the Idle Mode Notification on/off. If it is on, the accounting information is updated using the Diameter ACR/RADIUS Accounting Request message.

NOTE

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

4.1.4 Location Update

Inter-RAS Location Update

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

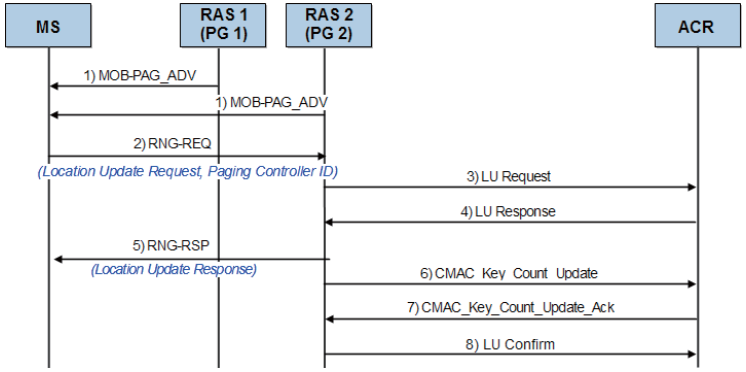

Figure 4.8 Inter-RAS Location Update Procedure

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

Category	Description
(6)~(7)	The RAS notifies the ACR, which is the authenticator, of the new CMAC_KEY_COUNT value updated by the MS.
(8)	The ACR sends the LU Confirm message to provide notification that the location update procedure has finished.

Inter-ACR Location Update (Anchor Relocation)-PMIP/CMIP

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

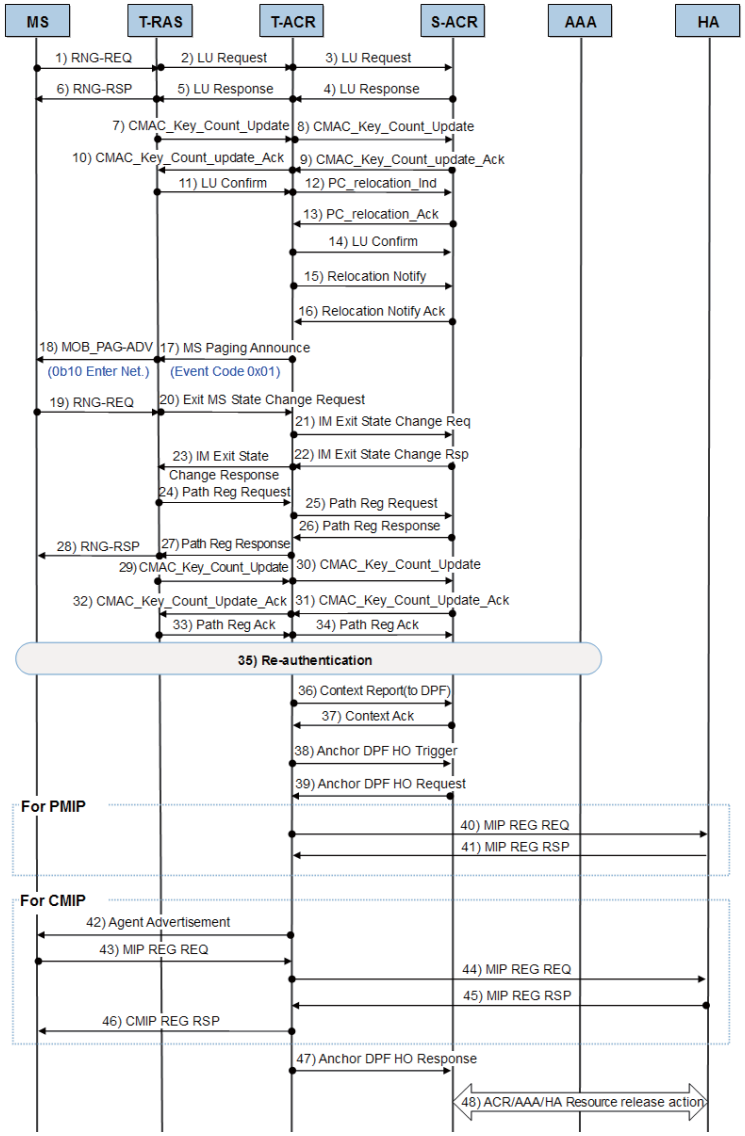

Figure 4.9 Inter-ACR Location Update Procedure (PMIP/CMIP)

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

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

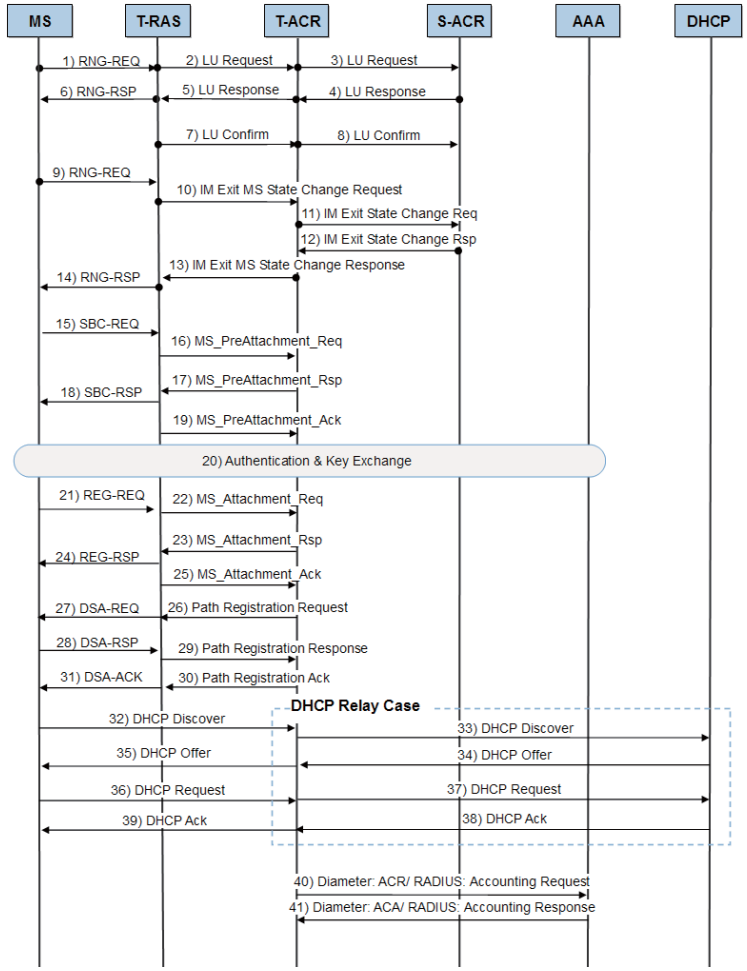

Figure 4.10 Inter-ACR Location Update Procedure (Simple IP)

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

4.1.5 Paging

Paging can be divided into the following two types:

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

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

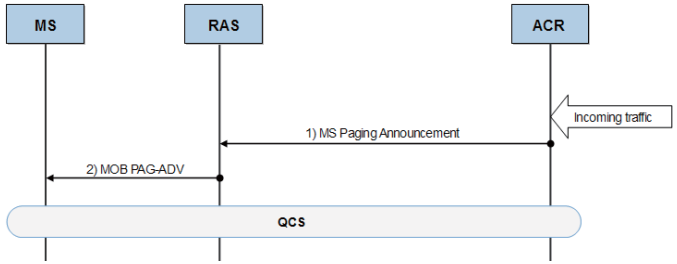

Figure 4.11 Paging Procedure

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

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

4.1.6 Handover

Inter-RAS Handover (HO)

The figure below shows the inter-RAS handover procedure.

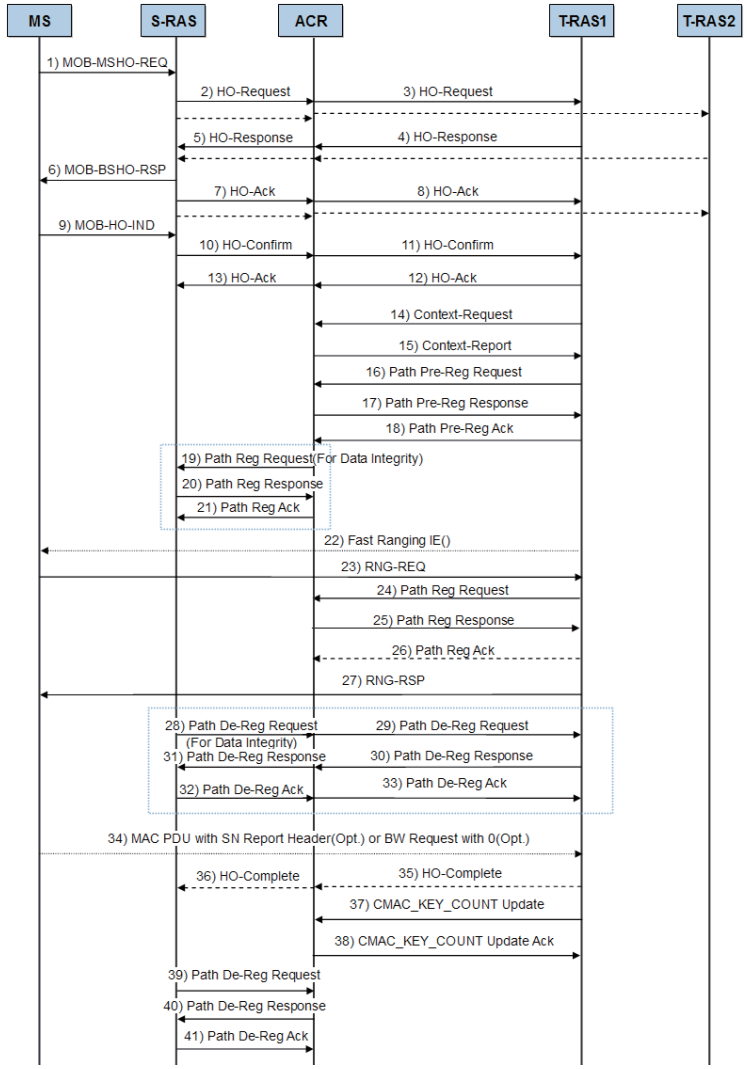

Figure 4.12 Inter-RAS Handover Procedure

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

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Inter-ACR Handover (HO)

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

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

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

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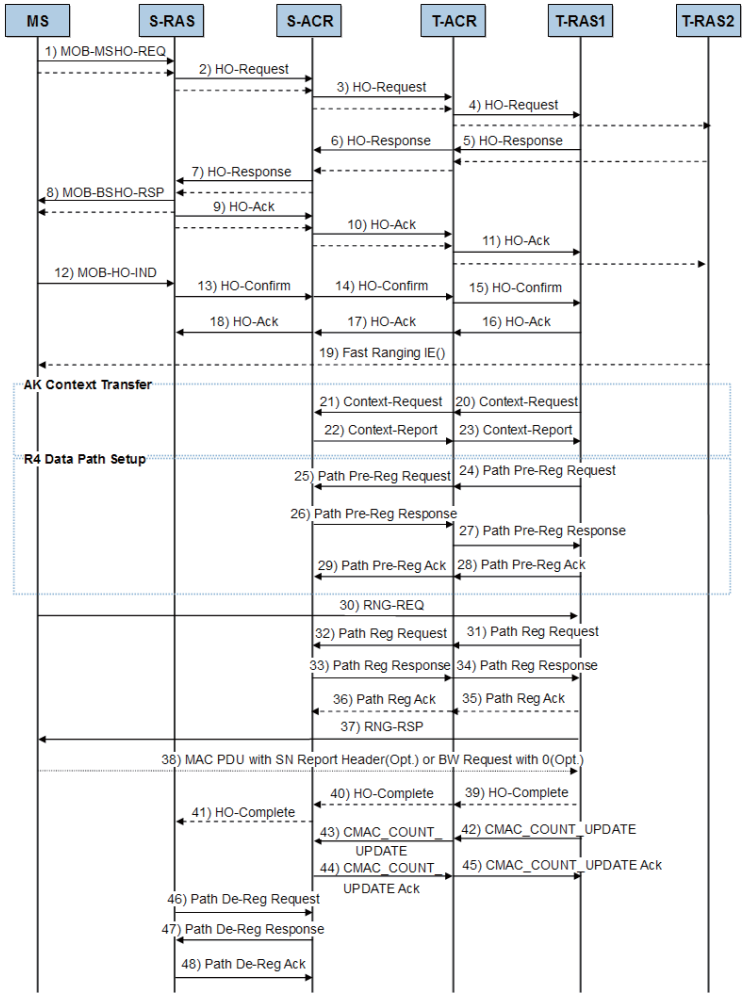

Figure 4.13 Inter-ASN Handover (ASN-Anchored Mobility)

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

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

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

Below is described the inter-ASN HO in the CSN-anchored mobility. The anchor function is relocated from the S-ACR (Serving ACR) to the T-ACR (Target ACR).
The CSN-anchored mobility method consists of the steps through which ASN-anchored mobility Ho is performed and the authenticator and DPF anchor are relocated to the target ACR. For convenience, the triggering of relocation by T-ACR is defined as Pull mode, and the triggering of relocation by S-ACR is defined as Push mode. The Mobile WiMAX system supports both pull mode and push mode.
The CSN-anchored mobility method complies with the MIP standard. The earlier steps of the CSN-anchored HO signaling procedure are the same as in the ASN-anchored mobility HO procedure. The figure below shows the steps after the ASN-anchored HO has been performed.

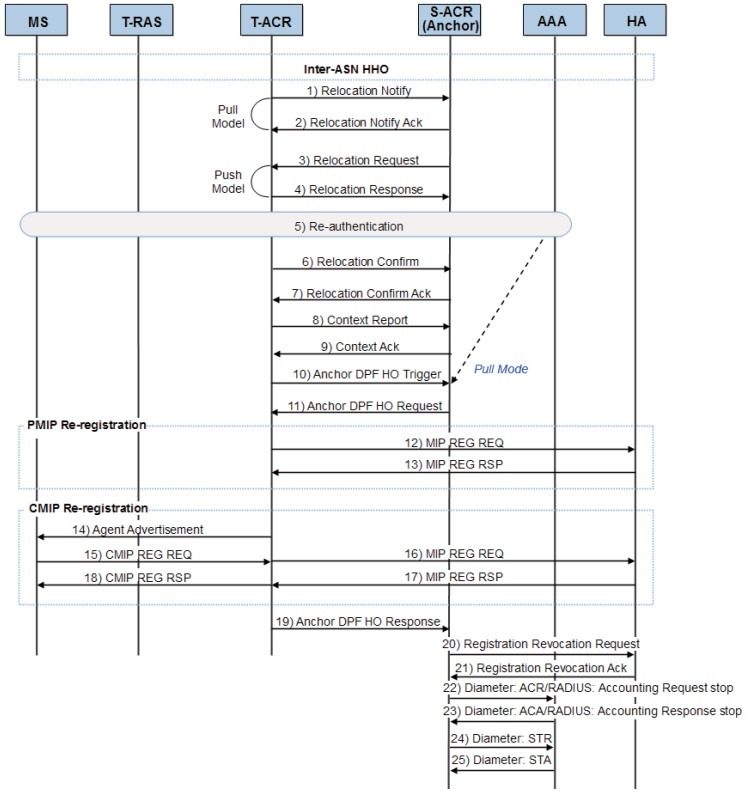

Figure 4.14 Inter-ASN Handover (CSN-Anchored Mobility)

Category	Description
(1)~(7)	This is the procedure for relocating the authenticator from the S-ACR to the T-ACR. The T-ACR triggers the MS to perform the EAP authentication procedure again with the AAA server. The T-ACR notifies the S-RAS of the authentication results to finish the authenticator relocation procedure.
(8)~(9)	The T_ACR transmits the context information for the MS to the S_ACR.
(10)~(19)	The authenticator and FA relocation are triggered and the PMIP or CMIP registration is processed.
(20)~(21)	The S-ACR cancels MIP registration of the MS in the HA.
(22)~(25)	The S-ACR updates the final accounting information for the MS in interoperation with the AAA server. If the Diameter protocol is used as the AAA protocol, the S-ACR performs the session release procedure with 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 Disconnection

Disconnection (Awake Mode)

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

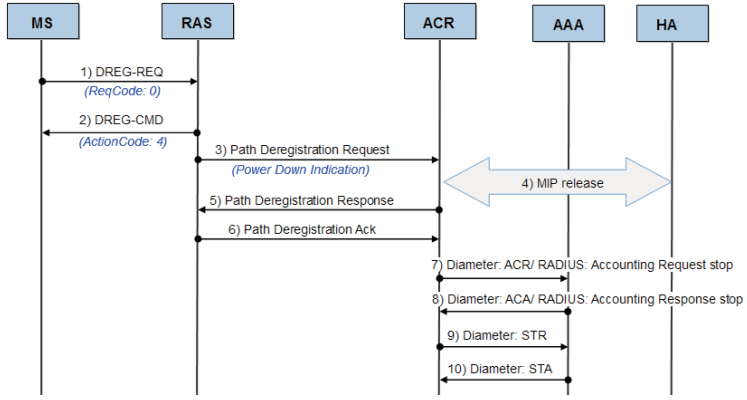

Figure 4.15 Disconnection (Awake Mode)

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

Disconnection (Idle Mode)

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

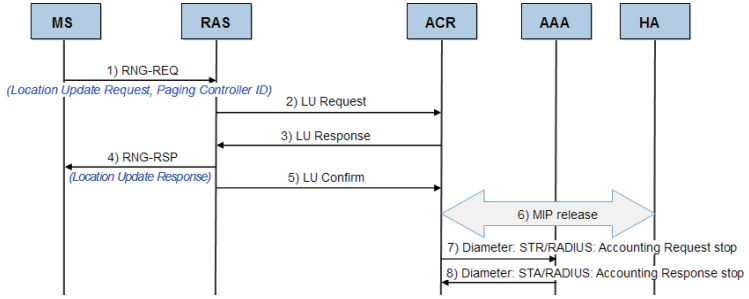

Figure 4.16 Disconnection (Idle Mode)

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

ULCB is the GPS receiving module mounted on the SPI-2C21, and it receives the GPS signals to generate the TOD, system clock (44.8 MHz), and PP2S. Then it supplies them to digital and RF blocks.
TSCM is a 1588 slave unit mounted on the SPI-2C21. It receives 1588 packets from the GM and generates the TOD, system clock (25 MHz), and PP2S. It then supplies them to the digital and RF blocks.

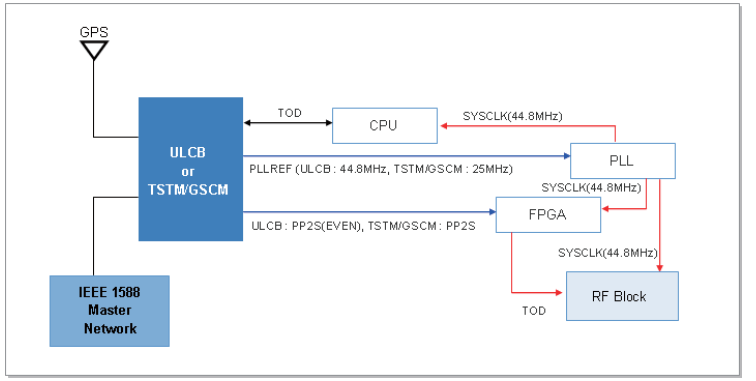

Figure 4.17 Network Synchronization Flow of the SPI-2C21

4.3 Alarm Signal Flow

The alarm that occurred in the digital/RF block or GPS receiver module of the SPI-2C21 is collected, then processed by the processor, then reported to the higher level.

- Digital Block
  When an alarm occurs, it is recorded in the corresponding register. The processor can detect the alarm occurrence by reading this. Alternately, the processor can detect that an alarm has occurred through the statistics processing, diagnosis processing, or communication with external devices etc. in the application.
- GPS Receiving Module
  The module is reported to the processor in the form of a TOD message.
- RF Block
  The PLL Unlock and Temperature High alarms are reported in the TTL format. The Over/Low Power alarm is recorded into the corresponding register when it occurs, and the processor can detect that the alarm has occurred by reading this.

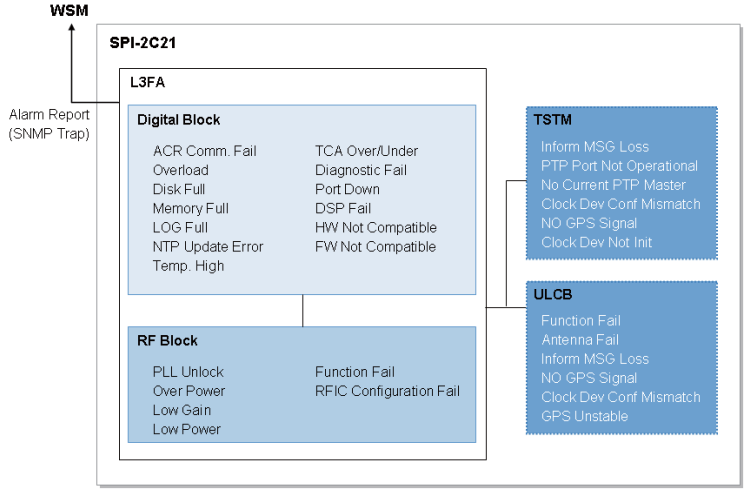

Figure 4.18 Alarm of the SPI-2C21

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 SPI-2C21. Loading the SPI-2C21 is performed in the procedure of initializing the system. In addition, if a specific board is mounted on the system or the hardware is reset, or if the operator of the upper management system reboots a specific board, loading is performed. Loading is classified into two types, one is loading by using its own non-volatile storage and the other is loading by using the remote IS. When the system is initialized for the first time, the SPI-2C21 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 SPI-2C21 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.

Loading Procedure

To perform the loading procedure when initializing the SPI-2C21, the loader performs the followings first. (Pre-loading)

- Boot-up
  The booter of the Flash ROM loads the kernel and the Root File System (RFS) from the flash ROM to the RAM Disk, and performs the kernel.
- IP configuration
  The IP address information is acquired from the flash ROM and is set to communicate with the first upper management system.
- 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 L3FA which performs the operation and the maintenance of the entire SPI-2C21 performs loading by using the FTP to the corresponding IS (remote ID or its own storage).
The information on the software loaded in the SPI-2C21 can be checked in the upper management system.
The loading message flow is as the following figure:

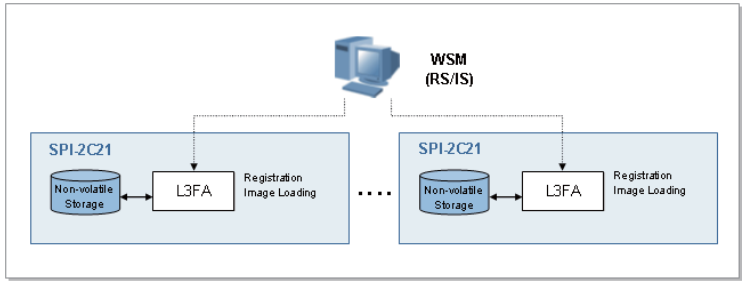

Figure 4.19 Loading Message Flow

4.5 Operation and Maintenance Message Flow

An operator can check and change the status of the SPI-2C21 by means of the management system. To this end, the SPI-2C21 provides the SNMP agent function. The function enables the WSM operator to perform the operation and maintenance function of the SPI-2C21 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 SPI-2C21 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 SPI-2C21 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 SPI-2C21 deals with various operation and maintenance messages received from the SNMP manager of the management system, transfers the results and reports the events, such as failure generation or status change, in real time as applicable. The statistical information is provided as statistical file format in unit of BI and the collection period can be specified as one of 15, 30 and 60 minutes.
The OAM signal flow is as shown in the figure below:

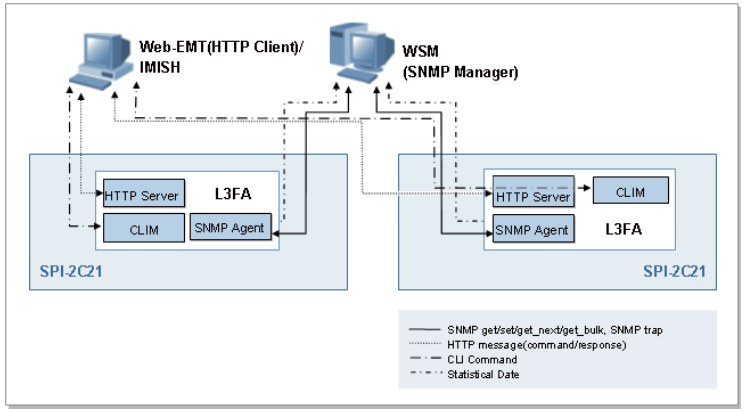

Figure 4.20 Operation and Maintenance Signal Flow

CHAPTER 5. GM

5.1 GM Introduction

The SPI-2C21 supports the IEEE 1588 protocol which can transmit the backhaul data and the synchronization-related information simultaneously through an Ethernet copper line. As the 1588 master unit of IEEE 1588 protocol, the GM generates the 1588 packet by receiving synchronization and the TOD information from GPS through an internal GPS receiver. This packet is transferred through the packet network to the 1588 slave unit within the SPI-2C21. And at this time, the GM sends/receives the 1588 packet with the 1588 slave unit within the SPI-2C21 using the IEEE 1588 protocol and 100BASE-T. Then the 1588 slave unit synchronizes with the GM system using the information contained in the 1588 packets received from the GM and then outputs the TOD information.
For remote control of the GM, its CPU can be accessed from the outside.
For reliable operation of the SPI-2C21, the GM is in a redundancy structure. For the GM, a single TGCU is composed of a ToP Grandmaster Clock Assembly (TGCA), a ToP Grandmaster Power Unit (TGPU), and a fan. The configuration and internal structure of GM that is equipped with the redundant structure of two identical systems (TGCU) is as follows.

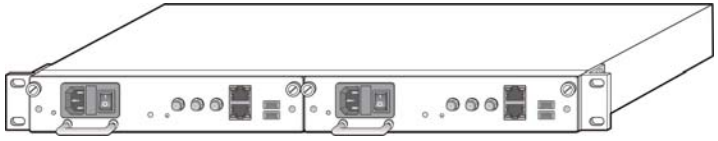

Figure 5.1 System Configuration of the GM

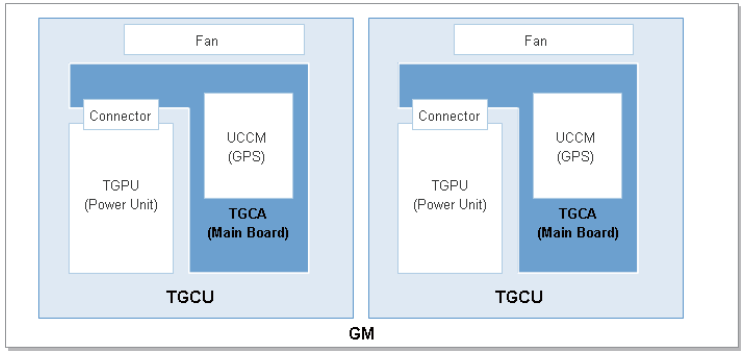

Figure 5.2 Internal Structure of the GM

Board	Quantity	Description
TGCA	1	– Receives synchronization signal through a GPS receiver – Extracts the PP2S, TOD, and 10 MHz signals from the received signals – Generates 1588 packets using the PP2S and TOD – Transmits the 1588 packets to the 1588 slave unit within the SPI-2C21 via the packet network – Sends/receives the 1588 packets with the 1588 slave unit – Supplies the 10 MHz and PP2S signals to external equipment
TGPU	1	Converts inputted power (AC 100–240 V) into DC +12 V to supply power within the board

5.2 GM Specifications

Dimensions and Weight

The table below lists the dimensions and weight of the GM.

Category	Specification
Dimensions (mm)	440 (W) × 300 (D) × 44.45 (H)
Weight (kg)	5.5

Environmental Alarms

The table below lists the environmental alarms provided by the GM by default.

Category	Description
Temperature Alarm	High Temperature
Fan Fail Alarm	Fan Fail

GPSR Specifications

The table below lists the characteristics of the GPS Receiver (GPSR) that is used to receive GPS signals.

Category	Description
Output from GPSR	PP2S, TOD, Digital 10 MHz
Frequency Accuracy	± 0.02 ppm
Time Accuracy	± 1 μs
Holdover Time	24 Hours

Ambience

Below are the ambience specifications such as temperature and humidity etc. and the related specifications for operation of the GM.

Category	Specification
Temperature a)	0~40°C (32~104°F)
Humidity a)	10~90% However, the moisture contained in 1 kg of air should not exceed 0.024 kg.
Altitude	–60~1,800 m (-200~6,000 ft)
Vibration	GR-63-CORE Sec.4.4 Earthquake Office Vibration Transportation Vibration
Noise (sound pressure level)	60 dBA or below at a distance that is 0.6 m away from the system surface (front/back/right/left) and at 1.5 m above the ground
Electromagnetic Interference(EMI)	FCC Title47 Part 15 Class B GR-1089-CORE Sec. 3.2 Emission Criteria

a) Temperature and humidity are measured at a position of 1.5 m (59 in.) from the floor and 400 mm (15.8 in.) from the front of the equipment.

Power Supply

The table below lists the power specifications of the GM. The GM meets the UL60950 electrical safety requirements.

Category	Description
System input voltage	AC 100~240V

5.3 External Interface Structure of GM

The following are the external port positioning and external interface structure of the GM.

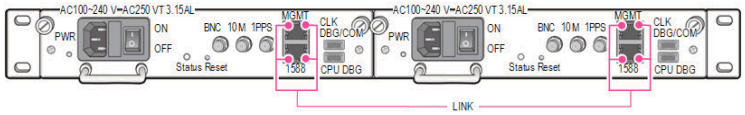

Figure 5.3 GM Port Positioning

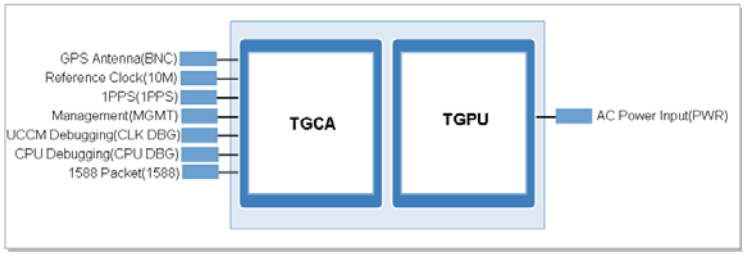

Figure 5.4 GM External Interfaces

Connector

Category	Interface	Number of Ports	Connector	Description
GPS Antenna	Analog RF	1	SMA	Connected to the GPS antenna to receive the synchronizing signal
Reference clock	LVTTL	1	SMA	Supplies 10 MHz reference clock signals to external equipment
1 PPS	LVTTL	1	SMA	Supplies 1 PPS signals to external equipment
Management	100BASE-T	1	RJ-45	Connected to the WSM antenna to send and receive GM maintenance signals
UCCM Debugging	100BASE-T	1	USB	UCCM Debugging
CPU Debugging	100BASE-T	1	USB	CPU Debugging
1588 Packet	100BASE-T	1	RJ-45	Connected to the 1588 slave unit to send and receive 1588 packets
AC Power Input	AC Power	1	AC power connector	Connected to an external power source to supply power to the system

LED

LED Status		Description
Status	(Green On)	Normal & Active
	(Red On)	Critical Alarm & Active
	(Orange On)	Major/Minor Alarm & Active
	(Green On)	– Loading was completed at power-on (200 ms On/200 ms Off) – Normal & Inactive(1s On/1s Off)
	(Red Blinking)	Critical Alarm & Inactive
	(Orange Blinking)	– Loading is in progress at power-on (200 ms On/200 ms Off) – Major/Minor Alarm & Inactive(1s On/1s Off)
LINK	(Green On)	Peer-to-peer link connection is normal
	(Green Off)	Peer-to-peer link connection is abnormal
	(Yellow Blinking)	When there is data transmitted
	(Yellow Off)	When there is no data transmitted
PWR	(Green On)	Power On
	(LED Off)	Power Off

Switch

This switch is for power on/off.

ABBREVIATION

A

AAA	Authentication, Authorization, and Accounting
AC	Admission Control
ACR	Access Control Router
ADC	Analog to Digital Conversion
AGC	Automatic Gain Control
AMC	Adaptive Modulation and Coding
API	Application Programming Interface
ARQ	Automatic Repeat request
ASN	Access Service Network

B

BI	Bucket Interval
BP	Board Processor

C

CC	Call Control
CID	Connection Identifier
CLIM	Command Line Interface Management
CLLI	Common Language Location Identifier
CMIP	Client Mobile IP
CoS	Class of Service
CSN	Connectivity Service Network
CTC	Convolutional Turbo Code

D

DAM	Diameter AAA Management
DCD	Downlink Channel Descriptor
DD	Device Driver
DHCP	Dynamic Host Configuration Protocol
DL	Downlink
DL-MAP	Downlink-MAP
DST	Daylight Saving Time

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E

E/O	Electrical to Optic
EAP	Extensible Authentication Protocol
EMI	Electro-Magnetic Interference
EMI	EMS Interface
EMS	Element Management System

F

FA	Foreign Agent
FA	Frequency Allocation
FE	Fast Ethernet
FEC	Forward Error Correction
FFT	Fast Fourier Transform
FRP	Frequency Reuse Pattern

G

GE	Gigabit Ethernet
GM	Grand Master
GPS	Global Positioning System
GPSR	GPS Receiver
GRE	Generic Routing Encryption
GSCM	GPS/1588 Slave Clock Mezzanine board assembly
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

L3FA	U-RAS Light series 3 Four-path main board Assembly

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M

MAC	Medium Access Control
MIMO	Multiple Input Multiple Output
MIP	Mobile IP
MLPPP	Multi Link Point to Point Protocol
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

PBA	Panel Board Assembly
PCB	Printed Circuit Board
PCRF	Policy & Charging Rules Function
PD	Powered Device
PDU	Protocol Data Unit
PF	Proportional Fair
PGID	Paging Cycle, Paging Offset
PHY	Physical Layer
PLD	Programmable Loading Data
PMIP	Proxy Mobile IP
PoE	Power over Ethernet
PP2S	Pulse Per 2 Seconds
PPP	Point to Point Protocol
PSE	Power Sourcing Equipment

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Q

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

R

RAS	Radio Access Station
RDM	RAS Diagnosis Management
RFIC	Radio Frequency Integrated Circuit
RFS	Root File System
ROHC	Robust Header Compression
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
SFF	Small Form Factor Fixed
SFP	Small Form Factor Pluggable
SFTP	Secure File Transfer Protocol
SNMP	Simple Network Management Protocol
SNMPD	SNMP Daemon
SoC	System on Chip
SSH	Secure Shell
SSL	Secure Sockets Layer

T

TCA	Threshold Cross Alert
TDD	Time Division Duplex
TGCA	ToP Grandmaster Clock Assembly
TGCU	ToP Grandmaster Clock Unit
TGPU	ToP Grandmaster Power Unit
TSTM	Top Slave clock without TCXO Mezzanine board assembly

U

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

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UDE	User Define Ethernet
UDP	User Datagram Protocol
UL	Uplink
ULCB	U-RAS Light series-3 Clock Board
UL-MAP	Uplink-MAP
ULM	Universal Loading Management

V

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 RAS SPI-2C21

System Description

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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 25cm during normal operation. The gain of the antenna is 12 dBi. The antenna(s) used for this transmitter must not be co-located or operating in conjunction with any other antenna or transmitter.

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