

802 eNB (OAM) Feature Description

for Release 8.5.0

Describes the concept, software release, dependency & limitation for each feature and its interconnection with the telecommunication network as a high-level design.

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Preface

This document provides detailed descriptions of each feature in the SLR 8.5.0 software release.



Some features, commands, parameters, or counters are not supported by all software releases or approved for all markets.

Relevance







This manual applies to the following products/software.

| Name | Type |
|-----------|----------|
| SLR 8.5.0 | Software |

Conventions in this Document

Samsung Networks product documentation uses the following conventions.

Symbols

| Symbol | Description |
|---|--|
|  | Indicates a task. |
|  | Indicates a shortcut or an alternative method. |
|  | Provides additional information. |
|  | Provides information or instructions that you should follow to avoid service failure or damage to equipment. |
|  | Provides information or instructions that you should follow to avoid personal injury or fatality. |
|  | Provides antistatic precautions that you should observe. |

Menu Commands

menu | command

This indicates that you must select a command on a menu, where **menu** is the name of the menu, and **command** is the name of the command on that menu.

File Names and Paths

These are indicated by a bold typeface. For example:

Copy **filename.ext** into the **/home/folder1/folder2/bin/** folder.

User Input and Console Screen Output Text

- The input and output text is presented in the Courier New font. For example, context `<designated epc-context-name>`
- The CLI command is presented in capital letters and Courier New, bold style. For example, Type the **RTRV-NE-STS** command in the input field.
- The YANG object is presented in the small letters and boldface. For example, **eutran-cell-conf-idle**

New and Changed Information

This section describes information that has been added/changed since the previous publication of this manual.

- The contents of the following features are changed since the previous publication of this manual, which is eNB (OAM) Feature Description for SLR 8.5.0_Ver.1.0.

| Types | Feature ID, Name |
|-----------------|--|
| Contents change | <ul style="list-style-type: none"> • OAM-TM0301, CPRI Loopback Test |

- The following table shows the features for SLR 8.5.0:

| Types | Feature ID, Name |
|--------------|---|
| New features | <ul style="list-style-type: none"> • OAM-CM0101, System Creation and Deletion • OAM-CM0104, Transmit Power and Receive Gain Control • OAM-CM0109, Automatic Update of Position Information • OAM-CM0201, State Management • OAM-CM0401, Configuration Data Management • OAM-CM0402, Retrieving Optic Module Information • OAM-ED0901, FAN Management • OAM-EM0101, Event Management • OAM-EM0201, Event and System Log Management • OAM-ET0101, VSWR Supervision • OAM-ET0102, RSSI Supervision • OAM-FM0101, Alarm Monitoring • OAM-FM0201, Alarm Parameter Configuration • OAM-FM0301, Fault Isolation and Recovery • OAM-FM0303, System Safeguard from Very High Temperature • OAM-HW0010, Frame Timing Offset Configuration |

| Types | Feature ID, Name |
|-------|--|
| | <ul style="list-style-type: none"> • OAM-IF0101, EMS Interface • OAM-IM0101, Inventory Management • OAM-PM0101, Performance Data Management • OAM-PM0201, Real time Performance Data Management • OAM-SM0501, Secure Management Protocol • OAM-SV0102, CBRS Support • OAM-SW0201, System Reset and Restart • OAM-SW0301, Software Upgrade and Update • OAM-SW0304, Automatic SW Upgrade by User Policy • OAM-SW0401, FW Upgrade and Update • OAM-SW0601, SW Block Management • OAM-SW0701, LMT (Local Maintenance Terminal) Loading • OAM-TM0101, Test Management • OAM-TM0201, Internal Path Test • OAM-TM0202, External Path Test • OAM-TM0301, CPRI Loopback Test • OAM-TM0302, CPRI BER Test • OAM-TM0303, CPRI Optic Length Test • OAM-TM0401, Tx Power and Rx Path Test • OAM-TM0402, VSWR Test • OAM-TM0501, TM (Test Model) Test • OAM-TM0502, OCNS (Orthogonal Channel Noise Simulator) Test • OAM-TM0504, Remote Spectrum Analysis • OAM-TS0101, NTP based Time Synchronization • OAM-TS0401, IEEE1588 based Synchronization Management • OAM-TS0601, Clock Switchover |

Revision History

The following table lists all versions of this document.

| Document Version | Publication Date | Remarks |
|------------------|------------------|---------------|
| 1.0 | November 2018 | First Version |
| 2.0 | November 2018 | - |

Organization of This Document

| Section | Title | Description |
|------------|---|---|
| Chapter 1 | Configuration Management | This chapter describes LTE features related to Configuration Management. |
| Chapter 2 | Event Management | This chapter describes LTE features related to Event Management. |
| Chapter 3 | External Device Management | This chapter describes LTE features related to External Device Management. |
| Chapter 4 | Fault Management | This chapter describes LTE features related to Fault Management. |
| Chapter 5 | Hardware | This chapter describes LTE features related to Hardware. |
| Chapter 6 | Inventory Management | This chapter describes LTE features related to Inventory Management. |
| Chapter 7 | Management Interface | This chapter describes LTE features related to Management Interface. |
| Chapter 8 | Performance Management | This chapter describes LTE features related to Performance Management. |
| Chapter 9 | Security Management | This chapter describes LTE features related to Security Management. |
| Chapter 10 | Service | This chapter describes LTE features related to Service. |
| Chapter 11 | Software Management | This chapter describes LTE features related to Software Management. |
| Chapter 12 | Test Management | This chapter describes LTE features related to Test Management. |
| Chapter 13 | Time and Clock Synchronization Management | This chapter describes LTE features related to Time and Clock Synchronization Management. |
| Chapter 14 | Etc | This chapter describes LTE features related to Etc. |

Related Documentation

- eNB (LTE) Feature Description
- eNB (Transport) Feature Description

Chapter 1 Configuration Management

OAM-CM0101, System Creation and Deletion

INTRODUCTION

This feature includes the functionality of creating and deleting an NE and resources in the NE. Creating the NE is to register it to the EMS so that an operator can manage it. To create the NE, system information and cell information are required. Those configuration specified by the operator during the NE creating procedure are saved in XML file in the EMS.

During the system initialization, those configuration data is downloaded together with the software package from the EMS. During the NE is providing service, additional resources can be created or deleted for the specific NE according to the requirement of system capacity. The NE can be deleted too if it is not required any more.

BENEFIT

With this feature, the operator can set NE configuration data remotely in advance instead of setting the NE-specific parameters at the NE site.

DEPENDENCY

Others

- The detail information to create the NE and resource can be different according to the system type, hardware type, and features supporting the system/resource.

LIMITATION

The functionalities provided by this feature can be executed only in the EMS.

FEATURE DESCRIPTION

This feature provides following functions.

- Creation or deletion of NE
- Creation or deletion of cell

Creation or Deletion of NEs

To manage the NEs easily in the EMS, several NEs are organized into a logical group. There are several logical groups in one EMS management window. For creation of the NE, the operator can select to which group the NE is created. Some specific NE can be deleted from its group too.

To create an eNB, the following data is required.

- Basic information such as system ID, software package version, clock information, eNB ID, eNB name, serial number, geographical location, and board type
- IPsec Profile for VPN, Network interface configuration, and MME configuration
- Cell information (See the creating and deleting cell below)

To start service for the NE, the administrative state of the NE and its specific resource is unlocked after system initialization. To delete the registered NE or its specific resource, the administrative state is changed to locked.

See *LSM-CM0101 NE Grow/Degrow* feature for details on creation and deletion NE procedure in LSM GUI.

Creation and Deletion of Cell in eNB

System capacity can be expanded via cell creating procedure. By this procedure, new cells of the specific technology type can be created to the system to provide service to new users or provided better service to existing users. An existing cell can also be deleted by the operator if it is not required any more.

To create LTE cell, the following data is required:

The number of cells to be created

- Self-Organized Network (SON) option configuration such as initial Physical Cell ID (PCI), initial Random Access Channel (RACH), initial Neighbor Relation Table (NRT), and initial Sounding Reference Signal (SRS) Pool
- Carrier information such as E-UTRA Absolute Radio Frequency Channel Number (EARFCN), channel bandwidth, Location information such as latitude, longitude, and height
- Cell information such as cell name, cell ID, PCI, Root Sequence Index (RSI), diversity, maximum transmit power, and Radio Access Network (RAN) sharing related configuration, and RU configuration

In the system, the channel cards are used for providing signal processing service for the cells created by cell creating procedure. If the existing equipped channel cards in the shelf are not enough for the new system capacity, new channel card has to be equipped to the shelf. During the cell creating procedure in the EMS, new channel card is equipped automatically without operator intervention.

The operator can import or export Frequency Configuration Profile, which includes the parameter values related to the intra-/inter-frequency information for supporting handover. If the operator applies Frequency Configuration Profile when

creating a new cell, the parameter values in Frequency Configuration Profile are automatically configured.

To provide service for the new cell, its administrative state is "unlocked". The operator can designate/change the port location of creating/created cell within same board.

The operator can delete cell in its administrative state is "locked".

See *LSM-CM0201 Cell Management* feature for details on creation and deletion cell procedure in LSM GUI.

SYSTEM OPERATION

This section describes how to configure the feature in Samsung system and provides associated key parameters, counters, and KPIs.

How to Activate

This section provides the information that you need to configure the feature.

Preconditions

There are no specific preconditions to activate this feature.

Activation Procedure

The operator can add system and other resources using EMS GUI.

- Grow eNB menu provides system addition.
- Cell Management menu provides cell addition

Deactivation Procedure

The operator can delete system or resources using pop-up menu by right-click on the NE in Tree Viewer frame.

- Delete NE menu provides system deletion
- Cell Management menu provides cell deletion

Key Parameters

There are no specific parameters associated with this feature.

Counters and KPIs

There are no specific counters or Key Performance Indicators (KPIs) associated with this feature.

REFERENCE

None

OAM-CM0104, Transmit Power and Receive Gain Control

INTRODUCTION

This feature provides the functionality to control the transmit power and the receive gain of the Radio Unit (RU).

The transmit power can be controlled on a carrier base by adjusting both maximum transmit power (Max Tx Power) and transmit attenuation (Tx Attenuation). The Max Tx Power is used to limit and guarantee the maximum transmit power capacity per carrier for operation scenarios such as RAN sharing, dynamic power sharing, multi-standard operation, and so on. The Tx Attenuation can be used to control transmit power within a range of the assigned Max Tx Power. The final transmit power of the carrier is decided as applying Tx Attenuation to Max Tx Power.

For example, in case of RAN sharing main operator can change Max Tx power of existing partner operator's carriers with mutual agreement.

The receive gain can be controlled on a path base by adjusting receive attenuation (Rx Attenuation). Rx Attenuation can usually be controlled in case the system operates with Tower Mounted Amplifier (TMA) or Distributed Antenna System (DAS) on which Rx Gain compensation is required. The operator can configure the Rx Attenuation of the RU considering both receive gain supported in TMA or DAS and feeder line loss.

BENEFIT

- The transmit power can remotely be controlled on a carrier base for flexible network operations during in-service without service interruption.
- The receive gain can remotely be controlled on a path base by the operator's in case the system operates with TMA or DAS on which Rx Gain compensation is required during in-service without service interruption.

DEPENDENCY

HW dependency

- The support of this feature is determined according to a RU type and RU firmware version.

LIMITATION

None

FEATURE DESCRIPTION

In this feature the following functionalities for transmit power and receive gain control are provided.

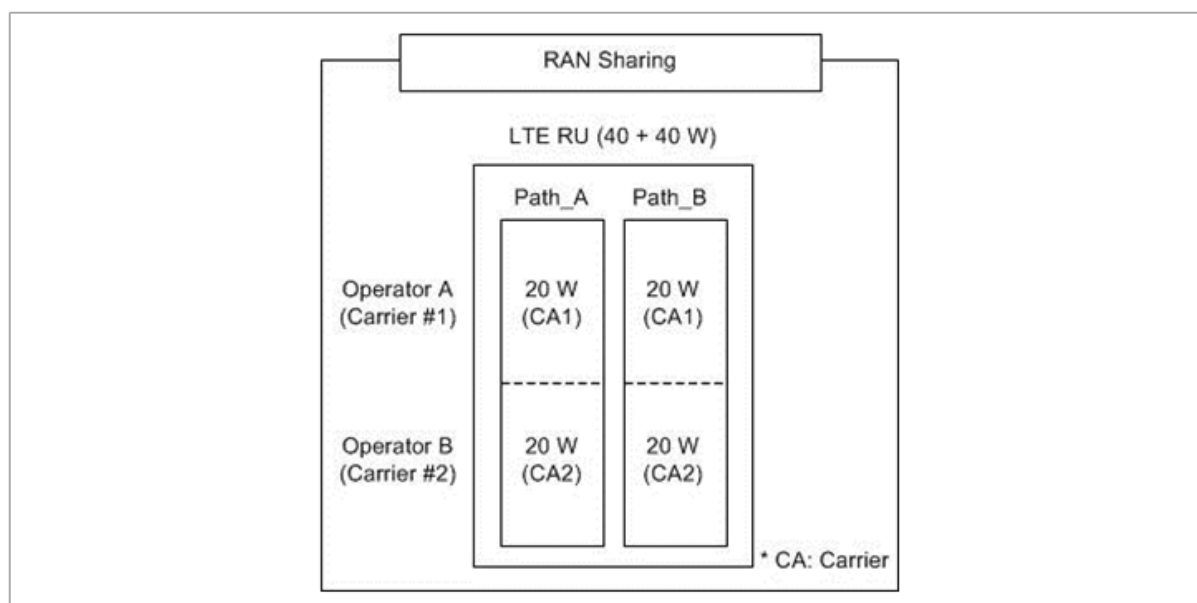
Transmit Power Control

The transmit power can be controlled on a carrier base by adjusting both Max Tx Power and Tx Attenuation.

Max Tx Power

Max Tx Power is used to limit and guarantee the maximum transmit power capacity per carrier for operation scenarios such as RAN sharing, dynamic power sharing, and so on.

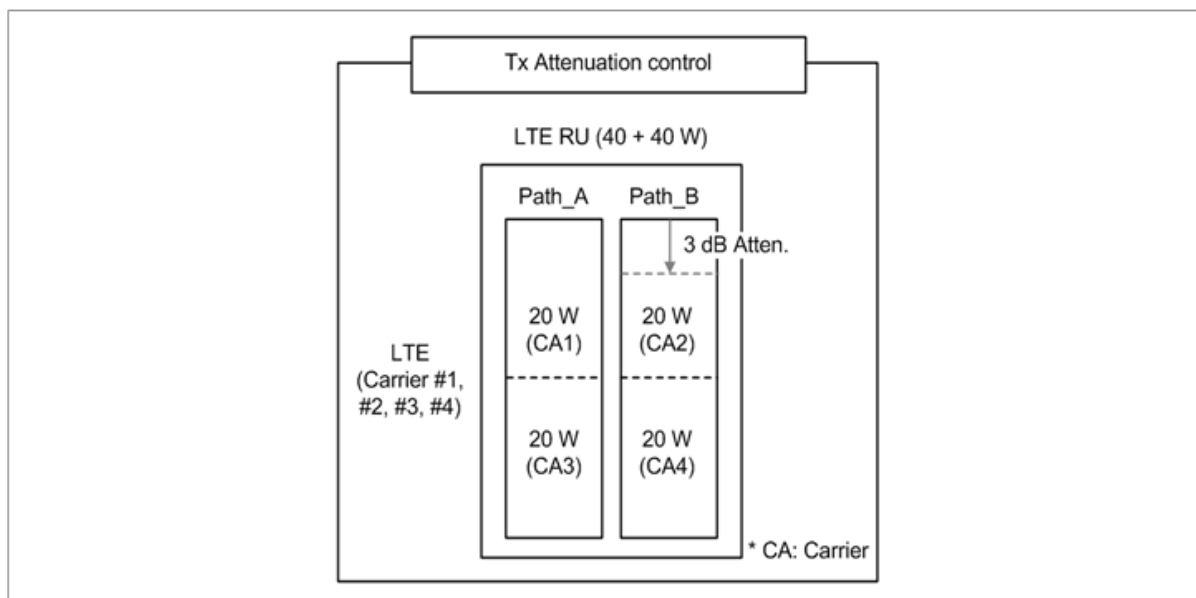
For example of RAN sharing below, operator A and operator B can share the transmit power of the 80 W (40 + 40 W) LTE RU that supports two carriers. The figure in RAN sharing shows the case the maximum transmit power capacity per carrier is evenly shared by 40 W (20 + 20 W) for each operator. In this case, each operator can operate the system within the maximum transmit power capacity per carrier of 40 W (20 + 20 W) as assigned. If needed, the main operator can change Max Tx power of existing partner operator's carriers with mutual agreement.



Tx Attenuation

Tx Attenuation can be used to control transmit power within a range of the assigned Max Tx Power and is controlled in dB scale.

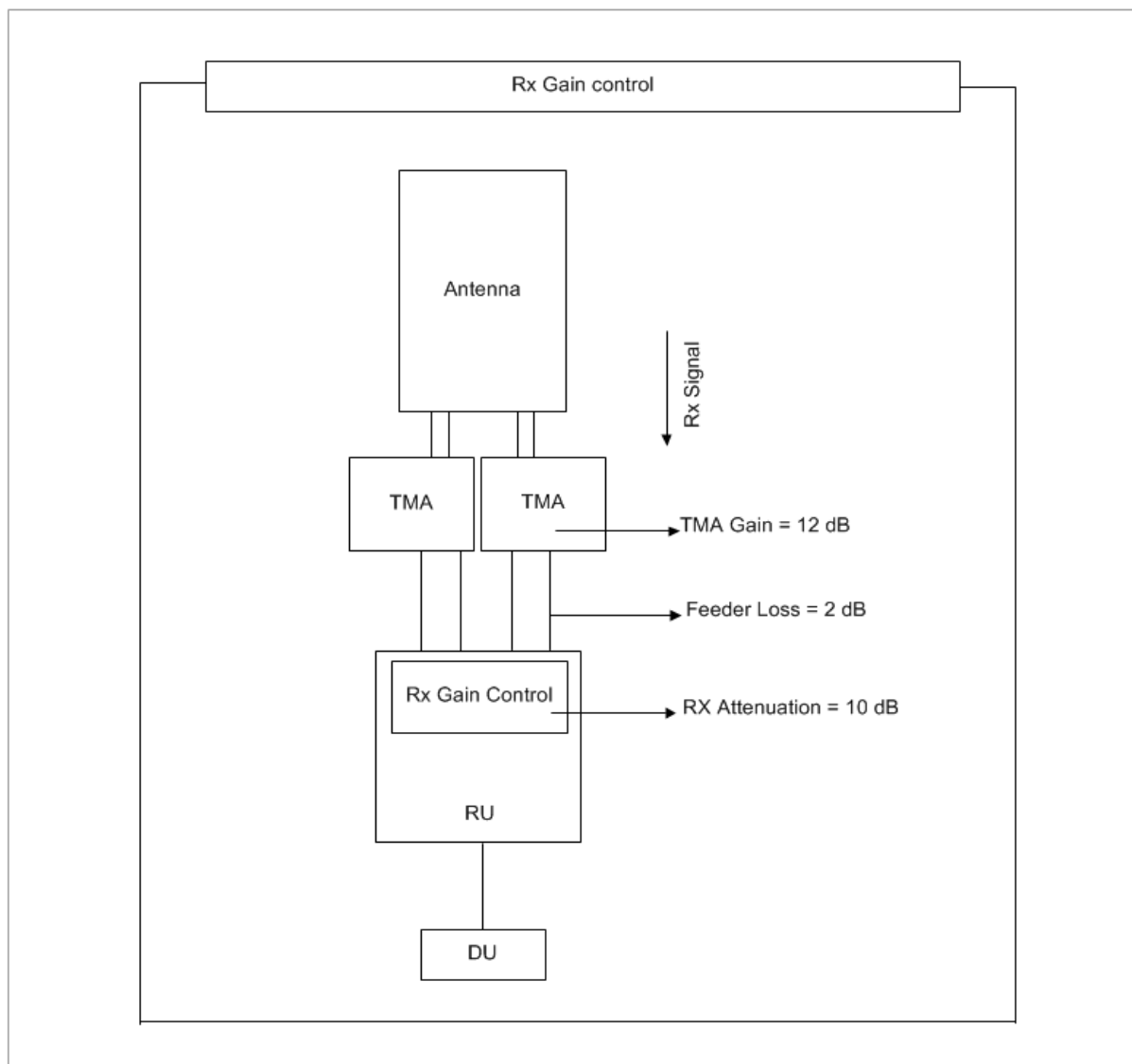
For example, in the figure below, the operator sets Max Tx Power as 20 W for all carriers and sets Tx Attenuation as 3 dB for carrier #2. In this case, RU transmits 10 W power for carrier #2 and 20 W power for all other carriers.



Receive Gain Control

The receive gain can be controlled on a path base by adjusting Rx Attenuation in dB scale and the receive gain can usually be controlled in case the system operates with TMA or DAS in which receive gain compensation is required.

For example, in the figure below, in case of site in which TMA or DAS supporting 12 dB gain is installed and feeder line loss is 2 dB, the operator can configure the Rx Attenuation of the RU as 10 dB.



SYSTEM OPERATION

This section describes how to configure the feature in Samsung system and provides associated key parameters, counters, and KPIs.

How to Activate

This section provides the information that you need to configure the feature.

Preconditions

Ensure that the following conditions are met before enabling this feature:

- RU is connected to DU to proceed this function

Activation Procedure

This feature is executed by user command.

- Use the command **[ENB] radio-unit-info/carrier-control-info** to change the **dl-max-tx-power** of the RRH.
- Use the command **[ENB] radio-unit-info/carrier-control-info** to change the **"tx-attenuation"** of the RRH.
- Use the command **[ENB] radio-unit-info/path-control** to change the **rx-attenuation** of the RRH.

Deactivation Procedure

The feature does not need to be deactivated.

Key Parameters

This section describes the key parameters for activation, deactivation, and configuration of the feature.

Activation/Deactivation Parameters

Parameter Descriptions of **[ENB] radio-unit-info**

| Parameter | Description |
|--------------------------------------|---|
| connected-digital-unit-board-id | This parameter is the board ID of the DU, which is connected to the RRH. |
| connected-digital-unit-port-id | This parameter is the port ID of the DU, which is connected to the RRH. |
| cascade-radio-unit-id | This parameter is the cascade ID of the DU port, which is connected to the RRH. |
| carrier-control-info/tx-attenuation | This parameter is the Tx attenuation value of the RRH |
| carrier-control-info/dl-max-tx-power | This parameter is the maximum output power of the RRH downlink |

Parameter Descriptions of **[ENB] radio-unit-info**

| Parameter | Description |
|---------------------------------|---|
| connected-digital-unit-board-id | This parameter is the board ID of the DU, which is connected to the RRH. |
| connected-digital-unit-port-id | This parameter is the port ID of the DU, which is connected to the RRH. |
| cascade-radio-unit-id | This parameter is the cascade ID of the DU port, which is connected to the RRH. |
| path-control/rx-attenuation | This parameter is the Rx attenuation value of the RRH. |

Counters and KPIs

There are no specific counters or Key Performance Indicators (KPIs) associated with this feature.

REFERENCE

None

OAM-CM0109, Automatic Update of Position Information

INTRODUCTION

This feature provides the functionality to update position information per cell in the eNB automatically. The position information per cell can be updated by using either position information acquired from GPS Receiver (GPSR) or operator-configured position information per eNB system. These kinds of reference position information are called as source data in this feature. If specific cell position information is needed to set different from the source data, the operator has to disable the automatic update function and configure valid position information for the cell.

BENEFIT

This feature helps the position information of cell in the eNB to be updated automatically without the operator's manual intervention.

DEPENDENCY

HW dependency

- If the operator wants to update position information per cell by using position information acquired from GPSR, then operator should connect the GPS antenna to the eNB and configure GPS to be included in the list of clock source.

LIMITATION

The position information provided by GPSR is not available when GPSR failure or GPS antenna installation are abnormal. In this case, normal operation of this feature cannot be guaranteed. The operator has to configure position information with exact value when the position information for a specific cell is to be set manually. If not, many other features, which refer to the position information per cell such as the Call trace, the Enhanced Cell ID, the OTDOA, the Initial NRT and the Automatic PCI Allocation, do not operate normally.

FEATURE DESCRIPTION

This feature provides the functionality to configure following parameter to control the method of cell position information update.

User Defined Mode

With User Defined Mode parameter setting, the source data can be selected from either the position information acquired from GPSR (GPSR Data) or the operator-

configured position information per eNB system (System Location Data).

System Location Data can be used for the case that the clock source of eNB system is IEEE1588v2 or SyncE, which cannot provide the position information.

GPSR Data can be selected to source data when the GPSR is equipped in the system.

The source data selections according to the User Defined Mode parameter setting, are referred as follows:

- User Defined Mode "True": System Location Data is selected as the source data.
- User Defined Mode "False": GPSR Data is selected as the source data.

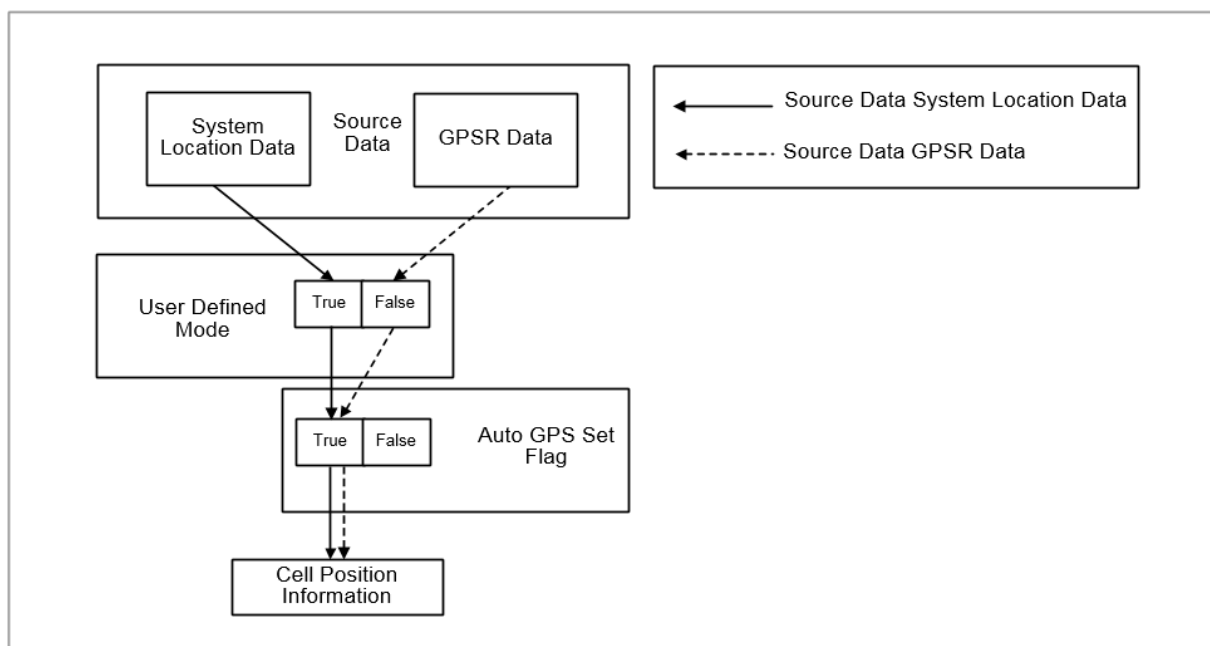
Auto GPS Set Flag

With Auto GPS Set Flag parameter setting, it can be determined whether the position information per cell is automatically updated with the source data or manually configured as fixed value by the operator.

These selections according to Auto GPS Set Flag parameter setting, are referred as follows:

- Auto GPS Set Flag "True": Cell position information is updated with the source data automatically.
- Auto GPS Set Flag "False": Cell position information is not updated with the source data. The operator should input valid position information for the cell.

The figure below depicts the flows that the cell position information is updated with the selected source data by related parameter setting.

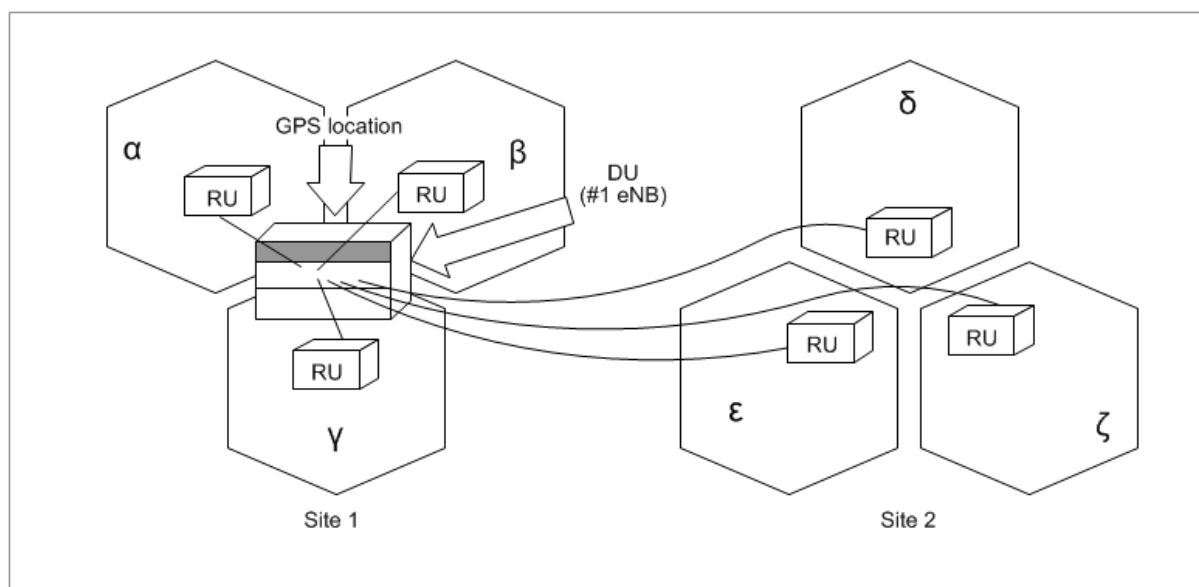


The following examples present the operation of automatic update of cell position

information according to the cell site configuration.

[Example: The cell configuration consisting of 6 cells] In case of using GPSR Data (User Defined Mode "False")

The figure below depicts an example that one eNB system with GPS clock consists of two sites. Cells belonging to the same eNB are located in different sectors.



In case of Site 1,

Cell position information of α , β and γ cells can be updated with the position information of GPSR because these cells are located near the position of GPSR.

- Parameter setting of α , β and γ cells
 - Auto GPS Set Flag can be configured as "True" by using CLI command.
- Position information update of α , β and γ cells
 - Position information of α , β and γ cells are updated with the source data, which is GPSR Data.

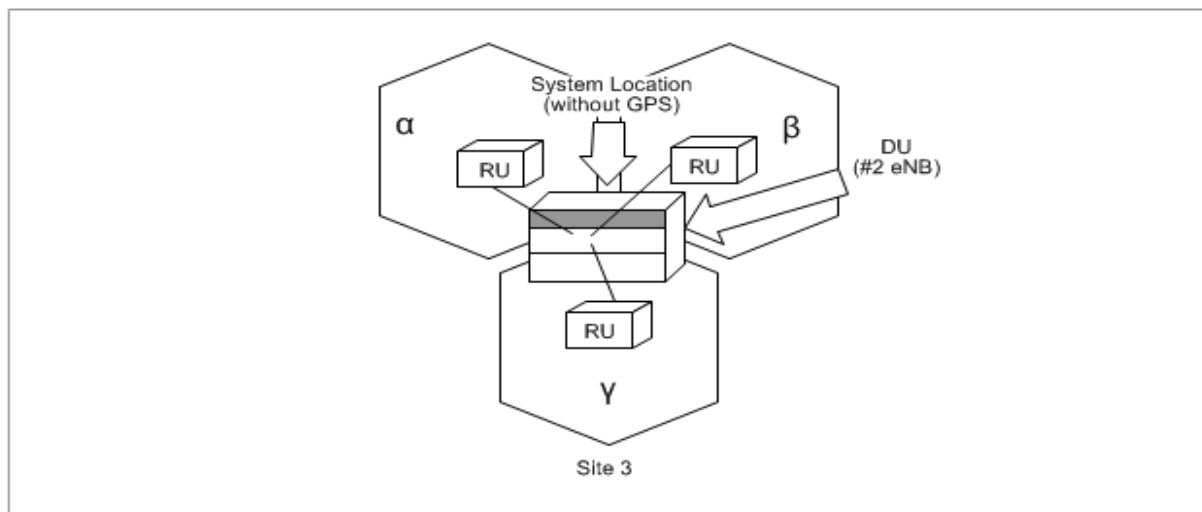
In case of Site 2,

Cell position information of δ , ϵ and ζ cells can be updated with fixed value configured by the operator because these cells are far away from the position of GPSR.

- Parameter setting of δ , ϵ and ζ cells
 - Auto GPS Set Flag is configured as "False" by using CLI command.
- Position information update of δ , ϵ and ζ cells
 - Position information of δ , ϵ and ζ cells are updated with the fixed value configured by using CLI command.

[Example: The cell configuration consisting of 3 cells] In case of using System Location Data (User Defined Mode "True").

The figure below depicts an example of eNB system with IEEE1588v2 clock.



In case of Site 3,

Cell position information of α , β and γ cells can be updated with the source or can have the fixed value configured by operator. In this case the source data should be System Location data because clock source of the eNB cannot provide position information.

- Parameter setting of α , β and γ cells
 - Auto GPS Set Flag can be configured as both "True" and "False".

If Auto GPS Set Flag of α cell is configured as "True", then it of β and γ cells can be configured as "False" by using CLI command.

- Position information update of α , β and γ cells
 - Position information of α cell is updated with the source data, which is System Location Data.

Position information of β and γ cells are updated with the fixed value configured by using CLI command.

SYSTEM OPERATION

This section describes how to configure the feature in Samsung system and provides associated key parameters, counters, and KPIs.

This section provides the information that operator needs to configure the feature.

Preconditions

If GPS is not included in clock sources, user-defined-mode is fixed to true.

Activation Procedure

User defined system location data

- Run **[ENB] user-defined-location**.
- Set **user-defined-mode** to True.
- Set location information (latitude, longitude, height).

Automatic update of cell position

- Run **[ENB] positioning-conf-info**.
- Set **auto-gps-set-flag** to True.

| Parameter | Description |
|-------------------|---|
| auto-gps-set-flag | If this flag value is 1, latitude, longitude, height value updated by using GPS. If this flag value is 0, latitude, longitude, height value defined by operator. |
| latitude | This parameter is the latitude of each cell to provide the OTDOA function. The latitude can be used to calculate the UE location information in a cell. The format used is "A BBB:CC:DD.DDD". <ul style="list-style-type: none"> • A: hemisphere. "N" or "S". • BBB: degrees. 000 to 090. • CC: minutes. 00 to 59. • DD.DDD: seconds. 00.000 to 59.999. |
| longitude | This parameter is the longitude of each cell to provide the OTDOA function. The longitude can be used to calculate the UE location information in a cell. The format used is "A BBB:CC:DD.DDD". <ul style="list-style-type: none"> • A: hemisphere. "E" or "W". • BBB: degrees. 000 to 180. • CC: minutes. 00 to 59. • DD.DDD: seconds. 00.000 to 59.999. |
| height | This parameter is the height information for each cell. The altitude of each cell to provide the OTDOA function. The altitude can be used to calculate the UE location information in a cell. The format used is "AAAA.AA m". <ul style="list-style-type: none"> • AAAA.AA: Sea level altitude. The range is from -1000.00 m to 4000.00 m. The unit "m" must be included. For example, 53.85 m |

Deactivation Procedure**User defined system location data**

- Run **[ENB] user-defined-location**.
- Set user-defined-mode to False.

Automatic update of cell position.

- Run **[ENB] positioning-conf-info**.
- Set **auto-gps-set-flag** to False.

| Parameter | Description |
|-------------------|---|
| auto-gps-set-flag | If this flag value is 1, latitude, longitude, height value updated by using GPS. If this flag value is 0, latitude, longitude, height value defined by operator. |
| latitude | This parameter is the latitude of each cell to provide the OTDOA function. The latitude can be used to calculate the UE location information in a cell. The format used is "A BBB:CC:DD.DDD". <ul style="list-style-type: none"> • A: hemisphere. "N" or "S". • BBB: degrees. 000 to 090. • CC: minutes. 00 to 59. • DD.DDD: seconds. 00.000 to 59.999. |

| Parameter | Description |
|-----------|---|
| longitude | <p>This parameter is the longitude of each cell to provide the OTDOA function. The longitude can be used to calculate the UE location information in a cell. The format used is "A BBB:CC:DD.DDD".</p> <ul style="list-style-type: none"> • A: hemisphere. "E" or "W". • BBB: degrees. 000 to 180. • CC: minutes. 00 to 59. • DD.DDD: seconds. 00.000 to 59.999. |
| height | <p>This parameter is the height information for each cell. The altitude of each cell to provide the OTDOA function. The altitude can be used to calculate the UE location information in a cell. The format used is "AAAA.AA m".</p> <ul style="list-style-type: none"> • AAAA.AA: Sea level altitude. The range is from -1000.00 m to 4000.00 m. The unit 'm' must be included. For example, 53.85 m. |

Key Parameters

This section describes the key parameters for activation, deactivation, and configuration of the feature.

Activation/Deactivation Parameters

To activate or deactivate the feature, run the associated commands and set the key parameters.

User defined system location data (user-defined-location)

| Parameter | Description |
|-------------------|---|
| user-defined-mode | <p>This determines whether to enable or disable user defined system location</p> <ul style="list-style-type: none"> • True: System location is defined by the operator. • False: System location is defined by GPS. |

Automatic update of Cell position (positioning-conf-info)

| Parameter | Description |
|-------------------|--|
| auto-gps-set-flag | <p>This determines whether to enable or disable this feature:</p> <ul style="list-style-type: none"> • True: Cell position is automatically updated as system location. • False: Cell position is defined by the operator. |

Configuration Parameters

User defined system location data (user-defined-location)

| Parameter | Description |
|-----------|---|
| latitude | <p>Latitude information of the system's location. This is changed when USER_DEFINED_MODE is True. The format used is "A BBB:CC:DD.DDD".</p> <ul style="list-style-type: none"> • A: Hemisphere, N or S. • BBB: Degrees, 0-90. • CC: Minutes, 0-59. • DD.DDD: Milliseconds, 00.000-59.999. |

| Parameter | Description |
|-----------|--|
| longitude | Longitude information of the system's location. This is changed when USER_DEFINED_MODE is True. The format used is "A BBB:CC:DD.DDD". <ul style="list-style-type: none"> • A: Hemisphere, E or W. • BBB: Degrees, 0-180. • CC: Minutes, 0-59. • DD.DDD: Milliseconds, 00.000-59.999. |
| height | Altitude information of the system location. This is changed when USER_DEFINED_MODE is True. The format used is "AAAA.AA m/-AAAA.AA m". <ul style="list-style-type: none"> • AAAA.AA m: -1000.00 m to 4000.00 m. |

Automatic update of Cell position (positioning-conf-info)

| Parameter | Description |
|-----------|--|
| latitude | This parameter is the latitude of each cell to provide the OTDOA function. The latitude can be used to calculate the UE location information in a cell. The format used is "A BBB:CC:DD.DDD". <ul style="list-style-type: none"> • A: hemisphere. "N" or "S". • BBB: degrees. 0 to 90. • CC: minutes. 0 to 59. • DD.DDD: seconds. 00.000 to 59.999. |
| longitude | This parameter is the longitude of each cell to provide the OTDOA function. The longitude can be used to calculate the UE location information in a cell. The format used is "A BBB:CC:DD.DDD". <ul style="list-style-type: none"> • A: hemisphere. "E" or "W". • BBB: degrees. 0 to 180. • CC: minutes. 0 to 59. • DD.DDD: seconds. 00.000 to 59.999. |
| height | This parameter is the height information for each cell. Altitude of each cell to provide the OTDOA function. The altitude can be used to calculate the UE location information in a cell. The format used is "AAAA.AA m". <ul style="list-style-type: none"> • AAAA.AA: Sea level altitude. The range is from -1000.00 m to 4000.00 m. The unit 'm' must be included. For example, 53.85 m. |

Counters and KPIs

There are no specific counters or Key Performance Indicators (KPIs) associated with this feature.

REFERENCE

None

OAM-CM0201, State Management

INTRODUCTION

This feature provides functionalities to manage the administrative state of the NE and its resources. According to the standard document ITU-T X.731, three values that are defined for the administrative states of managed objects are Unlocked, Locked, and Shutting down.

BENEFIT

With this feature, the operator can control the operability of the NE and its resources by changing their administrative states for management purpose.

DEPENDENCY

None

LIMITATION

When the state of the system is locked, the state of the cell cannot be changed to unlocked. Similarly, when the state of the cell is locked, the state of the subcell cannot be changed to unlocked. When you change the state of the system from locked to unlocked, the state of the cell should be changed from locked to unlocked for service restart. When you change the state of the cell from locked to unlocked, the state of the subcell should be changed from locked to unlocked for service restart.

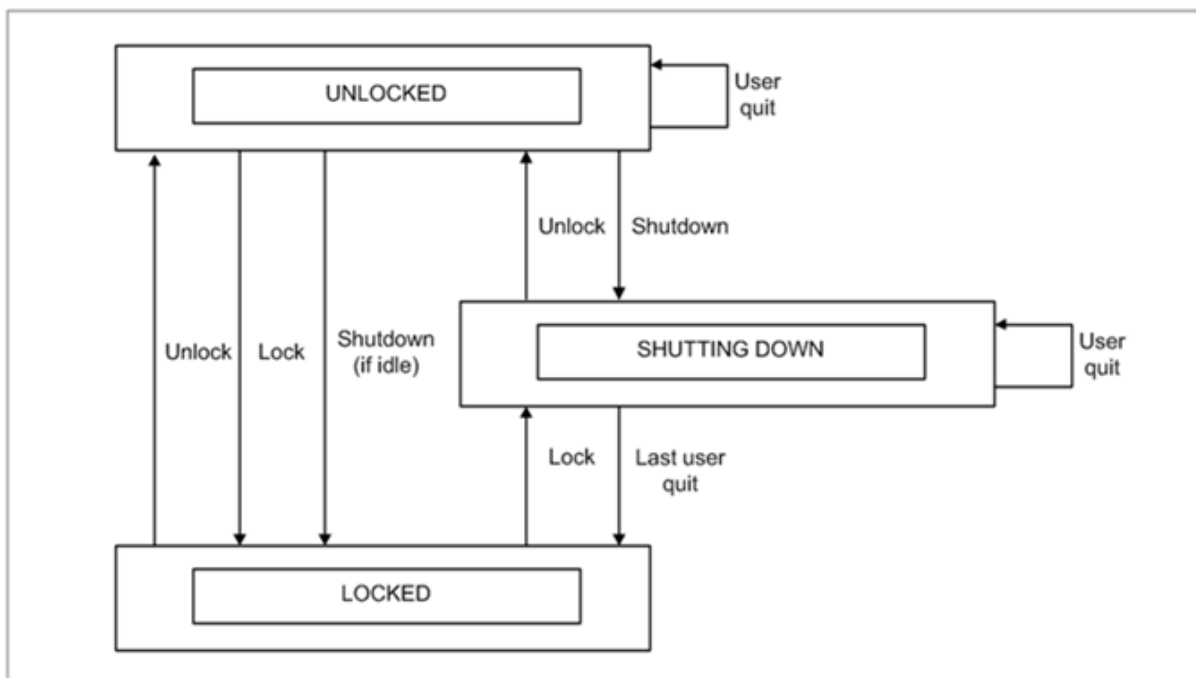
FEATURE DESCRIPTION

In the system, the administrative state of the NE, cells, and processing boards can be managed.

The administrative states defined in the ITU-T X.731 are as follows:

- **Unlocked:** The resource is administratively permitted to perform services for its users. This is independent of its inherent operability.
- **Locked:** The resource is administratively prohibited from performing services for its users.
- **Shutting down:** Use of the resource is administratively permitted to existing instances of use only. While the system remains in the shutting down state, the manager may at any time cause the managed object to revert to the unlocked state.

Specific events associated with the managed resource cause specific transitions from one administrative state value to another, depending upon the original value of the administrative state, the specific event, and also upon the number of users of the resource. These events and transitions are summarized in the figure below.



- **Unlock:** This event consists of an operation being performed at the managed object. To unlock the NE or its resource such as cell, unlock event is required. It can occur only if the administrative state of the managed object is locked or shutting down. It causes a transition to the unlocked administrative state.
- **Lock:** This event consists of an operation being performed at the managed object. To lock the NE or its resource such as cell, lock event is required. It can occur only if the administrative state of the managed object is unlocked or shutting down. It causes a transition to the locked administrative state.
- **Shut Down:** This event consists of an operation being performed at the managed object. To shut down the NE or its resource such as cell, shut down event is required. It can occur only if the administrative state of the managed object is unlocked. It causes a state transition as follows:
 - If, at the time of the event, the resource has existing users, the administrative state becomes shutting down
 - If, at the time of the event, the resource has no users, the administrative state becomes locked.
- **User Quit:** This event consists of an existing user of the resource terminating its use. It can occur only if the administrative state of the managed object is unlocked or shutting down. If the administrative state is unlocked, no administrative state transition occurs. If the administrative state is shutting down, the user quit event causes a transition as follows:
 - If, after the event, the resource still has existing users, the administrative state remains as shutting down
 - If, after the event, the resource has no users, the administrative state becomes locked.

When the administrative state of cell is changed to Shutting down, operator can

select whether the forced handover of current existing calls of the Shutting down cell is done or not.

When the forced handover is done, the forced handover schemes are selected according to the pre-configured target RAT/frequencies and call type. The operator can configure one of the following three preferred schemes per call type.

- 1 Inter-RAT handover is not allowed.
- 2 Inter-RAT handover is allowed (PS HO to 3G, SRVCC to 3G).
- 3 Both intra-LTE and inter-RAT handover are not allowed.

The operator can also configure the timer value for Shutting down. When the timer is expired, ongoing calls are redirected to the pre-configured target RAT/frequencies (intra-LTE, inter-RAT) or released. The operator can configure the option for protecting Emergency or High priority calls when UE selection for the Forced handover or Timer based call release. If the option is configured as activated, the eNB prohibits the forced handover of emergency or high priority calls when shutting down. If the option is configured as activated, the eNB also prohibits the timer based release of emergency or high priority calls when shutting down.

The administrative state can be only configured by the operator's management request. The operator can control the operability of NE or its resource to make a resource to provide service, or to put out of service by changing administrative states of them for management purpose. For example:

- For fault correction the administrative state can be used to isolate a faulty resource
- In case of redundancy the administrative state can be used to lock the active resource and let the standby resource to become active (preventive maintenance)
- For test management the administrative state can be used to put a resource out of service to run an intrusive test on it.

The operability of the NE/resource is represented with the operational state defined in ITU-T X.731, which has two possible values that is disabled and enabled.

- Disabled: The resource is totally inoperable and unable to provide service to the users.
- Enabled: The resource is partially or fully operable and available for use.

The relationship between administrative state and operational state is based on the 3GPP TS32.111-1. In case the operator locks a resource, if the current operational state is "Enabled", it is changed to "Disabled" and a state change notification is generated. Then, all the dependent resources are checked and, in case they are "Enabled" they are changed to "Disabled". In case the operator unlocks a resource, the operational state of that resource is changed from "disabled" to "Enabled" and all the dependent resources are turned back to "Enabled" (this is the simple case). In more complex cases, some of the objects may be disabled for different causes (different faults or faults plus locks on different superior resources), in this cases the repaired resource can be turned "Enabled" only when all the causes are cleared (in other words, faults are repaired and superior resources are unlocked). For

example,

The operator enables to force all connections disconnect of a specific cell for regardless of whether user traffic is currently being transmitted over the connection by changing the administrative state of the cell to "Locked". The operator enables to disconnect all connections of a specific cell in case the last user quits the cell by changing the administrative state to "Shutting down".

When the administrative state of the cell is changed to "Locked" by the operator, the operational state of the cell is changed to "Disabled" and the operational states of the dependent resources on the cell such as subcell are also changed to "Disabled".

The operator enables a specific cell to be available by changing the administrative state to "Unlocked".

When the administrative state of the cell is changed to "Unlocked" by the operator, the operational state of the cell is changed to "Enabled" and the operational states of the dependent resources on the cell are also changed to "Enabled" under the condition there are no other faults to make the operational state to be "Disabled".

SYSTEM OPERATION

This section describes how to configure the feature in Samsung system and provides associated key parameters, counters, and KPIs.

How to Activate

This section provides the information that you need to configure the feature.

Preconditions

There are no specific preconditions to activate this feature.

Activation Procedure

To activate this feature, do the following:

- Get or set **/managed-element/administrative-state** to retrieve/change the administrative state of the System.
- Get or set **/managed-element/enb-function/eutran-generic-cell/eutran-cell-fdd-tdd/administrative-state** to retrieve/change the administrative state of a LTE cell.
- Run **RTRV-GCREL-CONF/CHG-GCREL-CONF** and set shuttingDownMode to withForcedHo to use on-demand forced HO.
- Run **RTRV-GCREL-CONF/CHG-GCREL-CONF** and set shuttingDownTimerEnable to On to use timer based release.
- Run **RTRV-ONDMD-HO/CHG-ONDMD-HO** and set the administrative of the cell to shuttingDown to control ondemand forced HO execution for each cell
- Run **RTRV-ONDMD-HO/CHG-ONDMD-HO** to retrieve/change the onDemandHoEnable of a cell.

- Run **RTRV-ONDM-D-HO/CHG-ONDM-D-HO** to retrieve/change the targetFaRatType0 to 5 of a cell.
- Run **RTRV-ONDM-D-HO/CHG-ONDM-D-HO** to retrieve/change the targetFa0 to 5 of a cell.
- If target FA is Inter RAT, you need additional setting for band indicator and band class.

Deactivation Procedure

To deactivate this feature, do the following:

- Run **CHG-GRCREL-CONF** and set SHUTTING_DOWN_MODE to normalState to deactivate forced handover, when shuttingDown is triggered
- The changed SHUTTING_DOWN_MODE is reflected in the operation next period.

Key Parameters

This section describes the key parameters for activation, deactivation, and configuration of the feature.

Activation Parameters

Parameter Descriptions of **/managed-element**

| Parameter | Description |
|----------------------|---|
| administrative-state | <p>This parameter is the administrative state information of the system.</p> <ul style="list-style-type: none"> • locked: This is an intermediate state of system creation and deletion. Resources are added to the PLD, however, the system does not provide any call services. In this state, the operator can delete the related resources or switch the system to the unlocked state so that it can start providing services. • unlocked: Creating of the system is complete, its resources are added in the PLD and the system is ready to provide call services. • shutting-down: This is an intermediate state of system deletion. Resources are allocated in the PLD and the call service previously provided in the unlocked state continues, however, no further call services are provided. When the call service currently being provided ends, the cell automatically switches to the locked state. This state is applicable for eNB, only. |

Parameter Descriptions of **/managed-element/enb-function/eutran-generic-cell/eutran-cell-fdd-tdd**

| Parameter | Description |
|----------------------|--|
| cell-num | This parameter is the number of cells. This value must not exceed the maximum number of cells supported by the system. |
| administrative-state | <p>This parameter is the administrative state information of the cell. The default value at the time of creation is locked. This can be changed later by the operator.</p> <ul style="list-style-type: none"> • locked: This is an intermediate state of cell creation and deletion. Resources are added to the PLD, however, the cell does not provide any call services. In this state, the operator can delete the related resources or switch the cell to the unlocked state so that it can start providing |

| Parameter | Description |
|-----------|--|
| | <p>services.</p> <ul style="list-style-type: none"> • unlocked: Creating of the cell is complete, its resources are added in the PLD and the cell is ready to provide call services. • shutting-down: This is an intermediate state of cell deletion. Resources are allocated in the PLD and the call service previously provided in the unlocked state continues, however, no further call services are provided. When the call service currently being provided ends, the cell automatically switches to the locked state. |

Parameter Descriptions of **RTRV-GRCREL-CONF/CHG-GRCREL-CONF**

| Parameter | Description |
|----------------------------|--|
| SHUTTING_DOWN_MODE | This parameter is used to set shuttingDown operation mode when administrativeState (of CellConf) is transited to shuttingDown. There are normal and withForcedHo that triggers On-Demand Forced HO at transition to shuttingDown. |
| SHUTTING_DOWN_TIMER_ENABLE | This parameter is used to enable or disable timer operation. If you set this parameter to ON, the timer is triggered at transition to shuttingDown. Then, it makes the eNB forcibly release remained active calls in the cell under shuttingDown state, when timer is expired. |
| SHUTTING_DOWN_TIMER | This parameter is used to set timer duration in shuttingDown state. |

Parameter Descriptions of **RTRV-ONDMD-HO/CHG-ONDMD-HO**

| Parameter | Description |
|---------------------|---|
| CELL_NUM | Index per cell for OnDemand Handover function |
| ON_DEMAND_HO_ENABLE | On/Off parameter of On-demand Forced HO feature <ul style="list-style-type: none"> • 0: OFF • 1: ON |

Configuration Parameters

Parameter Descriptions of **RTRV-ONDMD-HO/CHG-ONDMD-HO**

| Parameter | Description |
|---------------------------|---|
| CELL_NUM | Index per cell for OnDemand Handover function |
| ON_DEMAND_HO_ENABLE | On/Off parameter of On-demand Forced HO feature <ul style="list-style-type: none"> • 0: OFF • 1: ON |
| REPORTING_EVENT_TYPE | This parameter decides Measurement Reporting Event Type during On-demand Forced HO operation <ul style="list-style-type: none"> • 0: A4 Event (use A4 event type) • 1: A5 Event (use A5 event type) |
| IRAT_REPORTING_EVENT_TYPE | This parameter determines a type of reporting event when On-demand Forced HO for Inter-RAT is executed. |
| TARGET_FA_RAT_TYPE0 | This parameter is a RAT type of the first target FA. |
| TARGET_FA0 | First HO target frequency of list used in On-demand Forced HO operation |
| BAND_INDICATOR0 | This parameter is band indicator information of the first target FA for GERAN. |
| BAND_CLASS0 | This parameter is band class information of the first target FA for HRPD. |

| Parameter | Description |
|----------------------|---|
| TARGET_FA_RAT_TYPE1 | This parameter is a RAT type of the second target FA. |
| TARGET_FA1 | First HO target frequency of list used in On-demand Forced HO operation |
| BAND_INDICATOR1 | This parameter is band indicator information of the second target FA for GERAN. |
| BAND_CLASS1 | This parameter is band class information of the second target FA for HRPD. |
| TARGET_FA_RAT_TYPE2 | This parameter is a RAT type of the third target FA. |
| TARGETFA2 | First HO target frequency of list used in On-demand Forced HO operation |
| BAND_INDICATOR2 | This parameter is band indicator information of the third target FA for GERAN. |
| BAND_CLASS2 | This parameter is band class information of the third target FA for HRPD. |
| TARGET_FA_RAT_TYPE3 | This parameter is a RAT type of the fourth target FA. |
| TARGET_FA3 | First HO target frequency of list used in On-demand Forced HO operation |
| BAND_INDICATOR3 | This parameter is band indicator information of the fourth target FA for GERAN. |
| BAND_CLASS3 | This parameter is band class information of the fourth target FA for HRPD. |
| TARGET_FA_RAT_TYPE4 | This parameter is a RAT type of the fifth target FA. |
| TARGET_FA4 | First HO target frequency of list used in On-demand Forced HO operation |
| BAND_INDICATOR4 | This parameter is band indicator information of the fifth target FA for GERAN. |
| BAND_CLASS4 | This parameter is band class information of the fifth target FA for HRPD. |
| TARGET_FA_RAT_TYPE5 | This parameter is a RAT type of the sixth target FA. |
| TARGET_FA5 | First HO target frequency of list used in On-demand Forced HO operation |
| BAND_INDICATOR5 | This parameter is band indicator information of the sixth target FA for GERAN. |
| BAND_CLASS5 | This parameter is band class information of the sixth target FA for HRPD. |
| PREFERENCE_FOR_VOLTE | This parameter configures types of HO preference for VoLTE UEs. <ul style="list-style-type: none"> • NotAllowIratHo: PS HO Only • AllowIratHo: PS HO and SRVCC (to UTRAN) |
| PREFERENCE_FOR_DATA | This parameter configures types of HO preference for Data UEs. <ul style="list-style-type: none"> • NotAllowIratHo: Allow LTE PS HO only, or Redirection to LTE/IRAT • AllowIratHo: Allow not only LTE PS HO, but also UTRAN PS HO, or Redirection to LTE/IRAT • RedirectionOnly: Redirection to LTE/IRAT Only |
| MEAS_CONFIG_UNIT | This parameter configures the number of UEs for load distribution during UE selection. After selecting UEs as many as the number of this configured UEs, eNB waits the measConfig operation during breakTime. Timer does not work when the parameter is set to MAX_CALL_COUNT_PER_CELL |
| BREAK_TIME | This parameter configures a waiting time for load distribution during UE selection. |

Counters and KPIs

The table below outlines the main counters associated with this feature.

| Family Display Name | Type Name | Type Description |
|---------------------|--------------------------------|--|
| ODHO_X2_OUT | OnDemandHoOutAtt | This type is counted by sending X2 handover request with Switch off ongoing cause |
| | OnDemandHoOutSucc | This type is counted by receiving UE context release command triggered by On-demand handover in Source eNB |
| ODHO_X2_IN | OnDemandHoInAtt | This type is counted by receiving X2 handover request with Switch off ongoing cause |
| | OnDemandHoInSucc | This type is counted by sending UE context release command triggered by On-demand handover from Source eNB |
| ODHO_S1_OUT | OnDemandHoOutAtt | Counted when the cause of S1 HO Request transmission is Miscellaneous::O & M Intervention. |
| | OnDemandHoOutSucc | Counted if the UE performs OnDemand Ho- based HO when the Source eNB successfully receives UE Context Release Request message. |
| | OnDemandHoOutAttToUTRAN | Counted when the cause of UTRAN HO Request transmission through S1 is Miscellaneous::O & M Intervention. |
| | OnDemandHoOutSuccToUTRAN | Counted if the UE performs OnDemand Ho-based HO when the Source eNB successfully receives UE Context Release Request message. |
| ODHO_S1_IN | OnDemandHoInAtt | Counted when the cause of HO Request reception through S1 is Miscellaneous::O & M Intervention. |
| | OnDemandHoInSucc | Counted if the UE performs OnDemand Ho-based HO when the target eNB successfully sends HO Notify message. |
| ODHO_INTRA_OUT | OnDemandHoIntraOutAtt | Counted when the eNB attempts Intra HO out caused by OnDemand forced HO. |
| | OnDemandHoIntraOutSucc | Counted if the UE performs OnDemand forced HO when the Source eNB successfully succeeds Intra HO out. |
| ODHO_INTRA_IN | OnDemandHoIntraInAtt | Counted when the eNB receives a request of Intra Hand-In caused by OnDemand forced HO. |
| | OnDemandHoIntraInSucc | Counted if the UE performs OnDemand Ho-based HO when the target eNB successfully Hand-in. |
| ODHO_REDIRECTION | RedirectionToLTEByOnDemandHo | This type is counted by conducting redirection to LTE (On-demand handover) |
| | RedirectionToWCDMAByOnDemandHo | This type is counted by conducting redirection to WCDMA (On-demand handover) |
| | RedirectionToGERANByOnDemandHo | This type is counted by conducting redirection to GERAN (On-demand handover) |
| | RedirectionToHRPDByOnDemandHo | This type is counted by conducting redirection to HRPD (On-demand handover) |
| | CcoToGERANByOnDemandHo | This type is counted by conducting CCO to GERAN (On-demand handover) |

| Family Display Name | Type Name | Type Description |
|---------------------|-------------------|--|
| ODHO_TIMER_RELEASE | ReleaseCntByTimer | Forced released UE by timer expiration |

The table below outlines the KPIs associated with this feature.

| KPI | Description |
|--------------------------------|---|
| LTE_CELL_UNAVAILABLE_TIME_LOCK | The cumulated of the time during the cell has been locked |

Related Status and Alarm

Status and alarms related to the administrative state are as follows:

| Status/Notification | Description |
|---------------------|---|
| REPORT STATE CHANGE | NOTI_OPERATIONAL_STATE shows disabled for that cell or system |

REFERENCE

- [1] ITU-T X.731 Information technology-Open Systems Interconnection-Systems management: State management function
- [2] 3GPP TS32.111-1 Telecommunication management; Fault Management; Part 1: 3G fault management requirements

OAM-CM0401, Configuration Data Management

INTRODUCTION

This feature provides functionalities to retrieve and change the current NE configuration information. For the modification, the validity and consistency check for the parameter values are executed. In case of configuration data change in local NE by Local Maintenance Terminal (LMT), a notification is sent to Element Management System (EMS). As a part of configuration data is also saved in the EMS, the data synchronization mechanism is supported by auditing the difference between the NE configuration data and the local copy saved in the EMS database.

The NE configuration data can be backed up to the EMS. The specific backup copy can be used to restore the NE configuration database. To make the restored data effective, NE self-reset is executed in the last step of the data restore procedure.

BENEFIT

This feature helps the operator operate and maintain both the network and the systems with own configuration and policy. The configuration data can be restored to a certain time point with the backup data, if any problems occur in them.

DEPENDENCY

None

LIMITATION

None

FEATURE DESCRIPTION

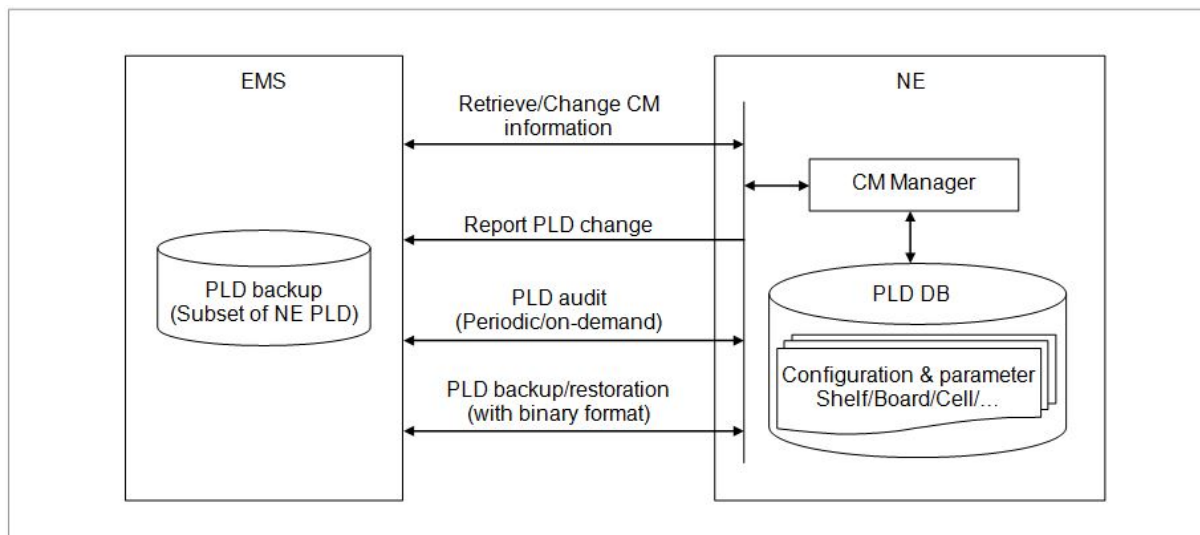
This feature consists of the following major functions:

- Retrieval and Changing of Configuration Data
- Configuration Data Synchronization between NE and EMS
- Configuration Data Backup and Restoration

The figure below depicts the interaction between the EMS and NE.



In the figure Programmable Loading Data (PLD) means the configuration data.



Retrieval and Changing of Configuration Data

This feature provides the functionalities to retrieve the current values of some parameters configured in the NE configuration database. The operator can adjust the values of those parameters for operation and maintenance purpose. For the modification of the values, data validity check and consistency check are done to prevent possible mistakes. Some parameters cannot be changed during system running. For modification of some parameters such as RF parameters, the cell has to be locked. For modification of some parameters, NE deletion and re-creation procedure or NE reset has to be done.

Configuration Data Synchronization between NE and EMS

If some configuration data is changed in the local NE, the NE reports a data change notification to the EMS. Then, the EMS can synchronize the configuration data saved in its local database.

The configuration data synchronization between the EMS and NE is performed by the following three kinds of methods:

- **Periodic audit by EMS:** This kind of audit is executed by the EMS once every day and the audit time is fixed. For each configuration data table has the sequence number. The sequence number is the value to be increased by 1 when the configuration data table has changed. The EMS compares its sequence number with one that of NE configuration database. If the sequence number is different, the EMS applies the value of NE database on its local database. For details see the LSM-CM0701 Configuration Data Management.
- **NE-initiated audit:** The NE notifies the EMS to do the configuration data audit for the abnormal cases such as restart of system, board and software block in charge of configuration management, which can possibly introduce data inconsistency between the NE configuration database and the EMS saved data, the NE notifies the EMS to do data audit. In this kind of audit, the EMS performs the synchronization of the all configuration data without comparison of sequence number between the EMS and NE.

- Manual audit by operator's request: The operator can also request the data audit by EMS GUI. The EMS performs the synchronization of the all configuration data without comparison of sequence number between the EMS and NE.

Configuration Data Backup and Restoration

Backup and restoration of configuration data in the NE to or from the EMS is supported. Periodically, the NE configuration data is backed up to the EMS. The operator can also request the backup of configuration data by CLI command.

The operator can restore the NE configuration data using a specific backup copy saved in the EMS. During the data restore procedure, at last the NE performs the system self-reset to make the new configuration data effective.

SYSTEM OPERATION

This section describes how to configure the feature in Samsung system and provides associated key parameters, counters, and KPIs.

How to Activate

This section provides the information that you need to configure the feature.

Preconditions

There are no specific preconditions to activate this feature.

Activation Procedure

- 1** *backup-db*: The operator can backup up the system's database binary files to EMS. This on-demand backs up the database of system to the EMS.

The operator must input the file name and location in the "*db-backup-file-location*" parameter in the EMS where the backup database is stored.

If nothing is entered, the basic directory and file name are designated automatically as shown below.

- Directory: log/bak/yang/{neTYPE}/{neID}.
- File name: {neTYPE}{neID}.yyyymmdd-hhMMss.backup.db.tar.gz.
- File information: yyyy: year, mm: month, dd: day, hh: hour, MM: minute, ss: second.

The backup database has a form where the binary data file forming the database collects as tar and compressed with gzip.

- 2** *restore-db*: The operator can restore the database binary files located in the EMS to the system. This on-demand applies a backup DB stored on the EMS to the system and restores it.

The operator must enter the location and file name for storing the backup DB on the EMS in the "*db-restore-file*" parameter. If this is not entered, an error is returned.

The backup DB has a form where the binary data file forming the DB collects

as tar and compressed with gzip.

This command must be used with caution. Selecting a file other than a backup DB file may result in a critical system error.

When the restore is complete, the system reboots.

- Run backup-db and input "*db-backup-file-location*" (the file name and location in EMS where the backup database is stored).
- Run restore-db and input the file name and location for storing the backup DB on the EMS in the "*db-restore-file*" parameter.

Deactivation Procedure

This feature does not need to be deactivated.

Key Parameters

There are no specific parameters associated with this feature.

Counters and KPIs

There are no specific counters or Key Performance Indicators (KPIs) associated with this feature.

REFERENCE

None

OAM-CM0402, Retrieving Optic Module Information

INTRODUCTION

This feature provides the information of optic module connected to DU and RU. The information includes power and wavelength of the optic module.

BENEFIT

This feature helps the operators to retrieve the information of power and wavelength of optic module.

DEPENDENCY

None

LIMITATION

- OAM-CM0402 depends on the optic module compliant to hardware specification (SFF-84721 and SFF-8436). Additionally, RU firmware version needs to be considered to support the temperature for optic module attached in RU
- The optic module that does not comply with hardware specification might have the unreliable data of optic temperature.

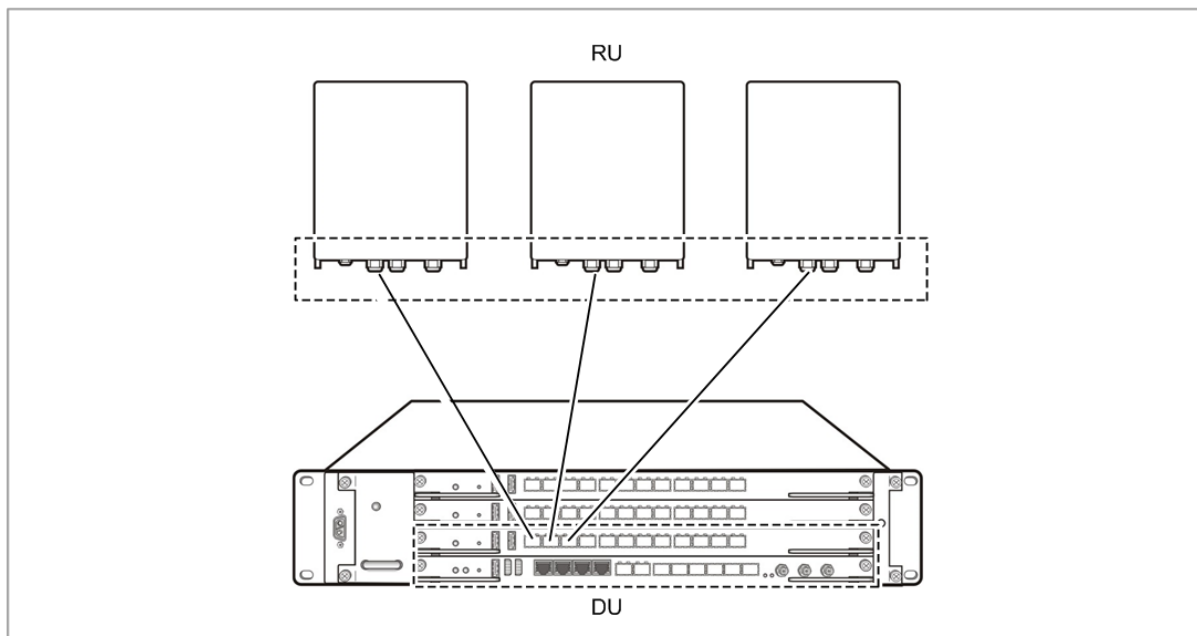
FEATURE DESCRIPTION

This feature enables operator to retrieve the information such as optic power and optic wave length of optic module that is connected with DU or RU by using the below commands:

- **[BBU] external-link-info and get tx-wavelength, tx-power, rx-power**
- **[BBU] ecp-external-link-info get and tx-wavelength, tx-power, rx-power**
- **[BBU] srio-port-info and get tx-wavelength, tx-power, rx-power**
- **[BBU] cpri-port-info and get tx-wavelength, tx-power, rx-power**

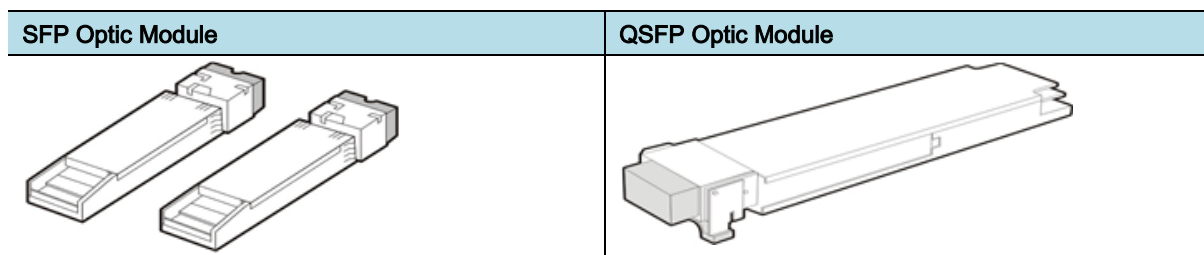
If the status of optic module is N_EQUIP, optic signal cannot be displayed.

Connected location of optic module is represented in below figure.



- Optic module has two types: SFP and QSFP.

See the figure below about the samples of SFP and QSFP optic module.



SYSTEM OPERATION

This section describes how to configure the feature in Samsung system and provides associated key parameters, counters, and KPIs.

How to Activate

This section provides the information that you need to configure the feature.

Preconditions

Ensure that the following conditions are met before enabling this feature:

Optic module must be present in below containers:

- [ENB] digital-unit-entries/external-port/ethernet-port/ethernet-port-entries
- [ENB] digital-unit-entries/external-port/ethernet-port/ecp-ethernet-port-entries
- [ENB] digital-unit-entries/external-port/cpri-port/cpri-port-entries

- [ENB] **digital-unit-entries/external-port/srio-port/srio-port-info**
- [ENB] **radio-unit-info/external-port/cpri-port/cpri-port-entries**

Activation Procedure

This feature runs automatically.

Deactivation Procedure

This feature does not need to be deactivated.

Key Parameters

This section describes the key parameters for activation, deactivation, and configuration of the feature.

Activation/Deactivation Parameters

There are no specific Activation/Deactivation parameters associated with this feature.

Configuration Parameters

Parameter Descriptions of **digital-unit-entries/ethernet-port-entries**, **digital-unit-entries/ecp-ethernet-port-entries**, **digital-unit-entries/cpri-port-entries**, **digital-unit-entries/srio-port-info**, **radio-unit-info/cpri-port-entries**

| Parameter | Description |
|---------------|--|
| tx-wavelength | This parameter is the Tx optical wavelength supported by the module. |
| tx-power | This parameter is the Tx optical power supported by the module. |
| rx-power | This parameter is the Rx optical power supported by the module. |

Counters and KPIs

There are no specific counters or Key Performance Indicators (KPIs) associated with this feature.

REFERENCE

None

Chapter 2 Event Management

OAM-EM0101, Event Management

INTRODUCTION

This feature provides the functionality of real time sending events happened in the NE to the EMS. Those events are very helpful to understand the running status of the NE. The events include state change of managed objects, alarms, result of running command, and so on.

The events are displayed in the "Event Viewer" GUI of the EMS in real time. Besides the EMS, you can also configure additional event destinations in the NE.

BENEFIT

You can understand the system running status in real time. Those events are very helpful for managing the NE and network.

DEPENDENCY

None

LIMITATION

None

FEATURE DESCRIPTION

This feature is decomposed into the following two sub features:

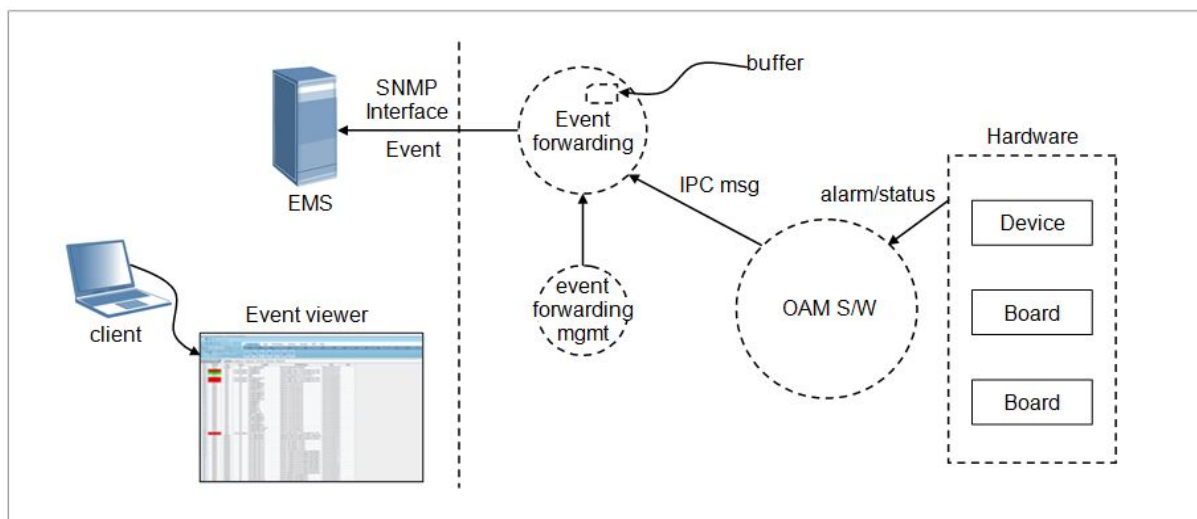
- Event Forwarding
- Management of Event Forwarding.

Event Forwarding sub feature provides event forwarding services for applications in the NE. OAM software generates status change events according to the system running status. For example, the system is in "locked" status after getting operator request. Or some board changes to "disabled" status because of hardware failure. The OAM software also detects the fault happened in the system and generates related alarm for it. The OAM software sends the generated alarms and state change via IPC messages and sends them to event forwarding function, which composes a Simple Network Management Protocol (SNMP) message according to the Management Information Base (MIB) defined between the EMS and the NE.

Management of Event Forwarding sub feature provides the functionalities for

management of the event forwarding. Beside the EMS, you can also configure additional event destinations in the NE.

The figure below depicts the operation of Event Forwarding.



Event Forwarding

Event Forwarding acts as the interface between applications running in the NE and the EMS. It receives the system status and alarm message from applications, translates them to the related SNMP message according to the MIB and sends the SNMP message to the EMS. It provides SNMP protocol adaptor functionality to applications in the NE, which are freed from the trivial and tedious SNMP protocol handling.

The OAM software monitors the system running status and detects the system fault. Then, it generates proper state change event and alarm event and sends to the event forwarding function. The event generation in the OAM software is not described in this document. It is covered in the fault management feature OAM-FM0101.

The Event Forwarding can only send the converted SNMP message to the EMS when the IP communication between the NE and EMS works correctly. If the NE cannot communicate with the EMS (for example, cable is disconnected), the real time forwarding of event cannot be guaranteed.

The NE periodically sends UDP ping message to the EMS to check connectivity between the EMS and NE. If it cannot receive the response message from the EMS within specified period, the IP communication with the EMS is considered broken. After that, event forwarding function does not send the events to the EMS. Instead, it saves those events in its local buffer temporarily.

If the event forwarding function detects the IP communication with EMS is recovered, it starts the sending of those events saved in local buffer one by one. However, if the IP communication is broken too long that the events generated during that period are more than 20, those saved events are discarded to prevent from EMS overload and network congestion.

In that case, EMS does not receive all the events since the some NEs discard the

saved events. For some important events such as alarms, EMS should keep the latest information, so it has to request NE to send the current active alarms again.

However, during that period, if some alarm is detected and cleared after some time, that kind of change history cannot be achieved by re-sending events. For that case, the event log has to be analyzed. See feature "OAM-EM0201: Event and System Log Management" for detail about event log management.

Management of Event Forwarding

Management of Event Forwarding provides the functionalities for stopping and restarting the event forwarding, adding servers for forwarding the events to. In addition to the EMS, other servers can be configured for listening the events happened in the NE. For the configuration of those servers, the IP address and listening port are mandatory. You can also request the NE to send the event log file to those servers by specifying the ftp user ID and password. The status of those servers including the EMS can be displayed by Command Line Interface (CLI) command. See feature *OAM-EM0201 Event and System Log Management* for detail.

By CLI command, you can also request to stop/restart sending events to the specified servers. If some server is not used for receiving events any more, it can be deleted from the server list by related CLI command.

SYSTEM OPERATION

This section describes how to configure the feature in Samsung system and provides associated key parameters, counters, and KPIs.

How to Activate

This feature runs automatically, and it cannot be disabled.

Key Parameters

There are no specific activation or deactivation parameters associated with this feature.

Configuration Parameters

There are no specific parameters associated with this feature.

Counters and KPIs

There are no specific counters or Key Performance Indicators (KPIs) associated with this feature.

REFERENCE

[1] RFC 1155 (STD 16)-Structure and Identification of Management Information for the TCP/IP-based Internets

[2] RFC 1156 (Historic)-Management Information Base for Network Management

of TCP/IP-based internets

- [3] RFC 1157 (Historic)-A Simple Network Management Protocol (SNMP)
- [4] RFC 1213 (STD 17)-Management Information Base for Network Management of TCP/IP-based internets: MIB-II
- [5] RFC 1452 (Informational)-Coexistence between version 1 and version 2 of the Internet-standard Network Management Framework (Obsoleted by RFC 1908)
- [6] RFC 1901 (Experimental)-Introduction to Community-based SNMPv2
- [7] RFC 1902 (Draft Standard)-Structure of Management Information for SNMPv2 (Obsoleted by RFC 2578)
- [8] RFC 1908 (Standards Track)-Coexistence between Version 1 and Version 2 of the Internet-standard Network Management Framework
- [9] RFC 2570 (Informational)-Introduction to Version 3 of the Internet-standard Network Management Framework (Obsoleted by RFC 3410)
- [10] RFC 2578 (STD 58)-Structure of Management Information Version 2 (SMIv2)
- [11] RFC 3410 (Informational)-Introduction and Applicability Statements for Internet Standard Management Framework
- [12] STD 62
- [13] RFC 3411-An Architecture for Describing Simple Network Management Protocol (SNMP) Management Frameworks
- [14] RFC 3412-Message Processing and Dispatching for the Simple Network Management Protocol (SNMP)
- [15] RFC 3413-Simple Network Management Protocol (SNMP) Applications
- [16] RFC 3414-User-based Security Model (USM) for version 3 of the Simple Network Management Protocol (SNMPv3)
- [17] RFC 3415-View-based Access Control Model (VACM) for the Simple Network Management Protocol (SNMP)
- [18] RFC 3416-Version 2 of the Protocol Operations for the Simple Network Management Protocol (SNMP)
- [19] RFC 3417-Transport Mappings for the Simple Network Management Protocol (SNMP)
- [20] RFC 3418-Management Information Base (MIB) for the Simple Network Management Protocol (SNMP)
- [21] RFC 3430 (Experimental)-Simple Network Management Protocol (SNMP) over Transmission Control Protocol (TCP) Transport Mapping
- [22] RFC 3584 (BCP 74)-Coexistence between Version 1, Version 2, and Version 3 of the Internet-standard Network Management Framework
- [23] RFC 3826 (Proposed)-The Advanced Encryption Standard (AES) Cipher Algorithm in the SNMP User-based Security Model
- [24] RFC 5343 (Proposed)-Simple Network Management Protocol (SNMP)

Context EngineID Discovery

[25] RFC 5590 (Draft)-Transport Subsystem for the Simple Network Management Protocol (SNMP)

[26] RFC 5591 (Draft)-Transport Security Model for the Simple Network Management Protocol (SNMP)

[27] RFC 5592 (Proposed)-Secure Shell Transport Model for the Simple Network Management Protocol (SNMP)

[28] RFC 5608 (Proposed)-Remote Authentication Dial-In User Service (RADIUS) Usage for Simple Network Management Protocol (SNMP) Transport Models.

[29] RFC 6353 (Draft)-Transport Layer Security (TLS) Transport Model for the Simple Network Management Protocol (SNMP)

OAM-EM0201, Event and System Log Management

INTRODUCTION

This feature provides the functionality of uploading event log file and system log files. If requested, the NE can upload the saved event log file to the EMS or any other configured server.

If some problem happens, which makes NE run abnormally, the NE collects system log files including mortem log file, application core files and application log files and transfers them to the EMS. Those files would be helpful for analyzing the root cause of the problem.

BENEFIT

You can analyze the system running history from the event log file. System log files help to analyze the root cause of the problem.

DEPENDENCY

Prerequisite Features

- This feature is dependent on feature "OAM-EM0101 Event Management". To upload event log file to some server, its IP address, FTP user ID and password shall be configured by CLI command, which is provided by that feature.

LIMITATION

In case the happening alarm exceeds the File Size, the oldest alarm is renewed by an up-to-date.

FEATURE DESCRIPTION

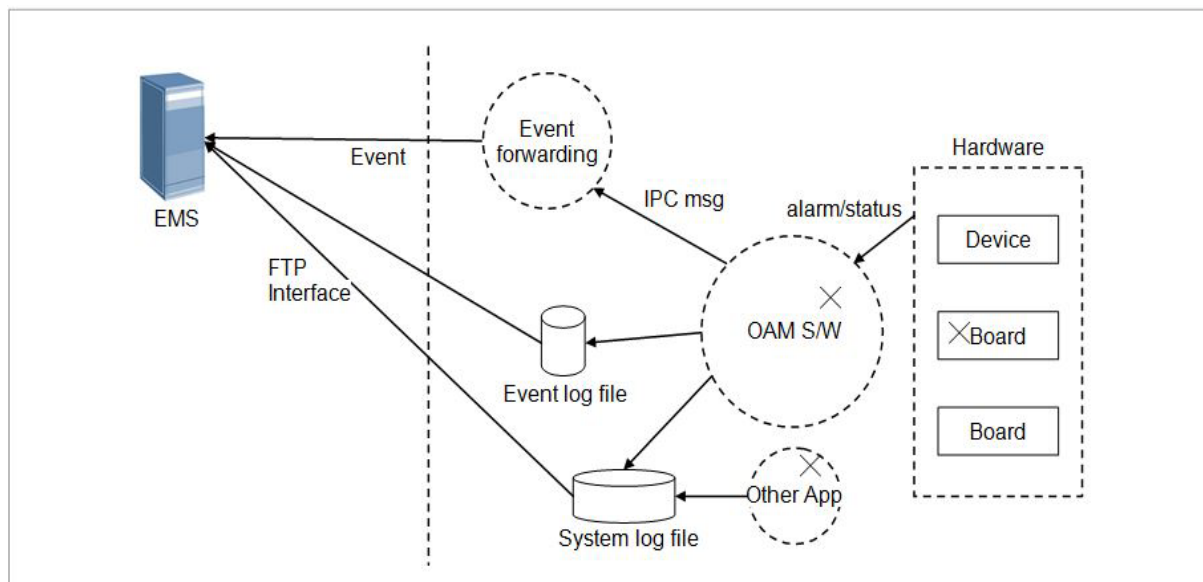
This feature is decomposed into the following two sub features:

- Event Log File Uploading
- System Log File Uploading

Event Log File Uploading provides the uploading of event log file to the EMS or any configured server if requested by the operator.

System Log File Uploading provides the functionalities for uploading of system log files to the EMS automatically if some abnormal case happens. The system log files include application core files, application log files and mortem log file.

The figure below depicts the architecture of Event Log Management.



Event Log File Uploading

When OAM software detects system running state change or system fault, it sends events to the EMS. See feature "OAM-EM0101 Event Management" for detail. At the same time, the OAM software saves those events to a local file. If requested by CLI command, that file is uploaded to the EMS or any configured server by File Transfer Protocol (FTP).

For any server to receive the event log file by FTP, its IP address, FTP user ID, and password have to be configured in Programmable Loading Data (PLD) by CLI command. This functionality is provided by feature "OAM-EM0101 Event Management". According to the configured information, if requested by the operator, the event log file is uploaded to the specified destination address.

The event log file can only be uploaded to the EMS or configured servers by operator's CLI command. It cannot be uploaded automatically.

There is a size limitation for the event log file. If the size of the accumulated events is more than the pre-defined limit, a new file is created with the previous one being saved temporarily. The previous log file can be accessed by logging in to the NE for checking the previous event history.

System Log Files Uploading

While the system is running, application blocks including OAM software, Call Processing software, and Traffic processing software generate running information (like state change, abnormal message, and system exception). This information is useful for the operators to understand the system running status, and application blocks save them to application log files appropriately.

If some block dies abnormally, operating system (Linux) generates core files for that block (including core file, process stack, callback trace, and process map). Those files are very helpful to analyze the root cause of abnormal death. In this case, the NE collects those application log files and core files and transfers them to

the EMS via FTP.

When some processing board restarts abnormally, all the application logs saved in that board would be lost. In this case, operating system saves the reset reason and other useful debug information in flash memory before the board restarts. After board re-initialization, the OAM software generates mortem log from the flash and transfers that mortem log file to the EMS automatically, which can be used by the operator to analyze the root cause of board restart.

However, if the board is restarted normally such as board reboot, hardware reset, or power off, the OAM software does not transfer the mortem log file to the EMS to reduce the operator's unnecessary efforts of analyzing the root cause.

SYSTEM OPERATION

This section describes how to configure the feature in Samsung system and provides associated key parameters, counters, and KPIs.

How to Activate

This section provides the information that you need to configure the feature.

Preconditions

There are no specific preconditions to activate this feature

Activation Procedure

To activate this feature, do the following:

- Run **UPLD-NOTI-LOG** to create a file of the notification log collected according to the notification categories configured for a registered notification manager and then transmits it to the notification manager.

To activate RU Hardware Log Collection feature, do the following:

- Run **CRTE-FTM-CONF** to configure the repository for RU Hardware Log (FILE_TYPE = ".rusts") and run **CHG-RRHEXT-CONF** to activate RU Hardware Log collection function and control period to collect RU Hardware Log.

Deactivation Procedure

This feature does not need to be deactivated

To deactivate RU Hardware Log Collection feature, do the following:

- Run **DLT-FTM-CONF** to delete configuration for RU Hardware Log and run **CHG-RRHEXT-CONF** to deactivate RU Hardware Log collection function.

Key Parameters

This section describes the key parameters for activation, deactivation, and configuration of the feature.

Activation/Deactivation Parameters

To activate or deactivate the feature, run the associated commands and set the key

parameters.

Parameter Descriptions of **UPLD-NOTI-LOG**

| Activation/Deactivation Parameters Example | |
|--|--|
| Parameter | Description |
| SUBSCRIPTION_ID | The subscription ID for the notification manager registered in the notification management system. |

Parameter Descriptions of **CRTE-FTM-CONF**

| Activation/Deactivation Parameters Example | |
|--|---|
| Parameter | Description |
| DB_INDEX | This parameter is the index of PLDFtmConf. |
| FTP_TYPE | This parameter is the file transfer method to upload files to the remote host. <ul style="list-style-type: none"> • FTP: Upload Files using File Transfer Protocol. • SFTP: Upload Files using Secure File Transfer Protocol. |
| IP_VER | This parameter is the version of the remote host address. It indicates whether the IP is IPv4 or IPv6. |
| IP_ADDR_V4 | This parameter is the IPv4 address of the remote host. It is only valid if the IP_VER parameter value is IPv4. |
| IP_ADDR_V6 | This parameter is the IPv6 address of the file upload server. It is only valid if the IP_VER parameter value is IPv6. |
| LOGIN_ID | This parameter is the login ID for the remote host. |
| LOGIN_PW | This parameter is the password to login remote host. |
| REMOTE_PATH | This parameter is the upload directory path of remote host. |
| FILE_TYPE | This parameter is the file extension or keyword of the file to be uploaded. User may input multiple file extension as the following example (It must be separated with a space and wild card expression is not allowed). Example) .rqa .log .tar.gz .core .mortem .rusts |

Parameter Descriptions of **DLT-FTM-CONF**

| Activation/Deactivation Parameters Example | |
|--|--|
| Parameter | Description |
| DB_INDEX | This parameter is the index of PLDFtmConf. |

Parameter Descriptions of **CHG-RRHEXT-CONF**

| Activation/Deactivation Parameters Example | |
|--|--|
| Parameter | Description |
| CONNECT_BOARD_ID | This parameter is the board ID of the DU, which is connected to the RRH. For example, if the RRH is connected to channel card #1, CONNECT_BOARD_ID is 1. ID of the RRH connected to the DU can be retrieved by executing the RTRV-RRH-CONF command. |
| CONNECT_PORT_ID | This parameter is the port ID of the DU, which is connected to the RRH. For example, if the RRH is connected to port #1 of the channel card, CONNECT_PORT_ID is 1. ID of the RRH connected to the DU port can be retrieved by executing the RTRV-RRH-CONF command. |

| Activation/Deactivation Parameters Example | |
|--|--|
| Parameter | Description |
| CASCADE_RRH_ID | This parameter is the cascade ID of the DU port, which is connected to the RRH. For example, if the RRH is the first RRH in cascade connection, CASCADE_RRH_ID is 0. If it is the second RRH in cascade connection, CASCADE_RRH_ID is 1. ID of the RRH in cascade connection to the DU port can be retrieved by executing the RTRV-RRH-CONF command. |
| LOG_CREATION_ON_OFF | This parameter is to control Hardware Fault Log Function of RF Unit. |
| LOG_CREATION_PERIOD | This parameter is to control period of Hardware Fault Log Function. |

Configuration Parameters

To configure the feature settings, run the associated commands and set the key parameters.

Parameter Descriptions of **RTRV-SBSC**

| Configuration Parameters Example | |
|----------------------------------|---|
| Parameter | Description |
| SUBSCRIPTION_ID | The subscription ID for the notification manager registered in the notification management system |

Parameter Descriptions of **RTRV-FTM-CONF**

| Activation/Deactivation Parameters Example | |
|--|---|
| Parameter | Description |
| DB_INDEX | This parameter is the index of PLDFtmConf. |
| FTP_TYPE | This parameter is the file transfer method to upload files to the remote host. <ul style="list-style-type: none"> FTP: Upload Files using File Transfer Protocol. SFTP: Upload Files using Secure File Transfer Protocol. |
| IP_VER | This parameter is the version of the remote host address. It indicates whether the IP is IPv4 or IPv6. |
| IP_ADDR_V4 | This parameter is the IPv4 address of the remote host. It is only valid if the IP_VER parameter value is IPv4. |
| IP_ADDR_V6 | This parameter is the IPv6 address of the file upload server. It is only valid if the IP_VER parameter value is IPv6. |
| LOGIN_ID | This parameter is the login ID for the remote host. |
| LOGIN_PW | This parameter is the password to login remote host. |
| REMOTE_PATH | This parameter is the upload directory path of remote host. |
| FILE_TYPE | This parameter is the file extension or keyword of the file to be uploaded. User may input multiple file extension as the following example (It must be separated with a space and wild card expression is not allowed). Example) .rqa .log .tar.gz .core .mortem .rusts |

Parameter Descriptions of **RTRV-RRHEXT-CONF**

| Activation/Deactivation Parameters Example | |
|--|--|
| Parameter | Description |
| CONNECT_BOARD_ID | This parameter is the board ID of the DU, which is connected to the RRH. For example, if the RRH is connected to channel card #1, CONNECT_BOARD_ID is 1. ID of the RRH connected to the DU can be retrieved by executing the RTRV-RRH-CONF command. |
| CONNECT_PORT_ID | This parameter is the port ID of the DU, which is connected to the RRH. For example, if the RRH is connected to port #1 of the channel card, CONNECT_PORT_ID is 1. ID of the RRH connected to the DU port can be retrieved by executing the RTRV-RRH-CONF command. |
| CASCADE_RRH_ID | This parameter is the cascade ID of the DU port, which is connected to the RRH. For example, if the RRH is the first RRH in cascade connection, CASCADE_RRH_ID is 0. If it is the second RRH in cascade connection, CASCADE_RRH_ID is 1. ID of the RRH in cascade connection to the DU port can be retrieved by executing the RTRV-RRH-CONF command. |
| LOG_CREATION_ON_OFF | This parameter is to control Hardware Fault Log Function of RF Unit. |
| LOG_CREATION_PERIOD | This parameter is to control period of Hardware Fault Log Function. |

Counters and KPIs

There are no specific counters or Key Performance Indicators (KPIs) associated with this feature.

REFERENCE

None

Chapter 3 External Device Management

OAM-ED0901, FAN Management

INTRODUCTION

This feature provides the functionality to manage the FAN equipped in the eNB. The management functions provided by the eNB depend on the type of the FAN module.

BENEFIT

This feature helps normal operation of the eNB through the FAN speed control from high temperature environment, and the notification of FAN module physical status, such as FAN module malfunction and FAN module deletion.

DEPENDENCY

HW dependency: DU FAN management functionality is applied to Cabinet DU (CDU) type only. The scope of this functionality is determined according to a FAN module type and FAN module firmware version. The interface of DU FAN is dependent on the system hardware.

LIMITATION

None

SYSTEM IMPACT

The implementation of this feature does not have any impact on the network.

FEATURE DESCRIPTION

The functionalities related to this feature are consisted as follows:

- FAN Management Function
- FAN Management Interface

FAN Management Function

The eNB provides the functionality of DU FAN management, such as Inventory management, Firmware remote update, FAN status and fault management, and FAN speed control as follows:

- FAN Inventory Management**

The eNB supports the inventory management functionality to manage DU FAN module related hardware information. The operator can retrieve FAN inventory information using CLI command. The FAN inventory information includes FAN module name, serial number, hardware version, and firmware version. For the detailed Inventory Management functionality, refer the feature "OAM-IM0101, Inventory Management".
- FAN Firmware Update**

The eNB supports the remote firmware download and update for DU FAN module using CLI command. After firmware image is downloaded to FAN module, it resets itself autonomously to activate the new image. If firmware update is completed normally, the update complete notification is sent to the EMS event viewer. Refer the feature "OAM-SW0401: Firmware Upgrade and Update" for detail.
- FAN Status and Fault Management**

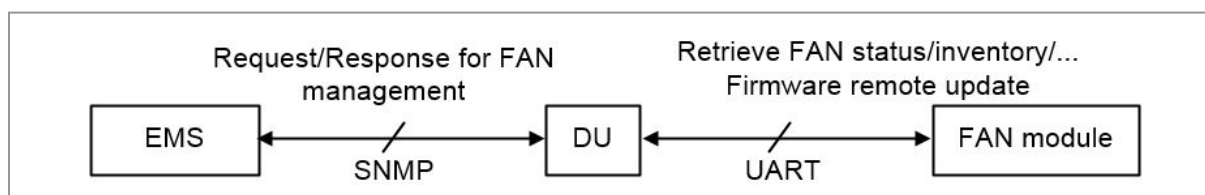
The eNB supports the status management functionality of DU FAN module using CLI command. FAN status information includes FAN operational status information such as FAN outlet temperature and FAN operational logic.

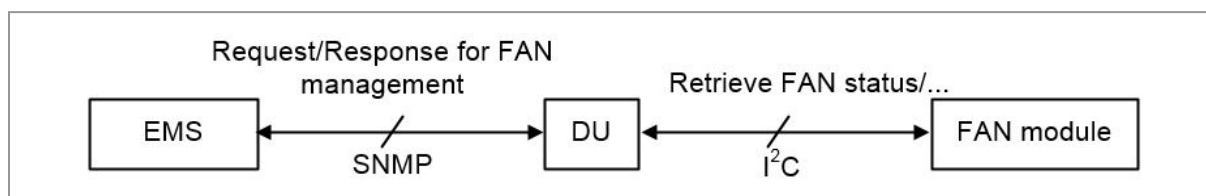
The eNB supports the fault management functionality of DU FAN module. FAN fault management provides the functionality to report alarm to the EMS when FAN is operated abnormally, such as FAN module malfunction, FAN module deletion and communication failure of FAN module. If abnormal FAN module is equipped in DU, the system temperature can rise up continuously. Eventually, system cannot be operated normally due to high temperature. The operator can know this abnormal status through FAN related alarm generation, and should recover the system through cleaning dust on FAN module or replacing FAN module.
- FAN Speed Control**

The eNB provides the functionality to control FAN speed and to optimize the system environmental condition through monitoring FAN outlet temperature. If the FAN outlet temperature exceeds corresponding high threshold, the FAN module is operated with higher speed by FAN speed control functionality. If the FAN outlet temperature is less than corresponding low threshold, the FAN module is operated with the low speed.

FAN Management Interface

The type of FAN module that is used at Samsung CDU is classified according to interface for FAN control, such as using UART interface or using I2C interface. DU FAN control structure is depicted in figure below.





DU sends the management request messages received from the EMS to the FAN module via specific communication protocol. After receiving request message from the DU, the FAN module sends back the status information or alarm information for itself according to the type of request message. Then, DU reports the received result message from the FAN module to the EMS if required.

In case of FAN module using UART interface, all DU FAN management functionalities can be supported that includes FAN firmware update and FAN inventory management. In case of FAN module using I2C interface, the functionalities of FAN status and fault management, and FAN speed control can be supported.

SYSTEM OPERATION

This section describes how to configure the feature in Samsung system and provides associated key parameters, counters, and KPIs.

How to Activate

This feature runs automatically, and it cannot be disabled.

Key Parameters

There are no specific parameters associated with this feature.

Counters and KPIs

There are no specific counters or Key Performance Indicators (KPIs) associated with this feature.

REFERENCE

None

Chapter 4 Fault Management

OAM-FM0101, Alarm Monitoring

INTRODUCTION

This feature provides functionalities to monitor the status of running system, detect the faults, and generate or clear appropriate alarms according to the error status of the system. The list of current active alarms in the system can be reported to the EMS if configured. The alarm information includes probable cause, alarm severity, alarm detection time, alarm clear time, and so on.

BENEFIT

With this feature, the operator can monitor system faults remotely and take necessary actions to resolve them.

DEPENDENCY

None

LIMITATION

Alarm Trap Flooding Prevention function: In the eNB, alarm related operations, such as cell state management, alarm correlation, LED control, RF control, and auto-recovery, are performed based on the real alarm. These operations are not performed based on the alarms declared by the Alarm Trap Flooding Prevention function. Therefore, the alarm state reported to the EMS can be mismatched with it in the eNB site.

SYSTEM IMPACT

None

FEATURE DESCRIPTION

This feature provides the following functions:

- Monitoring Alarms
- Retrieving Alarm History
- Alarm Suppression
- Synchronization with EMS

- Alarm Trap Flooding Prevention

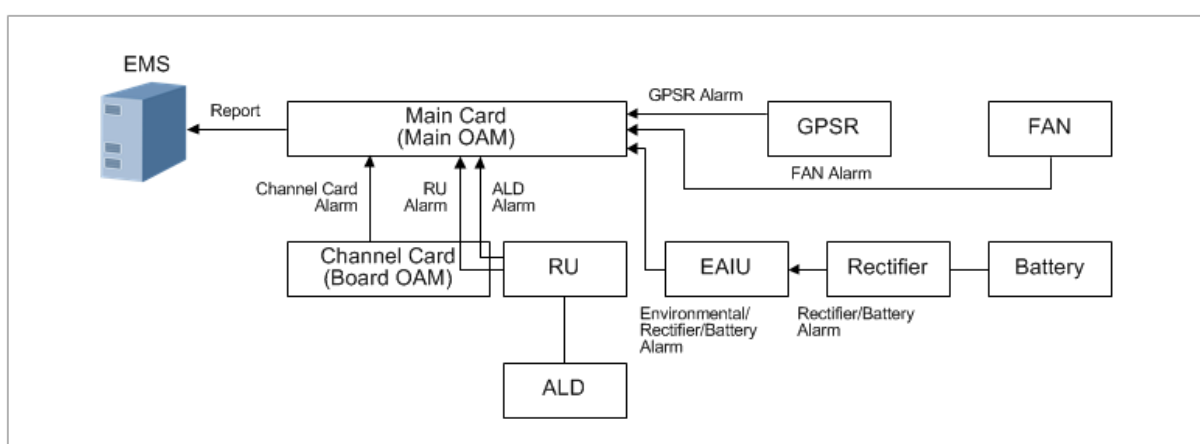
Monitoring Alarms

Generally, the main OAM block monitors and collects all alarms of physical and logical resources, a variety of devices, and software. The method of alarm detection is different according to the alarm type. For some alarms main OAM block directly monitors the fault status and for some other alarms it receives the alarm status raised or cleared by Board OAM block or other components such as Radio Unit (RU), Environment Alarm Interface Unit (EAIU), FAN, and Antenna Line Device (ALD).

The figure below depicts an example of alarm collection and reporting to the EMS by the eNB.



The components belongs to the eNB can be different according to the eNB type or configuration.



The alarms are raised or cleared based on the current system status. The operator can check the current alarm status of the system in the following ways:

- Via the Event Viewer of EMS
- By running commands in the CLI window of EMS

The table below outlines the information included in the alarm report.

| Parameter | Description |
|-----------|--|
| Severity | The severity of the fault, which can be: <ul style="list-style-type: none"> • Critical: Urgent alarm • Major: Major alarm • Minor: Minor alarm • Warning: Alarm information |
| Code | Alarm code |
| Group | The type of the fault, which can be: <ul style="list-style-type: none"> • Communication: Communication processes/procedures • Processing: Software/processing • Environmental: External equipment environment |

| Parameter | Description |
|----------------|---|
| | <ul style="list-style-type: none"> • QoS: Decreased service quality • Equipment: Equipment alarm • etc.: Remaining events and their status other than alarms |
| Location | The location of the fault |
| Probable Cause | The probable cause of the fault |
| Time | The time at which the fault was detected or released |
| Information | Any other information that helps understanding the probable cause |

Retrieving Alarm History

When an alarm is detected, the information related to the alarm is saved in a specific buffer while being reported to the EMS. Although the alarm can be cleared after some time, the information is not deleted from the buffer for future use.

Up to 100 alarms can be saved in the buffer. When the buffer is full, the oldest alarm is replaced by the new detected alarms. Therefore, the operator can check the history of latest 100 alarms.

Alarm Suppression

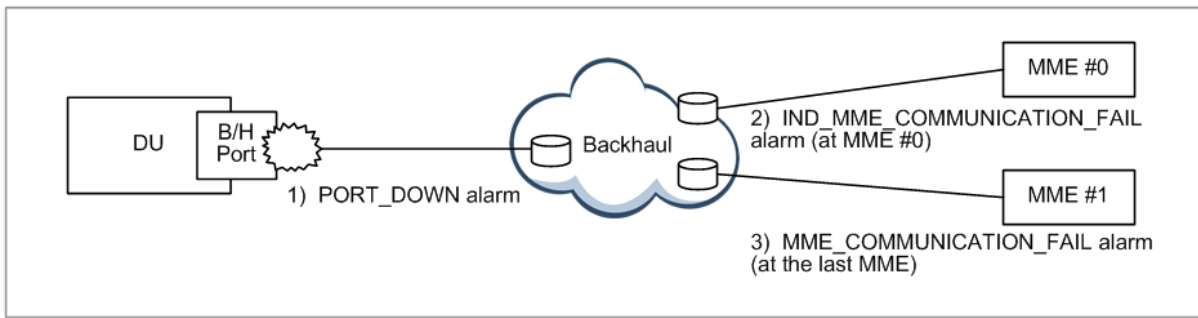
Alarm correlation refers to the relation between alarms. Sometimes, single hardware or software fault can result in the generation of multiple alarms. To reduce the alarm flooding to the EMS and make it easy for the operator to identify the root cause of those alarms, some alarms are suppressed by the base alarm. For example, when a board is pulled out, the BOARD_DELETION alarm is generated. With this alarm, the correlated alarms: COMMUNICATION_FAIL and FUNCTION_FAIL are also generated. These correlated alarms are suppressed by the BOARD_DELETION alarm, which is the root cause.

The COMMUNICATION_FAIL alarm and the same type of alarms are the end-to-end communication failure of application passed through the network layer. The system does not know all communication paths and failures in the network. However, for generating only one alarm due to its cause, these alarms are suppressed by the lower layer alarm, which is detected in the system. For example, when all backhaul ports are down due to the PORT_DOWN alarm, the MME_COMMUNICATION_FAIL alarm is suppressed. The COMMUNICATION_FAIL alarm between the DU and the RU is also suppressed when the CPRI_FAIL alarm is generated in all CPRI ports connected by one RU.

The figure below depicts a scenario of alarm suppression, where two MMEs are connected to DU through one backhaul port. When the backhaul port goes down:

- The PORT_DOWN alarm of the backhaul port results in the generation of MME_COMMUNICATION_FAIL alarms from two MMEs.
- The eNB reports only the PORT_DOWN alarm to the EMS based on the alarm correlation rule.
- IND_MME_COMMUNICATION_FAIL and MME_COMMUNICATION_FAIL alarms are suppressed by the

PORT_DOWN alarm, which is the root cause.



Synchronization with the EMS

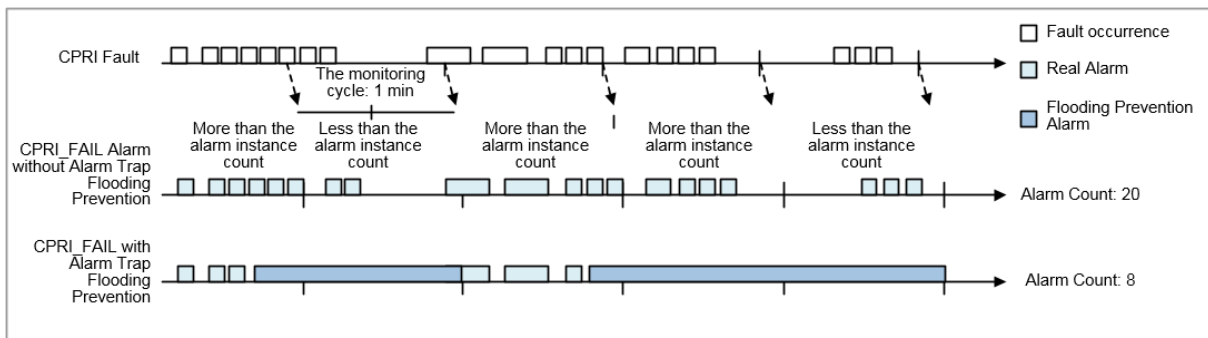
To prevent the alarm information mismatch between the NE and EMS, the alarm synchronization procedure is used. In this procedure, the NE reports the current active alarms to the EMS, which updates in the local database. The alarm synchronization procedure can be initiated in the following three situations:

- The EMS initiates the alarm synchronization if the sequence ID of the currently received alarm does not match.
- The EMS initiates the alarm synchronization if the EMS is restarted.
- The NE initiates the alarm synchronization if the NE or master board is restarted.

Alarm Trap Flooding Prevention

The alarm trap flooding indicates that a particular alarm is declared or cleared repeatedly for a short period. To prevent this, the eNB generates a Flooding Prevention Alarm if the configured monitoring period and the frequency threshold are met. The Flooding Prevention Alarm is not released until alarm flooding is resolved to reduce the alarm declare or clear trap count. These conditions can be set per board and alarm type.

The figure below depicts the alarm trap flooding prevention operation of the CPRI_FAIL alarm. In this scenario, the monitoring cycle is set to 1 minute and the alarm frequency is set to 4. In case with the alarm trap flooding prevention, the alarm count is reduced to 8 compared to the case without the alarm trap flooding prevention (20 alarms).



SYSTEM OPERATION

This section describes how to configure the feature in Samsung system and provides associated key parameters, counters, and KPIs.

How to Activate

This section provides the information that you need to configure the feature.

Preconditions

There are no specific preconditions to activate this feature.

Activation Procedure

Run **alarm-configuration/alarm-flooding-control** and flooding-switch to on to activate Alarm Trap Flooding Control.

Deactivation Procedure

Run **alarm-configuration/alarm-flooding-control** and flooding-switch to off to activate Alarm Trap Flooding Control.

Key Parameters

Activation/Deactivation Parameters

To activate or deactivate the feature, run the associated commands and set the key parameters.

Parameter Descriptions of **alarm-configuration/alarm-flooding-control**.

| Parameter | Description |
|-----------------|--|
| flooding-switch | This leaf indicates switch of alarm trap flooding control. |

Configuration Parameters

To configure the feature settings, run the associated commands and set the key parameters.

Parameter Descriptions of **alarm-configuration/alarm-flooding-control**.

| Parameter | Description |
|------------------|--|
| alarm-unit-type | This leaf indicates the unit type to which an alarm trap flooding control setting is applied. |
| alarm-type | This leaf indicates the alarm type to which an alarm trap flooding control setting is applied. |
| period | This leaf indicates unit time to check for alarm trap flooding. |
| flooding-count | This leaf indicates count of alarm outbreaks during unit time to check for alarm trap flooding. |
| unflooding-Count | This leaf indicates count of alarm outbreaks during unit time to check to clear alarm trap flooding. |

Counters and KPIs

There are no specific counters or Key Performance Indicators (KPIs) associated with this feature.

REFERENCE

- [1] 3GPP TS32.111-1 Telecommunication management; Fault Management; Part 1: 3G fault management requirements

OAM-FM0201, Alarm Parameter Configuration

INTRODUCTION

This feature enables the operator to retrieve and modify the parameters, such as severity, threshold, and inhibition, of each alarm. For external devices that are connected to the User Defined Alarm (UDA) ports, the operator can define the alarm types to reflect the fault status. The operator can configure the alarm name, severity, and control type for UDAs.

BENEFIT

With this feature, the operator can configure the alarm related parameters based on operator specific requirements.

DEPENDENCY

HW dependency: The maximum number of UDA ports is dependent on the system hardware.

LIMITATION

None

SYSTEM IMPACT

The implementation of this feature does not have any impact on the network.

FEATURE DESCRIPTION

The feature provides the following types of configuration:

- Alarm Severity
- Alarm Threshold
- Alarm Inhibition
- UDA

Alarm Severity Configuration

For an alarm, its default severity level can be modified by using operator command. However, the severity of threshold-related alarms cannot be changed. The possible levels for alarm severity are: critical, major, minor, and warning (optional).

Alarm Threshold Configuration

For some abnormal system behavior, alarms are detected or cleared according to the threshold. For example, when the CPU usage is over the defined threshold, the overload alarm is generated. For these alarms, the operator can define the threshold.

The operator can also define the threshold based on the severity levels for the same alarm by operator. For example, if the current measured value is over the minor level alarm declare threshold, minor level alarm is generated. When the situation becomes more severe, major or even critical level alarm is generated.

Alarm Inhibition Configuration

When a fault occurs, a proper alarm is generated and reported to the EMS. Based on the operator configuration, some alarms can be inhibited for reporting. If the alarm is inhibited, it is not detected and reported to the EMS even if the related fault occurs. The operator can retrieve the inhibition status for some alarms through operator command.

UDA Configuration

This function allows the operator to set or retrieve the alarm name, severity, equip status, and detect flag for each UDA port by using operator command. The UDA Rx is comprised of the external alarm detection ports. Each UDA Rx can be configured to detect an alarm whose signal level is high or low.

The UDA control configuration allows the operator to set or retrieve the control port name, equip status, and specified duration to control the external devices by operator command.

SYSTEM OPERATION

This section describes how to configure the feature in Samsung system and provides associated key parameters, counters, and KPIs.

How to Activate

This feature is enabled and the operator cannot disable.

Key Parameters

This section describes the key parameters for configuration of the feature.

Configuration Parameters

To configure the feature settings, run the associated commands and set the key parameters

Alarm severity configuration

Run alarm-severity to set alarm severity and run alarm-severity to retrieve alarm severity.

| Parameter | Description |
|-----------------|--|
| alarm-unit-type | This leaf indicates the unit type to which an alarm severity is applied. |
| alarm-type | This leaf indicates an alarm type. |
| severity | This leaf indicates the status severity of an alarm. |

Alarm threshold configuration

Run **resource-alarm-threshold** and set alarm threshold and run resource-alarm-threshold to retrieve alarm threshold.

| Parameter | Description |
|----------------------------------|--|
| alarm-unit-type | This leaf indicates the unit type to which an alarm threshold is applied. |
| alarm-type | This leaf indicates an alarm type. |
| critical-alarm-declare-threshold | Critical level threshold for alarm declare. critical-alarm-declare-threshold value must be greater than the value of major-alarm-declare-threshold. critical-alarm-declare-threshold value must be greater than or equal to the value of critical-alarm-clear-threshold. |
| major-alarm-declare-threshold | Major level threshold for alarm declare. major-alarm-declare-threshold value must be greater than the value of minor-alarm-declare-threshold. major-alarm-declare-threshold value must be greater than or equal to the value of major-alarm-clear-threshold. |
| minor-alarm-declare-threshold | Minor level threshold for alarm declare. minor-alarm-declare-threshold value must be greater than or equal to the value of minor-alarm-clear-threshold. |
| critical-alarm-clear-threshold | Critical level threshold for alarm clear. critical-alarm-clear-threshold value must be greater than the value of major-alarm-clear-threshold. critical-alarm-declare-threshold value must be greater than or equal to the value of critical-alarm-clear-threshold. |
| major-alarm-clear-threshold | Major level threshold for alarm clear. major-alarm-clear-threshold value must be greater than the value of minor-alarm-clear-threshold. major-alarm-declare-threshold value must be greater than or equal to the value of major-alarm-clear-threshold. |
| minor-alarm-clear-threshold | Minor level threshold for alarm clear. minor-alarm-declare-threshold value must be greater than or equal to the value of minor-alarm-clear-threshold. |

Alarm inhibition configuration

Run **digital-unit-alarm-inhibition** and set alarm inhibition and run digital-unit-alarm-inhibition to retrieve alarm inhibition.

[MACRO INDOOR DIST/IBS INDOOR]

| Parameter | Description |
|-----------------|--|
| alarm-unit-type | This leaf indicates the unit type to which an alarm inhibition is applied. |
| alarm-unit-id | This leaf indicates the unit ID to which an alarm inhibition is applied. |
| alarm-type | This leaf indicates an alarm type that can be inhibited. |

[EXT CMCE]

| Parameter | Description |
|-----------------|--|
| alarm-unit-type | This leaf indicates the unit type to which an alarm inhibition is applied. |
| alarm-unit-id | This leaf indicates the unit ID to which an alarm inhibition is applied. |
| alarm-side | This leaf indicates the unit side to which an alarm inhibition is applied. |
| alarm-type | This leaf indicates an alarm type that can be inhibited. |

RRH Alarm inhibition configuration

Run [MACRO INDOOR DIST] **radio-unit-alarm-inhibition** and set RRH alarm inhibition and run **radio-unit-alarm-inhibition** to retrieve RRH alarm inhibition.

| Parameter | Description |
|---------------------------------|--|
| alarm-unit-type | This leaf indicates the unit type to which an alarm inhibition is applied. |
| connected-digital-unit-board-id | This leaf indicates the unit ID of the digital unit, which is connected to the radio unit. |
| connected-digital-unit-port-id | This leaf indicates the port ID of the digital unit, which is connected to the radio unit. |
| cascade-radio-unit-id | This leaf indicates the cascade ID of the radio unit. |
| alarm-type | This leaf indicates the alarm type whose inhibit is applied. |

User Defined Alarms (UDA)

Run [ENB] **uda-port/rx-port** and set UDA and run **/uda-port/rx-port** to retrieve UDA.

| Parameter | Description |
|----------------|---|
| uda-rx-port-id | This object contains leaves related to the UDA RX port |
| detection-flag | This leaf indicates the criteria for detecting alarm, as follows: <ul style="list-style-type: none"> normal-open: The alarm occurs when the input signal through the UDA RX port is low (0). The alarm is cleared when the signal is high (1). normal-close: The alarm occurs when the input signal through the UDA RX port is high (1). The alarm is cleared when the signal is low (0). |
| alarm-name | This leaf indicates the name of the detected alarm |
| severity | This leaf indicates the severity of detected alarm. The alarm severity can be critical, major, minor, or warning (optional). |

Counters and KPIs

There are no specific counters or Key Performance Indicators (KPIs) associated with this feature.

REFERENCE

None

OAM-FM0301, Fault Isolation and Recovery

INTRODUCTION

This feature provides the functionalities to isolate the faulty resources for preventing their effect on the other in-service resources, and performs recovery actions.



The recovery actions are Samsung specific, which depends on the environment and severity of the fault, on the hardware and software capability, and on the current NE configuration.

BENEFIT

This feature provides to maximize the service availability and minimize the management cost.

DEPENDENCY

Others: If hardware is not available to receive hardware reset signal from master board the recovery action cannot be provided by using the reset signal.

LIMITATION

The recovery action on the PROCESS DOWN is applied to some blocks, which has impact on LTE call service or major functionality of the NE when process disabled.

SYSTEM IMPACT

The implementation of this feature does not have any impact on the network.

FEATURE DESCRIPTION

This feature can be decomposed to the following two sub features:

- Fault isolation
- Fault recovery

Fault Isolation

Once a fault has been detected, the eNB evaluates the effect of the fault on the services. The eNB isolates and removes from service the faulty resource so that it cannot disturb other working resources. For this, if an alarm is generated by a failure, such as RRH function failure or clock failure, affecting the call service, the RF output is blocked to avoid disturbing other services. The RF path is disabled if all carriers in the path are off due to the alarm or cell lock command.

Fault Recovery

After reporting alarm to the EMS, the eNB autonomously takes recovery actions to resume service for the faulty resource before user's manual troubleshooting. The eNB supports the following types of remedy action to recover faulty resources:

- Communication Failure with RU
- RU Path Shutdown/Enable
- DSP Keep-alive Failure
- System Frame Number (SFN) Compensation
- Communication Failure with sub-processor
- Function Failure of sub-processor
- Process Disabled
- Memory Full
- Function Failure of GPSR module
- Communication Failure with RU

If the Digital Unit (DU) cannot communicate with the Radio Unit (RU) for some specified time, the RU is reset for self-recovery.

RU Path Shutdown/Enable

If the major alarm is generated due to the RU path failure, the path is shutdown. The shutdown path is enabled again for self-recovery.

DSP Keep-alive Failure

The master board exchanges keep alive messages with the DSP. If the board does not receive the keep-alive response from any core in the DSP, the DSP is reset for self-recovery.

SOC Keep-alive Failure

The master board exchanges keep alive messages with the SOC. If the board does not receive the keep-alive response from the SOC, the SOC is restarted for self-recovery.

System Frame Number (SFN) Compensation

If the SFN is found to be different from the estimation based on Time of Day (TOD) during monitoring, the SFN compensation is performed for self-recovery.

Communication Failure with sub-processor

If the master board cannot communicate with the slave board for some specified time, the slave board is restarted to recover it.

Function Failure of sub-processor

If the alarm is caused by a failure of the board, the board is restarted to recover it.

Process Disabled

The processor board monitors the processing blocks. If the process in the specific software block that service outage causes is disabled, then the corresponding slave processor board is reset for self-recovery.

Memory Full

If memory usage is more than the specified threshold value, some temporary files are removed to free space.

Function Failure of GPSR module

The master processor board monitors whether the GPSR module is in function failure status. If the GPSR module is retained for specific times function failure status, then the GPSR module is reset for self-recovery.

SYSTEM OPERATION

This section describes how to configure the feature in Samsung system and provides associated key parameters, counters, and KPIs.

How to Activate

This feature is enabled and the operator cannot disable.

Key Parameters

There are no specific parameters associated with this feature.

Counters and KPIs

There are no specific counters or Key Performance Indicators (KPIs) associated with this feature.

REFERENCE

None

OAM-FM0303, System Safeguard from Very High Temperature

INTRODUCTION

The system has many principal elements including CPU, Ethernet Switch, sRIO Switch, DSP, and SoC/Modem. Each principal element has a temperature range that allows the elements to operate normally.

Ambient temperature can go up because of the site environment or failure of an air conditioner. As a result, the temperature of elements in the system exceeds the operating temperature, and this can lead to system fault.

When the system is developed, thermal analysis is performed targeting all principal elements of the system. Based on the thermal analysis result, the temperature-sensitive elements are chosen, and are used as temperature detecting targets.

This feature detects the temperatures of the targets periodically. If an element is out of normal operating temperature range, then this feature safeguards the system through protective action such as power reset or power off, until the element is under the normal temperature range. Therefore, this feature aims to prevent the system fault by protecting the principal elements of the system from damaging due to overheating.

BENEFIT

This feature prevents the breakdown of the system at very high temperature.

DEPENDENCY

HW dependency: This feature is supported in BBU, IBS, and CPRI Switch.

LIMITATION

None

SYSTEM IMPACT

The implementation of this feature does not have any impact on the network.

FEATURE DESCRIPTION

The feature provides the following two methods to reduce the calorific power:

- Power Reset
- Power Off

Power Reset

This function resets the board power by turning off-and-on the power. As the power is not supplied during the power off period, the calorific power is decreased during this time. The board restarts automatically after the scheduled time.

Power Off

This function maintains the power shutdown state. If the operator turns off or on the circuit breaker or equips the board, the board restarts as the power is on and reset is released. For the channel card, the operator can turn on the power remotely by the power reset command. When the power of main board is turned off, the main board periodically tries to turn on the power for every 0.1 s.

The table below outlines the airflow change by the fan state and the blockage in the air filter. The table also shows the details regarding the trace of temperature, protection method, service influence, and onsite actions.

| Condition | Normal Fan | Abnormal Fan |
|-------------------------------------|---|---|
| When the air filter is not blocked. | State: Air flow is normal <ul style="list-style-type: none"> Temperature is in the normal operating-temperature range. Safeguard action is not required. | State: Air flow is blocked <ul style="list-style-type: none"> Temperature rises rapidly if operators do not remedy. Emergency action is required. |
| When the air filter is blocked. | State: Air flow is weak Temperature rises gradually if operators do not remedy. Protection Method Power reset Service Influence Normal Service can be maintained when the temperature becomes lower. Onsite Action At the site, operators should remove the matter that causes the temperature rise. For instance, dust in the air filter should be cleared. | Protection Method Power off Service Influence Service off is maintained even though the temperature becomes lower. Onsite Action At the site, operators should turn off and on the circuit breaker after replacing the fan. |

The junction temperature of a part is less influenced due to the calorific power of the other cards or elements, as the airflow is weaker. The junction temperature of a part is highly influenced due to the calorific value of the power consumption of a part.

When the airflow is weak, the junction temperature of a part is less influenced due to the calorific value of other cards or elements. However, the junction temperature of a certain part can be highly influenced due to the calorific value of the power consumption of the part.

Use Case of Safeguard Feature

In normal operation, the CPU temperature of the main and channel cards can rise by malfunction of the air conditioner, blockage in the air filter, and fan failure. If the CPU temperature of the main card increases continuously and if the CPU temperature exceeds the threshold, the TEMPERATURE_HIGH major alarm

occurs. If the CPU temperature increases more and reaches to the system failure level, the system reports the `TEMPERATURE_HIGH` critical alarm to (somewhere) and operates the safeguard feature.

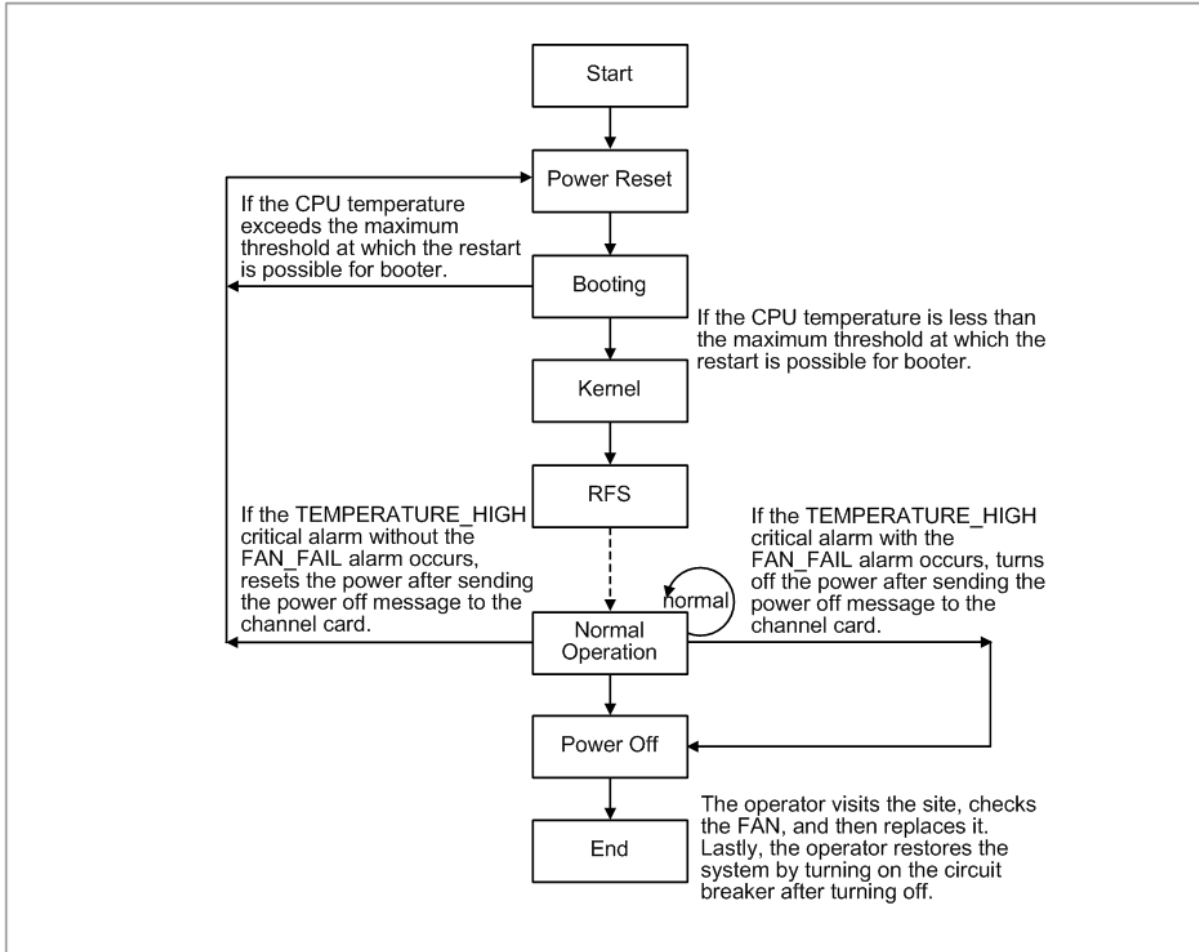
Feature Operations

When the fan is operating normally, the temperature increases slowly. After the channel card power is turned off, the system performs the protective action through the Power Reset method. This removes the cause of temperature rise and normalizes the system without operator's intervention. When the fan is operating abnormally, the temperature increases continuously even though the system performs the protective action through the Power Reset method. Therefore, turn off the system power to protect the system from being heated due to very high temperature. The operator can turn off or on the circuit breaker to recover the system through the fan management or by replacing the fan.

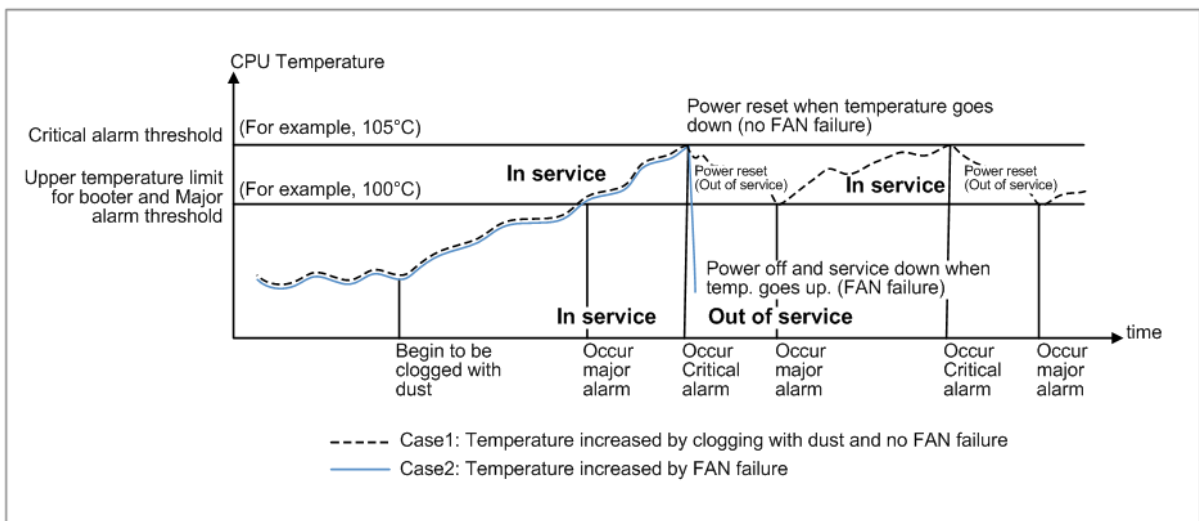
Even if the main card operates normally, when the CPU temperature of the channel card becomes high and reaches the part breakage level, the system performs the protective action. The system uses the channel card Power Off method for protection due to `POWER FAIL` alarm.

Safeguard Operations for a Main Card

The figure below depicts the state diagram of the main card.



The figure below depicts a graphical view of the Power Reset and Power Off methods in case of CPU temperature increase by dust clogging and fan failure.



The detailed operations of the main card that are indicated in the figure above are as follows:

- The temperature increases if the air filter is clogged by the dust.
- If the CPU temperature of main card exceeds the TEMPERATURE_HIGH major alarm threshold (for example, 100 degrees), the TEMPERATURE_HIGH major alarm of CPU occurs.
- If the CPU temperature of main card exceeds the TEMPERATURE_HIGH critical alarm threshold value, the TEMPERATURE_HIGH critical alarm of CPU occurs. This alarm threshold should be below the parts breakage level-for example, 105 degrees.

DU (main card) performs the following fault isolation and recovery functions according to the occurred alarm:

- RU: Turn off the RF of all RUs:
 - Turn off the Tx amplifier per carrier and disable the path if all the carriers are turned off in the path. For example, in case of single carrier in Single-DU, RF path is disabled. In case of single carrier in Multi-DU, the carrier on RF path is turned off.
 - In CPRI structure, if the power of the channel card is turned off, the RU itself turns off the RF due to Loss of Signal (LOS) fault.
- Channel card: Turn off the power of all channel cards:
 - The halt message (the request message for power off) is delivered to the channel card through IPC. While in considering the power off failure of the channel card, when POWER_FAIL fault in the channel card does not occur within 5 seconds, the main card should send the halt message again. The message can be sent a maximum of three times.

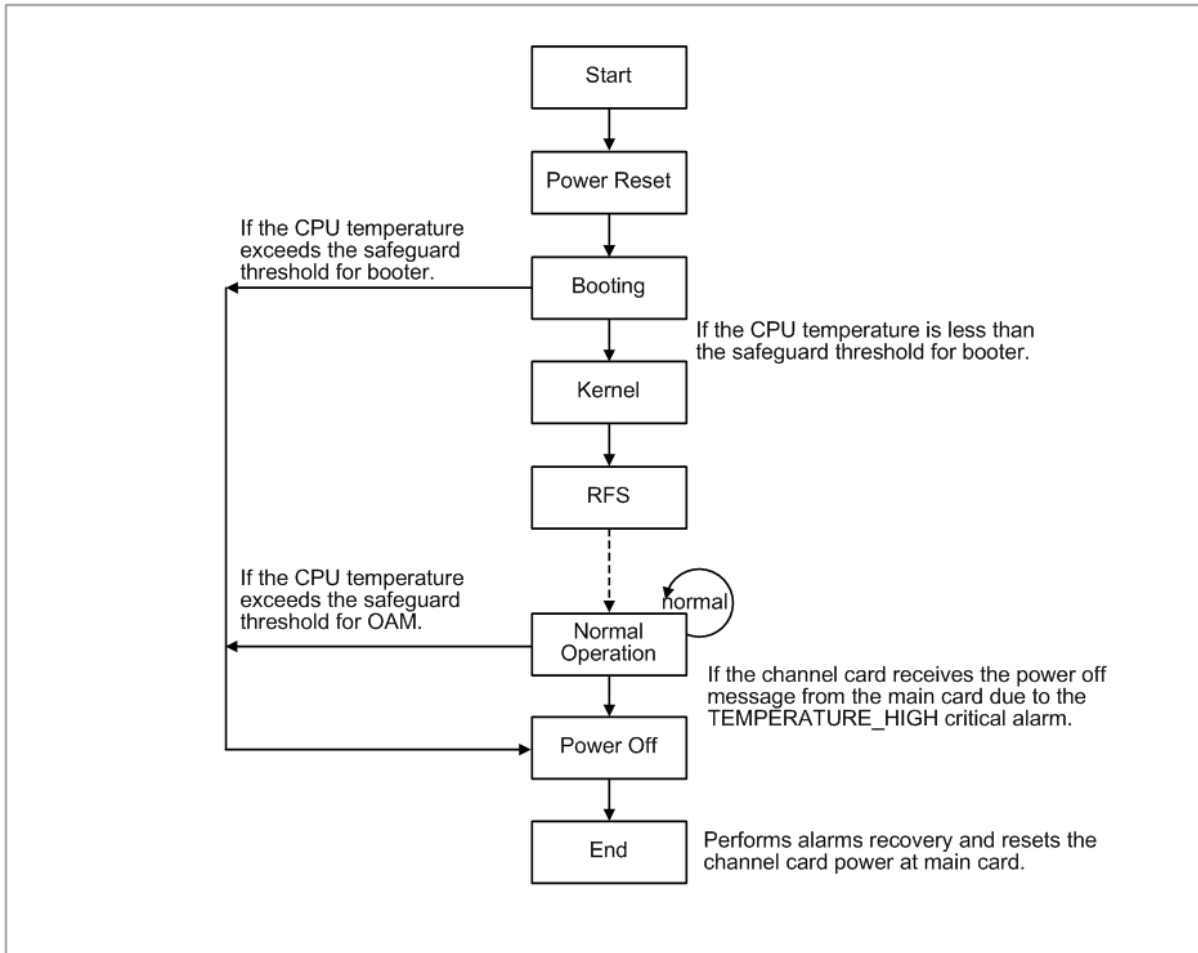
As Case2 indicated in the figure above, when the FAN_FAIL alarm occurs, the main card turns off the power by itself to protect the system after storing the mortem. However in Case1, the FAN_FAIL alarm does not occur and the main card resets the power by itself after storing the log.

If the power is reset, power reset circuit is released automatically after a while, and the main card is restarted.

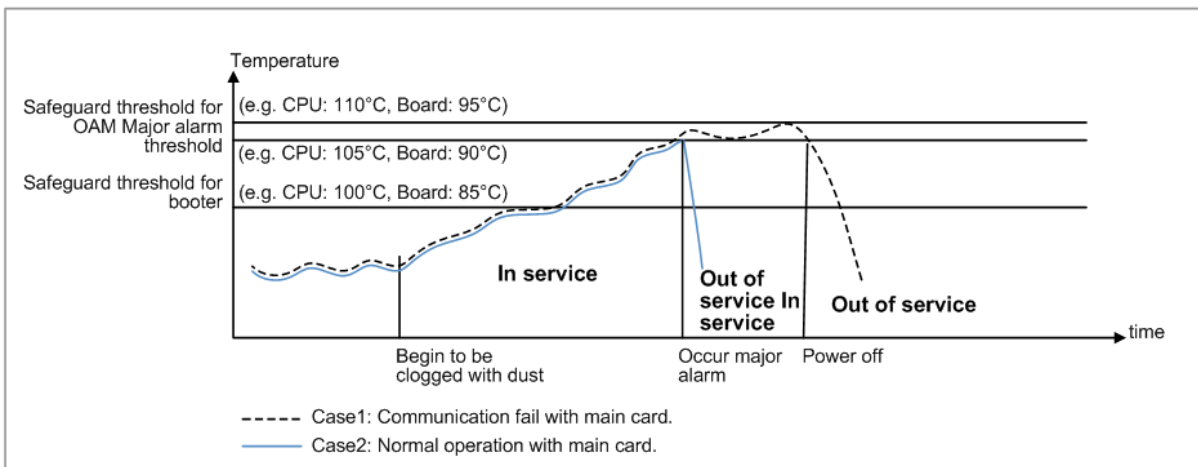
In the booting stage, the main card checks the temperature of its CPU. If the temperature of CPU exceeds the maximum threshold, which enables system restart (for example, 100 degrees), the main card resets the power by itself. When the CPU temperature is less than the maximum threshold, the main card proceeds to the next step after resetting the channel card power and releasing the reset.

Safeguard Operations for a Channel Card

The figure below depicts the state diagram of the channel card when its temperature increases during normal operation.



The figure below depicts a graphical view of the safeguard operation when the temperature of the channel card increases.



The detailed operations of the channel card indicated in the figure above are as follows:

As Case 2 indicated in figure above, if the channel card that provides the CPU

temperature information exceeds the threshold of a high temperature major alarm (for example, 105°C), then the TEMPERATURE_HIGH major alarm of the CPU occurs. When the channel card that cannot provide the CPU temperature information exceeds the threshold of a high temperature major alarm (for example, 90°C), then the TEMPERATURE_HIGH major alarm of the board is declared. When the temperature of one of the additional elements (of something) such as DSP or FPGA exceeds the threshold of high temperature major alarm (for example, 105°C), then the TEMPERATURE_HIGH major alarm of the board is declared.

DU (main card) performs the following fault isolation and recovery functions according to the declared alarm:

- RU: Turn off the RF of the RU that is connected with the channel card. To do this, turn off the Tx or disable the Tx path.
 - Turn off the Tx amplifier per carrier and disable the path if all carriers are turned off in the path. For example, for single-DU/single carrier, disable the path and for multi-DU/single carrier, turn off the Tx and disable the path when all carriers in the path are turned off.
 - In CPRI structure, if the channel card is turned off, the RU itself turns off the RF due to Loss of Signal (LOS) fault.
- Channel card: Turn off the power of all channel cards:
 - The halt message, request message for power off is delivered to the channel card through IPC. While in considering the power off failure of the channel card, when POWER_FAIL fault in the channel card does not occur within 5 seconds, the main card should send the halt message again. The message can be sent maximum of three times.

If the main card resets the channel card after a specific period for cooling, the initialization of the channel card proceeds.

In the booting stage, the channel card checks the temperature of its CPU. If the temperature exceeds the protection threshold of the booter (for example, 100°C), the power of the channel card is turned off by itself. If the board types are not able to measure the temperature of CPU, then the board temperature is used instead of the CPU temperature. For certain boards, the temperature of additional elements is used.

If the channel card receives the halt message from the main card during normal operation, the power of the channel card is turned off.

For protective action, the channel card checks the temperature of its CPU. If the temperature exceeds the protection threshold of OAM (for example, 110°C), the power of the channel card is turned off by itself. When the CPU temperature cannot be measured on the board, use the temperature of the board itself. The temperatures of additional elements are used in case of the specific board.



In case of Inter-BBU Switch (IBS), the main card and sub card of IBS operate using the same algorithm with the main card and channel card of DU. However, IBS does not see FAN status, and does not turn off the RF of RU.

SYSTEM OPERATION

This section describes how to configure the feature in Samsung system and provides associated key parameters, counters, and KPIs.

How to Activate

This feature runs automatically, and it cannot be disabled.

Key Parameters

There are no specific activation or deactivation parameters associated with this feature.

Configuration Parameters

Tables below outline the booter and OAM parameters set by the software internal operation. The operator cannot modify these parameters.

Main Card

| Environmental Variable | Default and Range for Booter | Comment |
|---|---|--|
| The maximum threshold at which restart is possible. | <ul style="list-style-type: none"> • CPU 100°C • LUC: <ul style="list-style-type: none"> ○ DSP (S8400 #1, 2): 100°C ○ FPGA: 97°C | <ul style="list-style-type: none"> • Safeguard action at booter: Power reset. • Valid range: default \pm 15 |

Channel Card

| Environmental Variable | Default and Range for Booter | Default and Range for OAM | Comment |
|------------------------|--|---|---|
| Safeguard threshold | <ul style="list-style-type: none"> • CPU 100°C • LCC: <ul style="list-style-type: none"> ○ DSP (S8400 #1, 2): 100°C ○ FPGA: 97°C • LCB3: <ul style="list-style-type: none"> ○ PBA: 85°C ○ CPU: 95°C | <ul style="list-style-type: none"> • CPU 105°C • LCC <ul style="list-style-type: none"> ○ DSP (S8400 #1, 2): 105°C ○ FPGA: 100°C • LCB3: <ul style="list-style-type: none"> ○ PBA: 90°C ○ CPU: 105°C | <ul style="list-style-type: none"> • If it is possible to monitor the CPU temperature: <ul style="list-style-type: none"> ○ Safeguard action at booter: Power off ○ Safeguard action at OAM: Power off ○ OAM creates the environmental variable and its value is same as the default value of booter. ○ Booter valid range = Booter default \pm 10 • In case of board with S8400, the temperature of DSP and FPGA is monitored. |
| | 100°C | 105°C | <ul style="list-style-type: none"> • In case of LUA1 in channel card mode. • If it is possible to monitor the CPU temperature: |

| Environmental Variable | Default and Range for Booter | Default and Range for OAM | Comment |
|------------------------|------------------------------|---------------------------|---|
| | | | <ul style="list-style-type: none"> ○ Safeguard action at booter: Power reset ○ Safeguard action at OAM: Power reset ○ OAM creates the environmental variable and its value is same as the default value of booter. ○ Booter valid range = Booter default \pm 10 |
| | 85°C | 90°C | <ul style="list-style-type: none"> • If it is unable to monitor the CPU temperature. ○ Safeguard action at booter: Power off. ○ Safeguard action at OAM: Power off. ○ OAM creates the environmental variable and its value is same as the default value of booter. ○ Booter valid range = Booter default \pm 10 |

Counters and KPIs

There are no specific counters or Key Performance Indicators (KPIs) associated with this feature.

REFERENCE

None

Chapter 5 Hardware

OAM-HW0010, Frame Timing Offset Configuration

INTRODUCTION

LTE frame normally aligns to GPS reference signal. This feature is enable to change LTE frame timing alignment.

BENEFIT

The operator can change LTE frame alignment according to frame timing offset that is configured.

DEPENDENCY

None

LIMITATION

If the operator configures frame timing offset, the eNB or modem card automatically restarts. Frame timing offset is applied on the modem card in the eNB after restarting of the modem card.

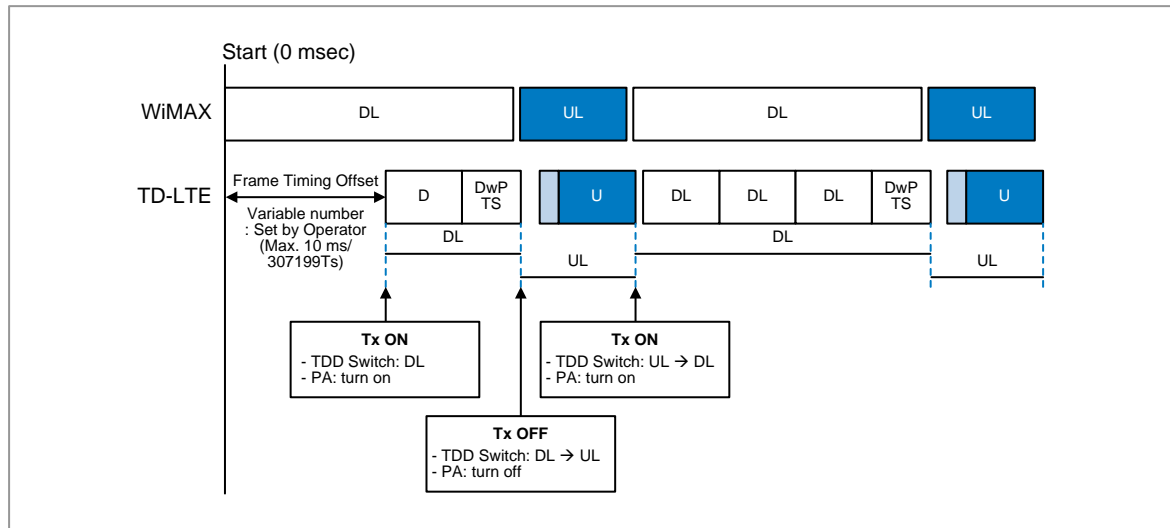
SYSTEM IMPACT

The implementation of this feature does not have any impact on the network.

FEATURE DESCRIPTION

This feature provides the functionalities to configure frame timing offset to adjust LTE frame alignment in the eNB.

The operator can configure frame timing offset as cell creation parameter or change this value of channel card on operator specific purpose (for example, WiMAX coexistence) through CLI command.



SYSTEM OPERATION

This section describes how to configure the feature in Samsung system and provides associated key parameters, counters, and KPIs.

How to Activate

This section provides the information that you need to configure the feature.

Preconditions

All cells on Channel Card or eNB must be in "cell lock" status before changing Frame Timing Offset value.

Activation Procedure

To activate this feature, do the following:

- Set the key parameter of managed-element hardware-management digital-unit digital-unit-entries dsp-miscellaneous-info frame-timing-offset-configuration.

| Parameter | Value |
|---------------------|-------------|
| frame-timing-offset | 5 to 307199 |

Deactivation Procedure

Set the key parameter of managed-element hardware-management digital-unit digital-unit-entries dsp-miscellaneous-info frame-timing-offset-configuration.

| Parameter | Value |
|---------------------|-------|
| frame-timing-offset | 0 |

Key Parameters

This section describes the key parameters for activation, deactivation, and configuration of the feature.

Activation/Deactivation Parameters

To activate or deactivate the feature, run the associated commands and set the key parameters

| Parameter | Description |
|---------------------|--|
| frame-timing-offset | Frame timing offset value applied on DSP |

Configuration Parameters

Same as "Activation/Deactivation Parameters."

Counters and KPIs

There are no specific counters or Key Performance Indicators (KPIs) associated with this feature.

REFERENCE

None

Chapter 6 Inventory Management

OAM-IM0101, Inventory Management

INTRODUCTION

This feature provides the functionality of managing inventory information of hardware units including processing boards, UCR, RU, ALD, EAIU, and FCM.

The inventory information can be displayed by CLI command. After system initialization, the NE uploads the inventory information file in XML format to the EMS. In that file, all the inventory information for the hardware units in the NE is included.

While the system is running, if some inventory information for any hardware unit is changed, for example, firmware update for RU board is finished, the inventory data change is notified to the EMS by inventory change notification. The EMS updates its local inventory database according to this change notification.

BENEFIT

The operator can use this feature to maintain the latest inventory information of hardware units.

DEPENDENCY

None

LIMITATION

In case of optic module inventory, this feature depends on the optic module compliant to hardware specification (SFF-84721 and SFF-8436).

FEATURE DESCRIPTION

This feature can be decomposed into the following two sub features:

- Retrieval of inventory data
- Inventory data reporting

Retrieval of Inventory Data

Retrieving of inventory data sub feature provides the functionality of displaying of inventory data for hardware units requested using by CLI commands "**RTRV-XXX- INVT**" or **retrieve-XXX-inventory** (XXX can become SW or PRCFW or

EXTFW or ` such as GPS or RRH)". After getting request, OAM software in the NE collects the inventory information for the requested boards and sends back the result to user interface for displaying.

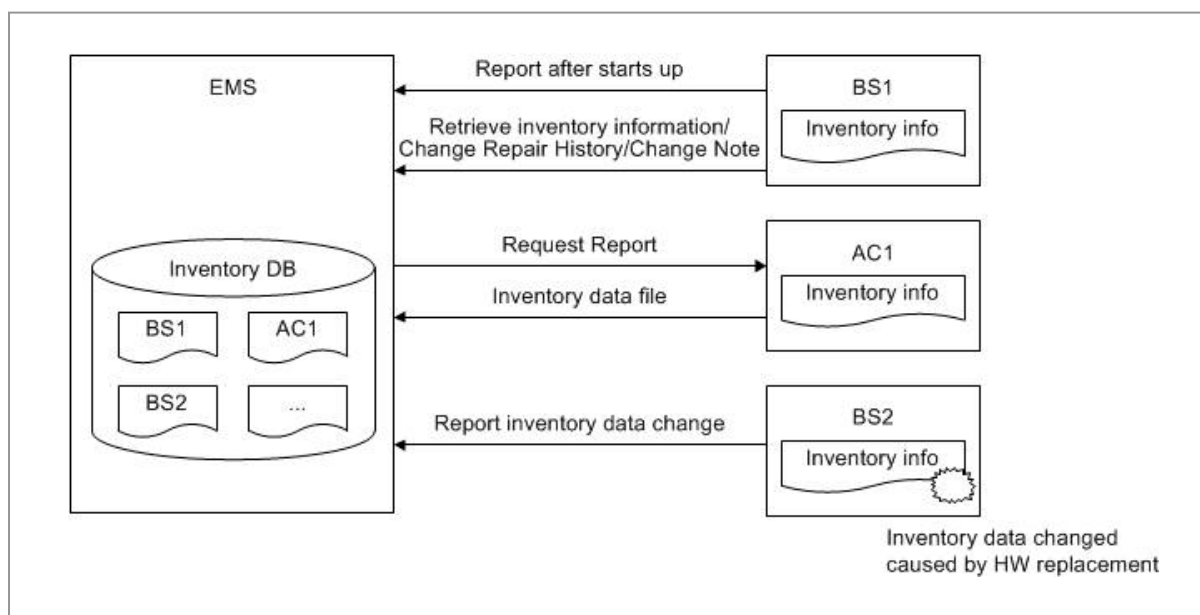
The inventory information includes hardware version information, serial number, firmware version information, manufacturing information, and so on. For the meaning of each inventory item, see 3GPP TS32.690 for detail. In case of optic module inventory, only optic module that complies with a hardware specification (SFF-84721 and SFF-8436) can be retrieved.

Inventory Data Reporting

Inventory data reporting sub feature provides the functionality of reporting NE inventory data information to the EMS. There are three cases that the NE reports the inventory information to the EMS:

- System initialization complete
- Report request by CLI command "UPLD-INVT"
- Inventory data change

The figure below depicts inventory data reporting architecture.



After system is initialized, the OAM software collects the inventory information for all the related hardware units and creates an inventory file in XML format. Then, the OAM software uploads this XML file to the EMS by (S)FTP. The EMS saves the inventory information in its local inventory database.

The operator can also request the upload of inventory file to the EMS. When the request is received, the OAM software uploads the created XML file to the EMS by (S)FTP.

While the system is running, the inventory information can be changed. For example, a new hardware board is added to system due to improving system capacity or when a faulty hardware board is detected, a new board replaces it. The changed inventory data is sent to the EMS by inventory data change notification.

After getting this inventory data change notification, the EMS updates its local inventory database according to the information included in the notification.

SYSTEM OPERATION

This section describes how to configure the feature in Samsung system and provides associated key parameters, counters, and KPIs.

How to Activate

This feature runs automatically, and it cannot be disabled.

Key Parameters

There are no specific parameters associated with this feature.

Counters and KPIs

There are no specific counters or Key Performance Indicators (KPIs) associated with this feature

REFERENCE

[1] 3GPP TS32.690 Telecommunication management; Inventory Management (IM); Requirements

[2] 3GPP TS32.692 Telecommunication management; Inventory Management (IM) network resources Integration Reference Point (IRP); Network Resource Model (NRM)

Chapter 7 Management Interface

OAM-IF0101, EMS Interface

INTRODUCTION

This feature provides the communication protocols used between the NE and EMS for operation and maintenance.

The EMS interface consists of the following communication protocols:

- NETCONF: Network Configuration Protocol
- FTP/sFTP: File Transfer Protocol/secure File Transfer Protocol
- UDP/Secure UDP: User Datagram Protocol/Secure User Datagram Protocol

BENEFIT

The user can manage network element remotely via the EMS interface without onsite visit.

DEPENDENCY

None

LIMITATION

None

SYSTEM IMPACT

The implementation of this feature does not have any impact on the network.

FEATURE DESCRIPTION

The EMS interface provides the communication protocols used between the NE and EMS for operation and maintenance.

The following standard protocols are used in the EMS interface:

- NETCONF: Network Configuration Protocol (NETCONF) is the protocol used to manage and monitor the NE from the EMS. The EMS can change and retrieve the NE information according to the YANG data model. The NE can also send notification to the EMS to notify the status change of the system or report the alarms generated in the system.

- **FTP/sFTP:** File Transfer Protocol (FTP) is a standard network protocol, which is used to transfer data files between the EMS and NE. Operation and maintenance related file such as the configuration data file, performance measurement file and inventory information file are transferred from the NE to the EMS via FTP. In the sFTP protocol, security features are provided for the file transfer.
- **UDP/Secure UDP:** User Data Protocol (UDP) is used for authentication message between the EMS and NE in boot-up time. Secure UDP provides security by encrypting payload message.

SYSTEM OPERATION

This section describes how to configure the feature in Samsung system and provides associated key parameters, counters, and KPIs.

How to Activate

This feature is enabled and the operator cannot disable.

Key Parameters

There are no specific parameters associated with this feature.

Counters and KPIs

There are no specific counters or Key Performance Indicators (KPIs) associated with this feature.

REFERENCE

None

Chapter 8 Performance Management

OAM-PM0101, Performance Data Management

INTRODUCTION

This feature includes the collection of data, which is used to verify the physical and logical configuration of the network and to find potential problems as early as possible. The measurement result is produced by the NE, and can be administered by the EMS. This feature includes the following tasks:

- Managing the process of collecting performance measurements
- Generating the performance measurement results
- Providing a local storage for measurement results in the NE
- Reporting the measurement results from the NE to the EMS

BENEFIT

This feature provides an efficient method for collecting performance measurement about various resources and services. This information can be used to monitor the network performance and optimize the network.

DEPENDENCY

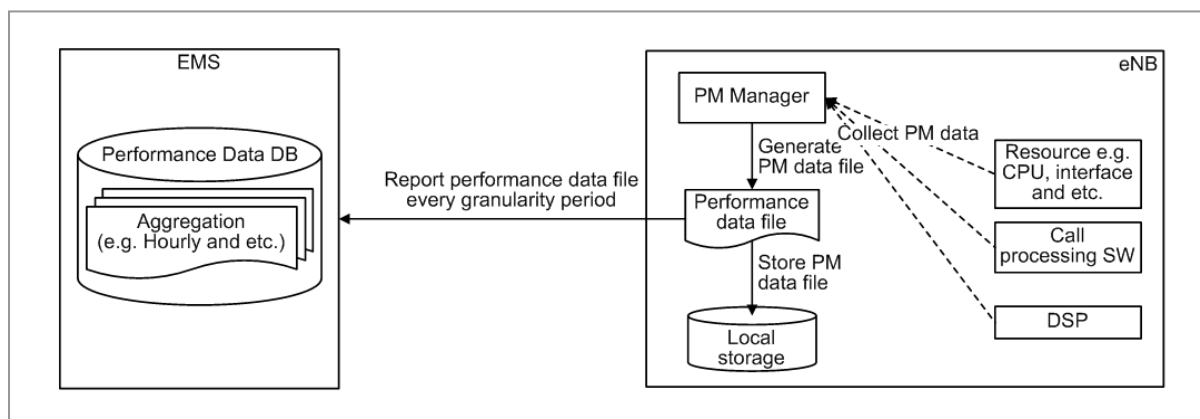
None

LIMITATION

None

FEATURE DESCRIPTION

The NE provides performance management functionalities including administration of measurement jobs, generating and reporting of the measurement results and storing the measurement results in local storage as shown in the figure below.



Administering the measurement job

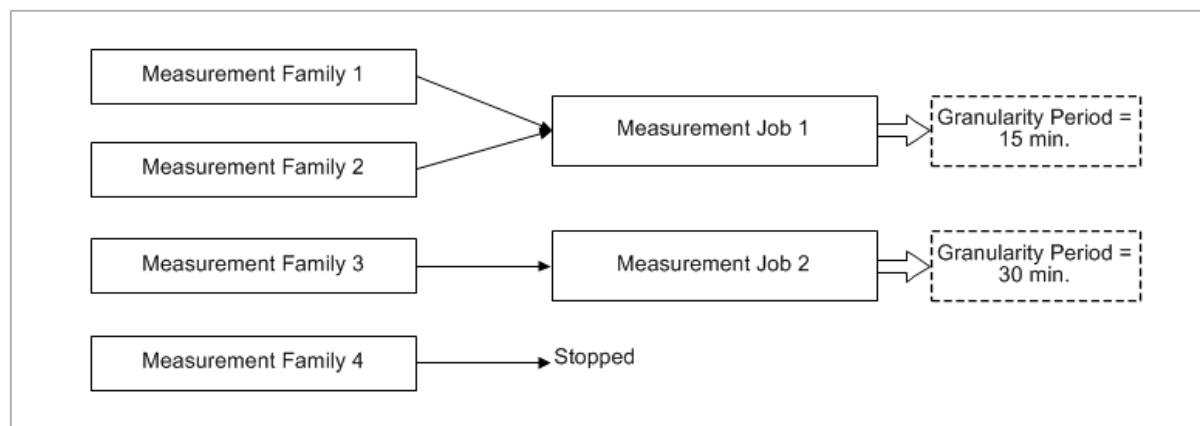
The operator can create and modify measurement jobs in the EMS GUI. Up to five measurement jobs can be defined for each NE. Measurement jobs are administered on the level of measurement family, which is a collection of related measurement types.

A specific measurement family can be included in only one measurement job.

The following parameters are required:

- Active/suspended: Performs the collection of measurement job or stops the collection of measurement job.
- Granularity period: 15 minutes, 30 minutes or 1 hour
- Start time (for example, 2013-08-30 09:15); "Immediately" can be selected.
- Stop time (for example, 2013-08-30 09:30); "Forever" can be selected.

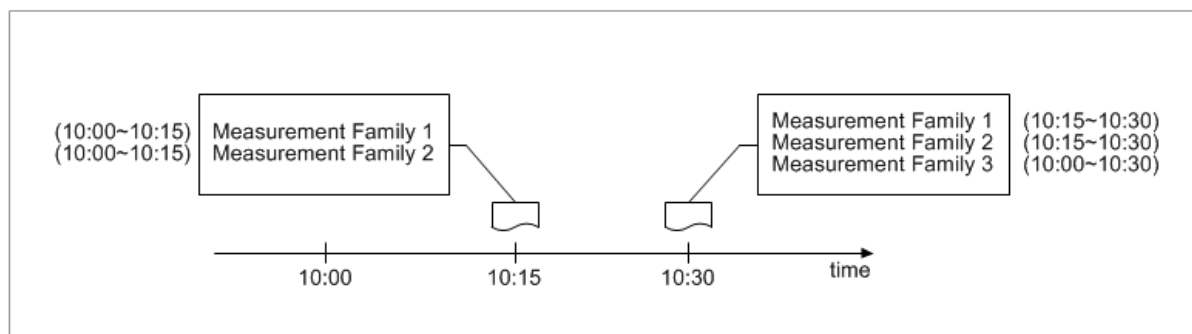
The measurement job administration is depicted in the figure below.



Generating the measurement result

Each measurement job collects the measurement result periodically. The collection period is called the granularity of the measurement job. At the end of the granularity period, a measurement result is generated, which includes the result of the measurement data for one or several measurement jobs.

The measurement result generation is depicted in the figure below.



Storing the Measurement Results

The measurement result files can be saved in the NE locally for a period, which is configurable by the operator (maximum 8 hours) through the parameter `disk-usage-threshold` (performance-management/pm-file-backup-information).

However, if the disk does not have enough free space to store the result files, those files are deleted. The deletion is performed if the disk usage ratio is over some specified threshold. That threshold value can also be configured by the operator through the parameter `backup-time-threshold` (performance-management/pm-file-backup-information).

Reporting the Measurement Results

The measurement results generated by the NE in Comma Separated Value (CSV) format are transferred to the EMS using File Transfer Protocol (FTP or sFTP). They can be used by the system operators for further evaluation. IP address of server to collect measurement results file can be configured by the operator.

SYSTEM OPERATION

This section describes how to configure the feature in Samsung system and provides associated key parameters, counters, and KPIs.

How to Activate

This section provides the information that you need to configure the feature.

Preconditions

This feature is executed by EMS GUI.

Activation Procedure

To activate this feature, do the following:

- Run `pm-file-backup-information`

Deactivation Procedure

To deactivate this feature, do the following:

- Run `pm-file-backup-information`

Key Parameters

This section describes the key parameters for activation, deactivation, and configuration of the feature.

Activation/Deactivation Parameters

To activate or deactivate the feature, run the associated commands and set the key parameters.

Parameter Descriptions of measurement-job-family

| Parameter | Description |
|--------------|---|
| family-id | This parameter is the Family ID |
| job-id | This parameter is the Measurement Job Id |
| family-state | This parameter specifies the state of the specified family. <ul style="list-style-type: none"> • enable-state: Statistics data is collected for the specified family. • disable-state: Statistics data is not collected for the specified family. |

Parameter Descriptions of measurement-job-schedule

| Parameter | Description |
|--------------------|---|
| job-id | This parameter is the Measurement Job Id |
| job-state | This parameter specifies the state of Measurement Job. <ul style="list-style-type: none"> • active-job: Statistics data is collected for Measurement Job. • suspend-job: Statistics data is not collected for Measurement Job |
| granularity-period | This parameter is the Granularity Period of Measurement Job. |

Configuration Parameters

To configure the feature settings, run the associated commands and set the key parameters

Parameter Descriptions of pm-file-backup-information

| Parameter | Description |
|-----------------------|---|
| disk-usage-threshold | This parameter is the disk usage ratio threshold. If the current disk usage ratio exceeds the disk-usage-threshold value, all statistics backup files are deleted. |
| backup-time-threshold | This parameter is the time (h) for saving the statistics backup files. The statistics backup file is saved in the NE as much as the backup-time-threshold value before being deleted. |
| backup-mode | This parameter is the measurement file backup mode. It is determined where to backup. <ul style="list-style-type: none"> • flash: It runs the backup only Storage. |

Parameter Descriptions of pm-file-server-configuration

| Parameter | Description |
|--------------|---|
| ipv4-address | This is IPv4 address of PM Server. It is used when the management-ip-version is IPv4. |
| ipv6-address | This is IPv6 address of PM Server. It is used when the management-ip-version is IPv6. |

Counters and KPIs

There are no specific counters or Key Performance Indicators (KPIs) associated with this feature.

REFERENCE

[1] 3GPP TS 32.401 Performance Management (PM); Concept and requirements

OAM-PM0201, Real time Performance Data Management

INTRODUCTION

In addition to regular collection of performance measurement data (for example, 15 minutes period), the operator can monitor the selected performance counters in real time.

BENEFIT

This feature provides a functionality to monitor the selected performance measurements in real time.

DEPENDENCY

HW dependency

- This feature can only be activated by the EMS.

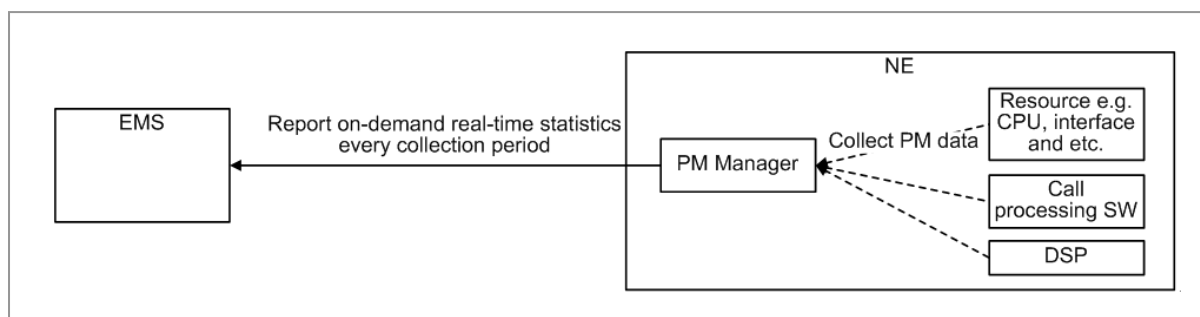
LIMITATION

The maximum number of selected performance measurements per NE is 6, which can be activated simultaneously.

FEATURE DESCRIPTION

This feature provides a functionality to monitor the selected performance measurements in real time through the EMS GUI. When the function is activated by the EMS, the NE collects and transfers performance measurement data every collection period for the collection duration as depicted in the figure below.

The collection period is a report interval of a specific performance measurement. The collection duration is a total time for monitoring a specific performance measurement.



The operator can monitor up to six performance measurements per NE. The monitoring result is displayed on the EMS.

When monitoring performance measurements, the operator should input all indexes of the specific performance measurement that the operator wants to monitor in real time. For example, up to six performance measurements per one NE can be monitored simultaneously as follows:

- Input the indexes as
 - 1) Shelf ID = 0 and Slot ID = 1 for Resource Family
 - and 2) Shelf ID = 0 and Slot ID = 2 for Resource Family: Two performance measurements for Resource Family are monitored.
- Input the index as Cell ID = 3 for Air MAC Packet Family
: One performance measurement for Air MAC Packet Family is monitored.
- Input the indexes as
 - 1) Cell ID = 2 and QCI = 9 for PDCP Packet Family
 - and 2) Cell ID = 2 and QCI = 1 for PDCP Packet Family
 - and 3) Cell ID = 4 and QCI = 9 for PDCP Packet Family: Three performance measurements of PDCP Packet Family are monitored.

The six performance measurements can be configured with different or same collection period and collection duration. The collection period can be configured as 30 s or 60 s. The collection duration can be configured as 5 minutes, 15 minutes, 30 minutes, or 1 hour.

Some measurements related to KPI such as handover success rate cannot be configured for real time collection.

Figures below depict EMS GUI example for the real time performance data management.

The operator can configure indexes, collection period and collection duration to monitor a specific performance measurement.

PM On Demand Registration

TARGET
eNB_10911

Statistics Family

- Resource Management
 - Resource
 - PSU Power Consumption
 - Rectifier Power Consumption
 - DU Power Consumption
- Packet Statistics
- RRC
- E-RAB
- HO EUTRAN
- HO UTRAN
- CSL
- MRO
- eICIC
- VoLTE
- GTP
- SRB
- DRB
- RRU
- S1SIG
- Paging
- Quality Protection

Parameter Index (LLOC)

Shelfid: 0

Slotid: 0

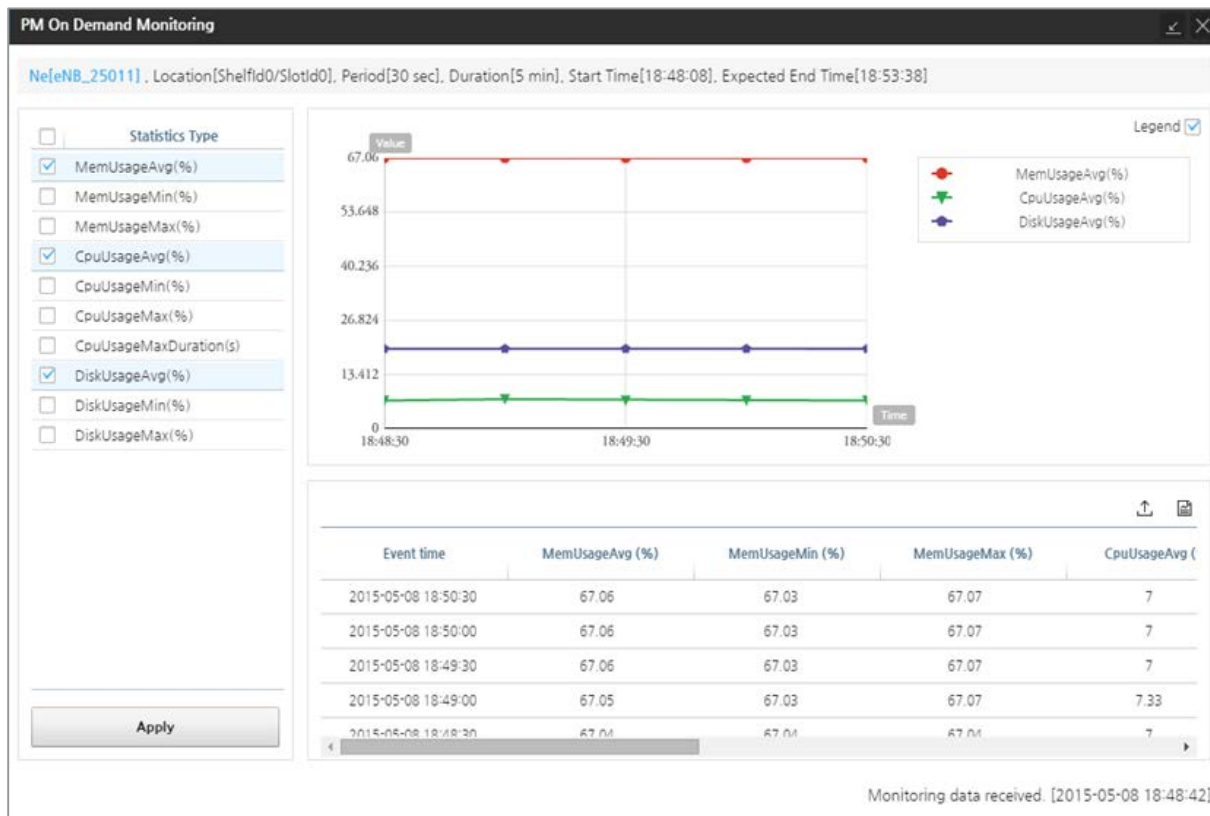
Condition

Period: 30 sec

Duration: 5 min

Threshold Register Cancel

The operator can monitor the result of the performance data in table and graph formats:



SYSTEM OPERATION

This section describes how to configure the feature in Samsung system and provides associated key parameters, counters, and KPIs.

How to Activate

This section provides the information that you need to configure the feature.

Preconditions

There are no specific preconditions to activate this feature.

Activation Procedure

To activate this feature, do the following:

- *Select PERFORMANCE | On Demand from the EMS menu bar.*
- *In the On Demand Window that appears, select the TARGET and click Register button (+).*
- *Configure the parameters and click Register button.*

| Parameter | Description |
|------------------------------|--|
| Statistics Family | This parameter selects the measurement family to register. |
| Parameter Index | The index specifies the source location of measurement family. |
| Period (collection interval) | The collection interval can be specified 30 seconds and 60 seconds |

| Parameter | Description |
|-----------|--|
| Duration | The collection duration can be specified 5 minutes, 15 minutes, 30 minutes and 60 minutes. |

- *Select Start button.*

Deactivation Procedure

To activate this feature, do the following:

- *Select Stop button.*
- *Select Delete button in the On Demand Window.*

Key Parameters

This section describes the key parameters for activation, deactivation, and configuration of the feature.

Configuration Parameters

To configure the feature settings, run the associated commands and set the key parameters.

Parameter Descriptions of PERFORMANCE | On Demand (EMS GUI).

| Parameter | Description |
|------------------------------|--|
| Statistics Family | This parameter selects the measurement family to register. |
| Parameter Index | The index specifies the source location of measurement family. |
| Period (collection interval) | The collection interval can be specified 30 seconds and 60 seconds |
| Duration | The collection duration can be specified 5 minutes, 15 minutes, 30 minutes and 60 minutes. |

Counters and KPIs

There are no specific counters or Key Performance Indicators (KPIs) associated with this feature.

REFERENCE

- [1] NGMN Recommendation on SON and O & M Requirements

Chapter 9 Security Management

OAM-SM0501, Secure Management Protocol

INTRODUCTION

For the management interface between the NE and EMS/LMT, this feature provides the following secure communication protocols:

- Simple Network Management Protocol version 3 (SNMPv3)
- secure File Transfer Protocol (sFTP)
- Secure Shell (SSH) for text-based LMT
- Hypertext Transfer Protocol over SSL (HTTPs) for web-based LMT

BENEFIT

This feature provides secure communication protocols between the NE and EMS/LMT.

DEPENDENCY

None

LIMITATION

None

SYSTEM IMPACT

The implementation of this feature does not have any impact on the network.

FEATURE DESCRIPTION

This feature provides the secure communication protocol between the EMS or LMT and NE. The following secure communication protocols can be provided.

Simple Network Management Protocol version 3

The NE uses SNMPv3 protocol to communicate with the EMS securely. SNMPv3 is enhanced with more secure environment from previous version of SNMP, such as security model and security policy.

SSH File Transfer Protocol

The NE uses sFTP protocol to transmit the files for system operation and maintenance such as software package, statistics files, and configuration data file. The file is encrypted using SSL and then transmitted in Ciphertext format.

Secure Shell) for text-based LMT

The LMT user can access to the NE using SSH, which can be replaced with Telnet. SSH provides network services securely over unsecured network for LMT user.

HTTP over SSL

The web-based LMT uses HTTPS to transmit the data securely. Data transmitted over HTTPS is secured using Secure Sockets Layer (SSL).

SYSTEM OPERATION

This section describes how to configure the feature in Samsung system and provides associated key parameters, counters, and KPIs.

How to Activate

This feature is enabled and the operator cannot disable.

Key Parameters

There are no specific parameters associated with this feature.

Counters and KPIs

There are no specific counters or Key Performance Indicators (KPIs) associated with this feature.

REFERENCE

- [1] RFC 1157 A Simple Network Management Protocol
- [2] RFC 3411 Architecture for SNMP Management Frameworks
- [3] RFC 3414 User-based Security Model (USM) for version 3 of the Simple Network Management Protocol (SNMPv3)
- [4] RFC4252 The Secure Shell (SSH) Authentication Protocol

Chapter 10 Service

OAM-SV0102, CBRS Support

INTRODUCTION

This feature provides procedures for the CBSD-DP-SAS interface.

BENEFIT

This feature enables wireless service via a new Citizens Broadband Radio Service (CBRS) for shared wireless broadband use of the 3550-3700 MHz band (3.5 GHz Band).

DEPENDENCY

- HW dependency: CBRS RU that has full band IBW for CBRS band 3550 to 3700 MHz 150 M
- Related Radio Technology: E-UTRAN (LTE)
- Interfaces & Protocols: REST over HTTP/HTTPs

LIMITATION

In the state of CBRD registered to the SAS, if there is a change in the serialNo or the GroupParam included in the CBSD Registration Request message, the deregistration and after registration procedures are not performed automatically. The re-registration procedure is done via command manually.

SYSTEM IMPACT

The implementation of this feature does not have any impact on the network.

FEATURE DESCRIPTION

CBRS, co-used by private sector for shared wireless broadband use of the 3550-3700 MHz, defines frequency users as 3-tiers according to Authority and interference protection level. The three tiers are:

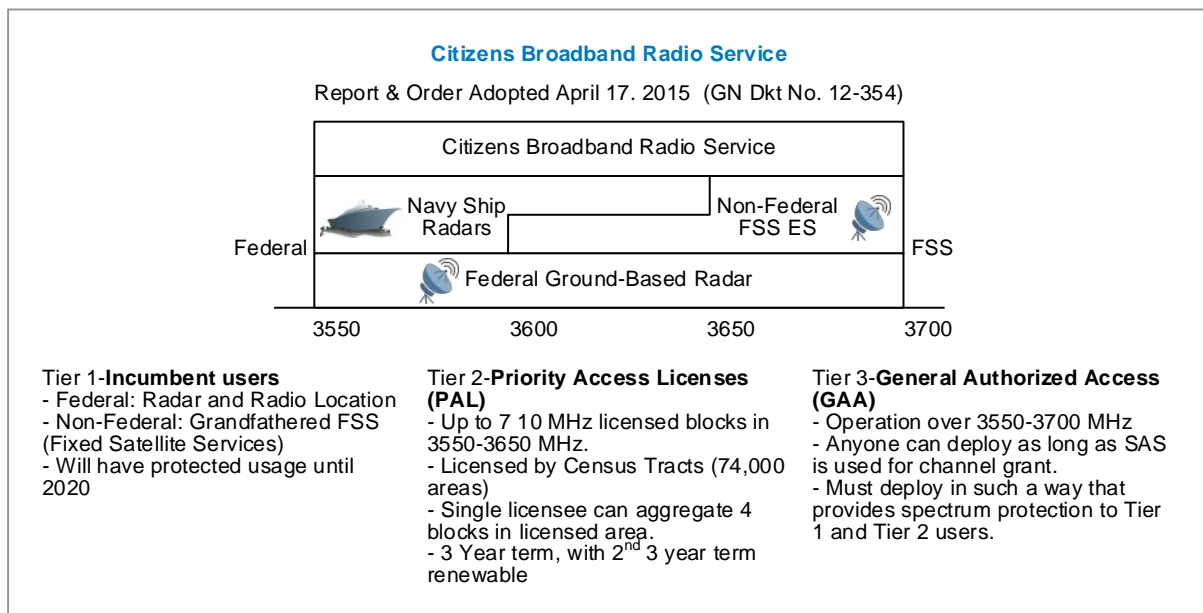
- Incumbent Access
- Priority Access
- General Authorized Access

Incumbent Access users include authorized federal and grandfathered Fixed Satellite Service users currently operating in the 3.5 GHz Band. These users are

protected from harmful interference from Priority Access and General Authorized Access users.

The Priority Access tier consists of Priority Access Licenses (PALs) that are assigned using competitive bidding within the 3550-3650 MHz portion of the band. Each PAL is defined as a non-renewable authorization to use a 10 MHz channel in a single census tract for three-years. Up to seven PALs may be assigned in any census tract with up to four PALs going to any single applicant. Applicants may acquire up to two-consecutive PAL terms in any license area during the first auction.

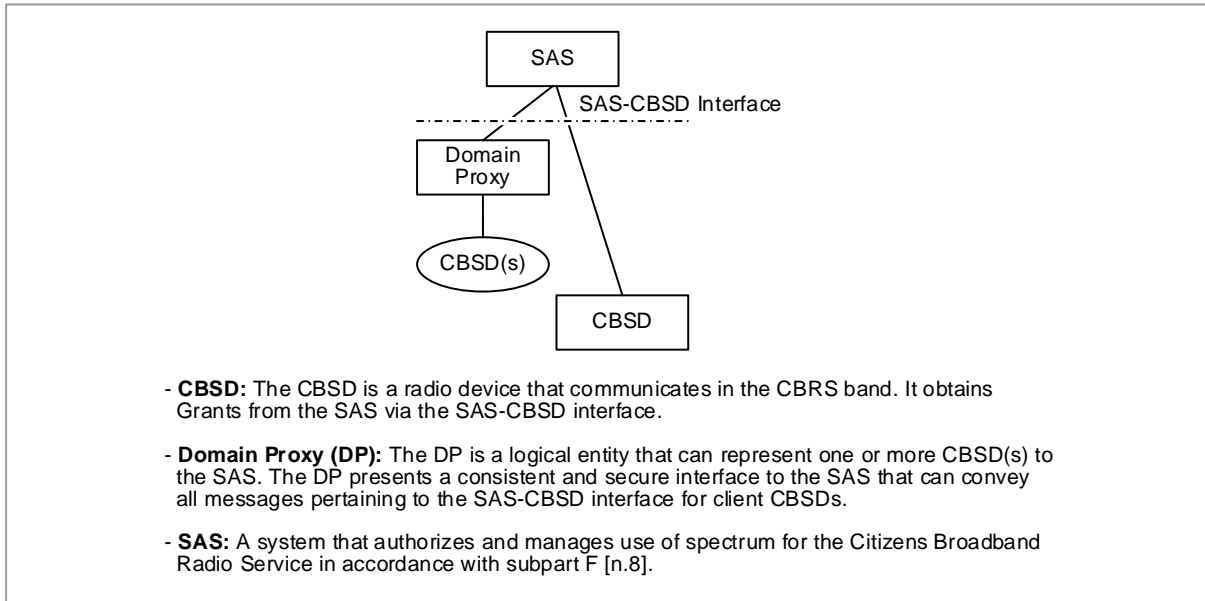
The General Authorized Access tier is licensed-by-rule to permit open, flexible access to the band for the widest possible group of potential users. General Authorized Access users are permitted to use any portion of the 3550-3700 MHz band not assigned to a higher tier user and may also operate opportunistically on unused Priority Access channels. The Spectrum Access System (SAS) and the Environmental Sensing System (ESC) enable protections for existing and priority access users of the spectrum. The SAS enables protected spectrum, therefore short term ownership of spectrum is enabled. The ESC enables the coastal usage of spectrum when naval ships are not present. Without the ESC, 100 MHz of spectrum is not available for ~40 miles inland along the coast, impacting significant amount of populated areas, such as NYC, Miami, and Boston.



To inform SAS of the wireless environment of adjacent cells, CBRS RRH should support the measurement report function that needs to measure and inform the received power. BBU requests the RU only if all cells of the RU are not in service. BBU is able to request RU to scan the RSSI with requested measurement band unit (5 M or 10 M), RU should measure the RSSI by operating as Rx mode when receiving corresponding Request message.

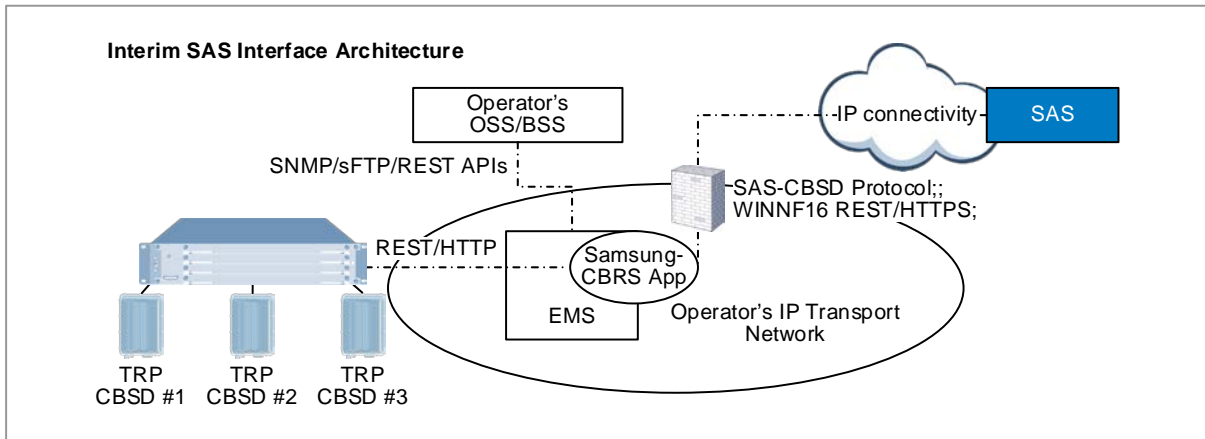
WINNF SAS Interface Architecture

The figure below depicts an architecture of the WINNF SAS interface.

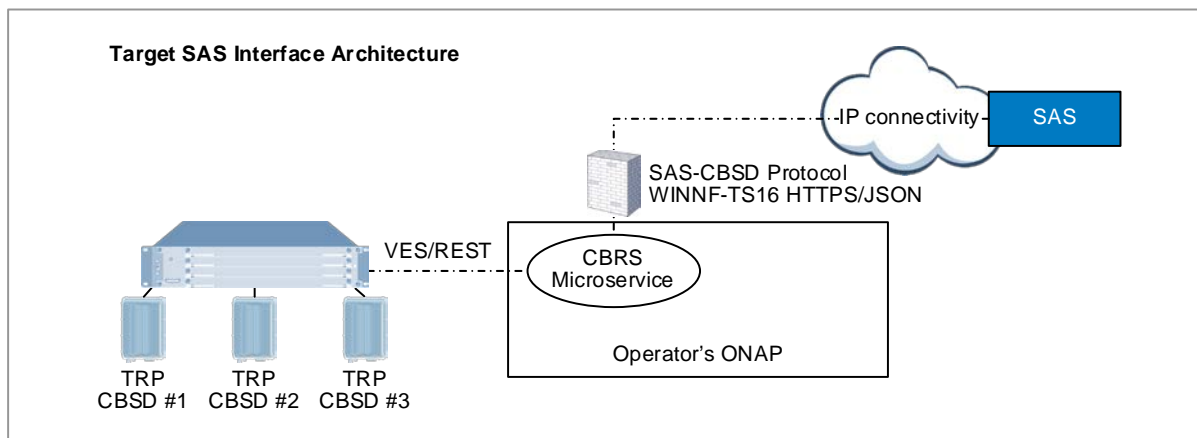


SAS Interface Architecture

The figure below depicts an interim architecture of the SAS interface.



The figure below depicts the architecture of the target SAS interface.



CBSD SAS Message Protocol

CBSD Registration

The CBSD performs mutual authentication with the SAS and provides its device identity and user identity information. If the user and the CBSD are successfully authenticated, the CBSD registers with the SAS and provides its CBSD parameters to the SAS including CBSD category, location information, optional group membership, and other device specific information. If the CBSD Registration procedure succeeds, the SAS informs the CBSD that it has successfully completed registration. At this point, the CBSD can initiate requests for spectrum.

CBSD Spectrum Inquiry

The CBSD may initiate this procedure any time after successfully registering with the SAS. The Spectrum Inquiry procedure is invoked prior to sending the Grant Request object if the CBSD requests the SAS to indicate specific information on spectrum availability. The key steps in this procedure are:

- The CBSD initiates a spectrum inquiry request to the SAS. The CBSD includes the frequency ranges for which the CBSD seeks information. The CBSD may request information for one or more frequency ranges.
- The SAS performs an assessment of spectrum availability for the frequency ranges indicated in the request and provides the CBSD information on available spectrum in a spectrum inquiry response.

CBSD Grant Procedure

The CBSD initiates this procedure to request spectrum access managed by a SAS. Precondition of this procedure is that CBSD Registration has been completed successfully. Prior to initiating a Grant request, the CBSD determines the operational parameters used in the Grant request. These operational parameters include the frequency range and maximum EIRP the CBSD wants to use for operation. The determination of the specific operational parameters indicated in the Grant request depends on CBSD capabilities, current operation, and configuration. The key steps in this procedure are:

- The CBSD initiates a Grant request, including CBSD maximum EIRP and the desired frequency range, to the SAS.

- The SAS determines if the desired frequency range is acceptable. If so, the request is granted and the SAS responds to the CBSD that the Grant request is accepted and includes a Grant identifier, a Grant expiration time, and a heartbeat interval. The CBSD cannot use the spectrum (that is, activate its radio transmitter) until successfully completing the CBSD Heartbeat procedure.
- If the SAS determines the desired operational parameters are not available for the CBSD to use, it responds to the CBSD that the Grant request is denied. As part of this response, the SAS may include a recommendation on new operational parameters for the CBSD to use. The CBSD can issue a new Grant request using the SAS recommended operational parameters.

CBSD Heartbeat

The CBSD initiates this procedure to inform the SAS that the CBSD is requesting authorization to use or continue to use granted spectrum. It also allows the SAS to suspend or terminate the Grant. If the Grant is suspended or terminated, the SAS can recommend different operational parameters to the CBSD. The key steps in this procedure are:

- The CBSD Heartbeat procedure is governed by a timer, which is set by the SAS. The CBSD initiates this procedure any time prior to the expiration of this timer.
- The CBSD initiates the CBSD Heartbeat procedure by sending a heartbeat request to the SAS.
- The Heartbeat procedure informs the CBSD whether it can begin using or continue using the granted spectrum, suspend its use of the granted spectrum, or terminate its use of the granted spectrum. Subsequent CBSD behavior is based on the information the SAS includes in its responses. Using the Heartbeat procedure, the SAS can suspend or terminate the CBSD radio transmission by suspending or revoking permission to use specific Grant spectrum.

CBSD Grant Relinquishment

The CBSD initiates this procedure to relinquish a Grant. The precondition is that the CBSD has been granted spectrum access.

The key steps in this procedure are:

- If the CBSD no longer needs access to the Grant prior to its expiration, the CBSD initiates the Grant Relinquishment procedure.
- If the CBSD initiates the Grant Relinquishment procedure, the SAS revokes the Grant of the CBSD. The CBSD can initiate a new CBSD Grant procedure if the CBSD still requires access to the spectrum as specified in 6.5. The CBSD can choose not to invoke the Grant Relinquishment procedure for an expired Grant.

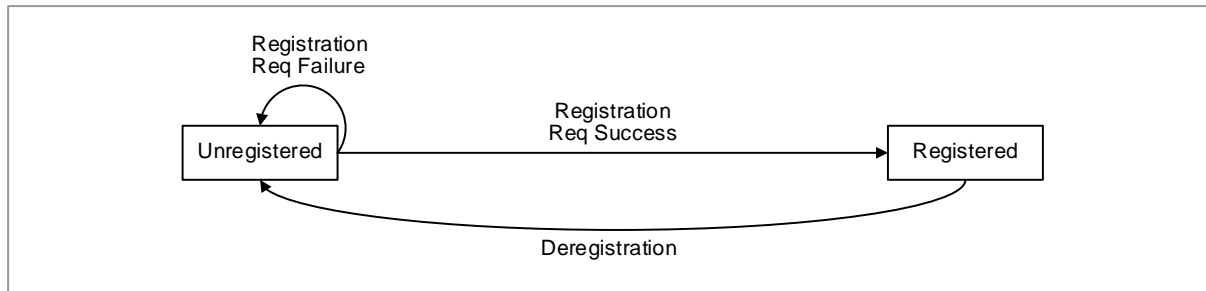
CBSD Deregistration

When the CBSD determines that it should deregister from the SAS, it ceases transmission associated with any Grants and then requests deregistration to the SAS. The CBSD then cancels any Grants that are still allocated to it. The SAS

marks the CBSD as Unregistered, removes any existing Grants, and responds to CBSD.

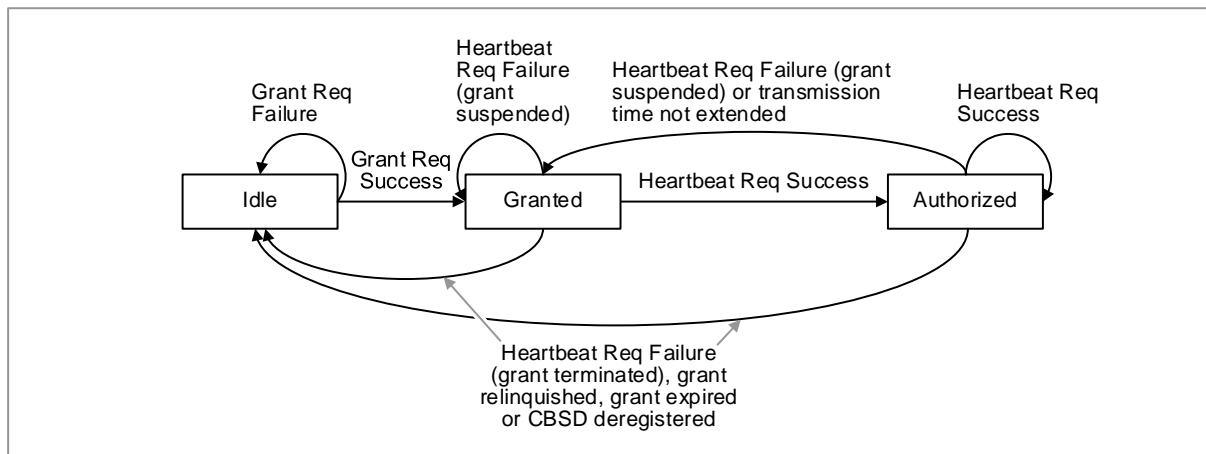
CBSD States and State Transitions

The figure below depicts the procedure of CBSD state transitions.



CBSD Registration State Diagram

The figure below depicts a block diagram of CBSD grant state.



SYSTEM OPERATION

This section describes how to configure the feature in Samsung system and provides associated key parameters, counters, and KPIs.

How to Activate

This section provides the information that you need to configure the feature.

Preconditions

Ensure that cbrs-mode should be set to cbrs-on when new eNB is added.

Activation Procedure

There is no specific activation procedure associated with this feature.

Deactivation Procedure

There is no specific deactivation procedure associated with this feature.

Key Parameters

This section describes the key parameters for configuration of the feature.

Configuration Parameters

To configure the feature settings, run the associated commands and set the key parameters

Parameter Descriptions of **[ENB] enb-function/cbrs** (these parameters define the cbrs parameters for the NE)

| Parameter | Description |
|------------------------|---|
| measure-unit | This leaf indicates the measurement unit of RSSI Measurement for all cbsd and it is configured by operator. |
| user-id | This leaf indicates the system-wide unique identifier for all cbsd. |
| max-heartbeat-interval | This leaf indicates the configured heartbeat interval between two heartbeat requests. |

Parameter Descriptions of **[ENB] eutran-cell-fdd-tdd/cbrs-info** (these parameters define CBRS related information of the cell)

| Parameter | Description |
|---------------------------------|---|
| frequency-select-rssi-threshold | This leaf indicates the rssi threshold to be used for frequency selection for grant procedure. |
| max-eirp-threshold | This leaf indicates the maximum eirp threshold to be used as an operating parameters for CBRS procedures. |
| max-heartbeat-interval | This leaf indicates the configured heartbeat interval between two heartbeat requests. |

Parameter Descriptions of **[ENB] eutran-cell-fdd-tdd/cbrs-info/preferred-earfcn-info** (these parameters define list of preferred earfcn for the cell, priority is earfcn with minimum RSSIO)

| Parameter | Description |
|------------------|---|
| preferred-earfcn | Indicates the preferred earfcn, to be provided priority during CBRS frequency selection procedure |

Parameter Descriptions of **[ENB] radio-unit-info/cbrs** (these parameters define the CBRS information related to the RU, and required for CBRS-SAS interworking)

| Parameter | Description |
|---------------|---|
| fcc-id | This leaf indicates the FCC certification identifier of the cbsd. |
| call-sign | This leaf indicates the device identifier for the cbsd provided by the FCC. |
| cbsd-category | This leaf indicates the device category of the cbsd in conformance with CBRS federal regulations. |

Parameter Descriptions of **[ENB] radio-unit-info/cbrs/group-info** (these parameters define list, which provides the information of the group the cbsd belongs to)

| Parameter | Description |
|------------|--|
| group-id | This list provides the information of the group the cbsd belongs to. |
| group-type | This leaf specifies the type of group for this group ID. |

Counters and KPIs

There are no specific counters or Key Performance Indicators (KPIs) associated with this feature.

REFERENCE

[1] FCC part96 Rule and Order;

Report and Order and Second Further Notice of Proposed Rulemaking:
<https://ecfsapi.fcc.gov/file/60001044294.pdf>

Order on Reconsideration and Second Report and Order:
<https://ecfsapi.fcc.gov/file/60001755029.pdf>

[2] WINNF-15-S-0112, V1.3.0: CBRS Operational and Functional Requirements.

[3] WINNF-TS-0016, V1.2.1: SAS to CBSD Technical Specification.

[4] WINNF-TS-0012, V1.4.1: CBRS Operational and Functional Requirements.

[5] WINNF-17-SSC-0002-V2.0.2-WInnForum Registered CBRS Air Interfaces and Measurements

Chapter 11 Software Management

OAM-SW0201, System Reset and Restart

INTRODUCTION

This feature provides functionalities to reset or restart of the whole system or a specific hardware unit or a specific software block. After system reset, initialization procedure including registration and software image/configuration data downloading is followed.

BENEFIT

- Provides activation of new software or firmware images by restarting hardware unit or software unit after upgrade
- Provides different level of fault recovery by restarting the system or a software block or a hardware unit

DEPENDENCY

None

LIMITATION

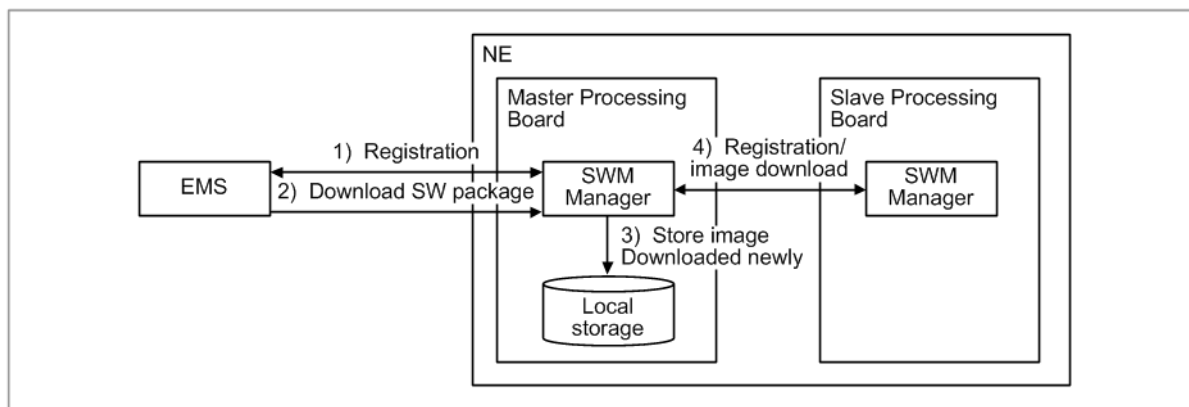
None

FEATURE DESCRIPTION

This feature provides functionalities to reset or restart the whole system or a specific hardware unit or a specific software block. After system reset, initialization procedure including registration and loading is followed.

System Initialization

The figure below depicts the detailed flow of system initialization.



0) system power on

1) The master board starts to execute the registration procedure with the EMS (acts as Registration Server).

2) After successfully authenticated, it downloads the required software packages from the EMS (acts as Image Server) and installs them.

According to the values of the environment variables stored in the FLASH memory of master board, the system can download the software packages from the following three different locations:

- EMS
- Non-volatile local storage in system
- Local Maintenance Terminal (LMT)

For details on LMT loading, see the feature "OAM-SW0701 LMT (Local Maintenance Terminal) Loading".

When the IP address of the EMS during in-service is changed while the NE is in-service, NE transfers WARM START notification to the new EMS to register to the EMS. The EMS IP address of environment variables in the FLASH memory should be changed together to register to the EMS when NE reboots.

3) SWM manager stores the images downloaded newly in local storage.

4) The slave boards download the software packages from the master board instead of from the EMS.

System Reset and Restart

The Samsung NE provides reset and restart functions and these are used for fault recovery, software upgrade and update, and firmware update.

When the operator resets or restarts the NE, the operator can select both the type and target of the reset and restart process.

Types of Reset/Restart are as follows:

- Hardware reset with disconnecting and reconnecting the power
- Software reset including the OS
- Restarting the software unit excluding the OS

Targets of Reset/Restart are as follows:

- System (All hardware boards and software blocks of NE)
- Hardware unit (The specified hardware units, such as processor boards, radio unit, and clock unit, can also be the target to be reset)
- Software unit (All or specified software in selected processor)

The relation of targets to the reset and restart types are as outlined in the table below.

| Target | Hardware reset | Software reset Including the OS | Software restart excluding the OS |
|---------------|----------------|-------------------------------------|-----------------------------------|
| System | Support | support | N/A |
| Hardware unit | Support | Support in case of processing board | N/A |
| Software unit | N/A | N/A | Support |

To reset system (all hardware boards and software blocks of NEs)

This is for the restart of entire system. When the reset is executed, the NE performs the booting and initialization procedure as described in the figure above.

When the master board receives the command for this, the master board performs reset of slave boards first and then resets itself. This is classified into two modes: hardware and software.

- Hardware restart mode: All processing boards and radio units in base station are restarted by disconnecting and reconnecting the power.
- Software restart mode: All software blocks including OS on all processing boards are restarted without disconnecting the power.

Because of system reset, the alarm related to communication failure with the NE occurs and cleared on the EMS. After boot-up, alarm data synchronization between the NE and EMS is performed.

To reset a processing board in the NE

This is for the restart of processing board (unit type) in the NE. The operator can select the processing board to be reset. This is classified into two modes: hardware and software.

- In the hardware mode, the processing board is restarted by disconnecting and reconnecting the power.
- In the software mode, all software blocks including OS running on the processing board are restarted without disconnecting the power.

If the specified processing board is the master board, the communication failure with the NE occurs and cleared on the EMS and alarm data synchronization is performed same with the case of system reset above. If the slave board is reset, the FUNCTION FAIL alarm of the slave board occurs. When the loading is completed, the function failure alarm is cleared. In the case of base station, the transmission of output power is halted during reset and initialization of the master or slave board.

To reset Radio Unit (RU)

This is for the restart of RU in Base Station (BS). The operator can select the RU to be reset. This is reset by disconnecting and reconnecting the power.

When the reset RU is executed, operational state changes to disable and initialization of the RU is performed. After initialization is completed normally, the operational state changes to enable.

To reset Universal Clock Receiver (UCR) unit

This is for the restart of UCR in the NE. When the reset UCR is executed, the function failure alarm of the UCR occurs.

In the case of BS the clock failure alarm of each processing board, operational state of RU path can be changed to disable by CPRI reset in DU.

To reset Digital Signal Processor (DSP) unit

This is for the restart of DSP in BS. The operator can select the DSP to be reset. When the DSP is reset, the loading and initialization of the DSP is performed and the loading complete notification is reported to the EMS. When the DSP has MAC scheduling functionality, SoC is also reset with the DSP.

To reset software

This is for the software reset. The operator can select the reset type; a particular software unit in the board or all the running software units in the specified board at once.

SYSTEM OPERATION

This section describes how to configure the feature in Samsung system and provides associated key parameters, counters, and KPIs.

How to Activate

This section provides the information that you need to configure the feature.

Preconditions

There are no specific preconditions to activate this feature.

Activation Procedure

To activate this feature, do the following:

- Reset the system.
 - Run [ENB] initialize-system to reset the system.
 - Run [MCE] initialize-system to reset the system.
- Reset software unit or each device unit
 - Run [ENB] initialize-software to reset a software unit.
 - Run [MCE] initialize-software to reset a software unit.
 - Run [ENB] initialize-processor-unit to reset the Processor Unit of the system.

- Run [MCE] initialize-processor-unit to reset the Processor Unit of the system.
- Run [ENB] initialize-radio-unit to reset the RRH.
- Run [ENB] initialize-ucr to reset the UCR (Universal Clock Receiver).
- Run [ENB] initialize-dsp to reset the DSP.
- Run [ENB] initialize-antenna-line-device to reset the remote Antenna Line Device.
- Run [ENB] initialize-third-party-radio-unit to reset the third-party radio unit of the system.

Deactivation Procedure

This feature is used only for software reset or restart. So this feature does not need to be deactivated.

Key Parameters

This section describes the key parameters for activation, deactivation, and configuration of the feature.

Activation Parameters

This feature is used only for system reset or restart. So this feature does not need to be deactivated.

To activate the feature, run the associated commands and set the key parameters.

Parameter Descriptions of [ENB] initialize-system

| Parameter | Description |
|-------------|---|
| reset-mode | This parameter is the reset method. Two methods are supported: hard reset and soft reset. |
| forced-mode | This parameter indicates whether forced reset is used. |

Parameter Descriptions of [MCE] initialize-system

| Parameter | Description |
|-------------|--|
| forced-mode | This parameter indicates whether forced reset is used. |

Parameter Descriptions of initialize-software

| Parameter | Description |
|---------------------|---|
| processor-unit-type | This parameter is the type of the processor unit or vnfc. It varies by the system configuration. |
| processor-unit-id | This parameter is the ID of the processor unit or vnfc. |
| subunit-id | This parameter is the sub ID of processor unit of the BBU. |
| unit-name | This parameter is the name of the software recorded in the software list. Only the file name is entered without the directory name. If no name is entered, all software units are reset. Up to 128 bytes can be entered for the software unit name. |

Parameter Descriptions of initialize-radio-unit

| Parameter | Description |
|---------------------------------|---|
| connected-digital-unit-board-id | This parameter is the board ID of the DU, which is connected to the RRH. For example, if the RRH is connected to channel card #0, connected-digital-unit-board-id is 0. If no board ID is entered, all boards are selected. |
| connected-digital-unit-port-id | This parameter is the port ID of the DU, which is connected to the RRH. For example, if the RRH is connected to port #0 of the channel card, connected-digital-unit-port-id is 0. If no port ID is entered, all ports are selected. |
| cascade-radio-unit-id | This parameter is the cascade ID of the DU port, which is connected to the radio unit. |

Parameter Descriptions of initialize-processor-unit

| Parameter | Description |
|---------------------|---|
| processor-unit-type | This parameter is the type of the processor unit. It varies by the system configuration. |
| processor-unit-id | This parameter is the ID of the Processor Unit. |
| subunit-id | This parameter is the sub ID of processor unit of the BBU. |
| reset-mode | This parameter is the reset method. Two methods are supported: hard reset and soft reset. |

Parameter Descriptions of initialize-vnfc

| Parameter | Description |
|------------|--|
| vnfc-type | This parameter is the type of the vnfc. It varies by the system configuration. |
| vnfc-id | This parameter is the ID of the vnfc. |
| reset-mode | This parameter is the soft reset method. |

Parameter Descriptions of initialize-ucr

| Parameter | Description |
|-----------|-------------|
| N/A | N/A |

Parameter Descriptions of initialize-dsp

| Parameter | Description |
|-----------|---|
| board-id | This parameter is the Board ID of the DSP to reset. If no Board ID is entered, all boards are selected. |
| dsp-id | This parameter is the ID of the DSP to reset. If no DSP is entered, all DSPs are selected. |

Parameter Descriptions of initialize-antenna-line-device

| Parameter | Description |
|---------------------------------|--|
| connected-digital-unit-board-id | This parameter is the ID of the board connected to the ALD to be reset. |
| connected-digital-unit-port-id | This parameter is the port ID of the board connected to the ALD to be reset. |

| Parameter | Description |
|--------------------------|--|
| cascade-radio-unit-id | This parameter is the cascade ID of the DU port, which is connected to the radio unit. |
| antenna-line-device-id | This parameter is the ID of the ALD to be reset. |
| antenna-line-device-type | This parameter is the ALD type (RET/TMA/RAS). |

Parameter Descriptions of initialize-third-party-radio-unit

| Parameter | Description |
|-----------------------------------|---|
| connected-digital-unit-board-id | This parameter is the ID of the board connected to the ALD to be reset. |
| connected-digital-unit-port-id | This parameter is the port ID of the board connected to the ALD to be reset. |
| cascade-radio-unit-id | This parameter is the cascade ID of the DU port, which is connected to the radio unit. |
| third-party-radio-unit-reset-type | This parameter is the type of reset. <ul style="list-style-type: none"> • FULL: The third-party radio unit processor and all internal hardware to reset. • PROCESSOR: The third-party radio unit to execute a software reset without disturbing the operation of the cpri ports. • SESSION: The third-party radio unit to clear any settings associated with the requesting REC, such as carrier configuration settings. • SOFT: The third-party radio unit to clear all session settings associated with all RECs as well as all common attributes data. |
| third-party-radio-unit-image-type | This parameter is the on-the currently active image (ACTIVE) or the currently inactive image (INACTIVE). |

Counters and KPIs

There are no specific counters or Key Performance Indicators (KPIs) associated with this feature.

REFERENCE

None

OAM-SW0301, Software Upgrade and Update

INTRODUCTION

This feature provides the functionality of applying a new software release or a software patch to the NE. The concept of "software" mentioned in this document does not include "firmware", which is described in feature "OAM-SW0401: FW Upgrade and Update".

During package upgrade or patch update, the new package or patch is downloaded to the NE. The new package or patch replaces the old software files and is saved in storage device. They take effect after system reboot. The mechanism for software patch update is same as software package upgrade. In this feature, the term "software package upgrade" is used for both software package upgrade and software patch update.

BENEFIT

The operator can use this feature to apply new software package easily and correctly.

DEPENDENCY

None

LIMITATION

The new package need system reboot to take effect.

FEATURE DESCRIPTION

This feature has the following four main functions:

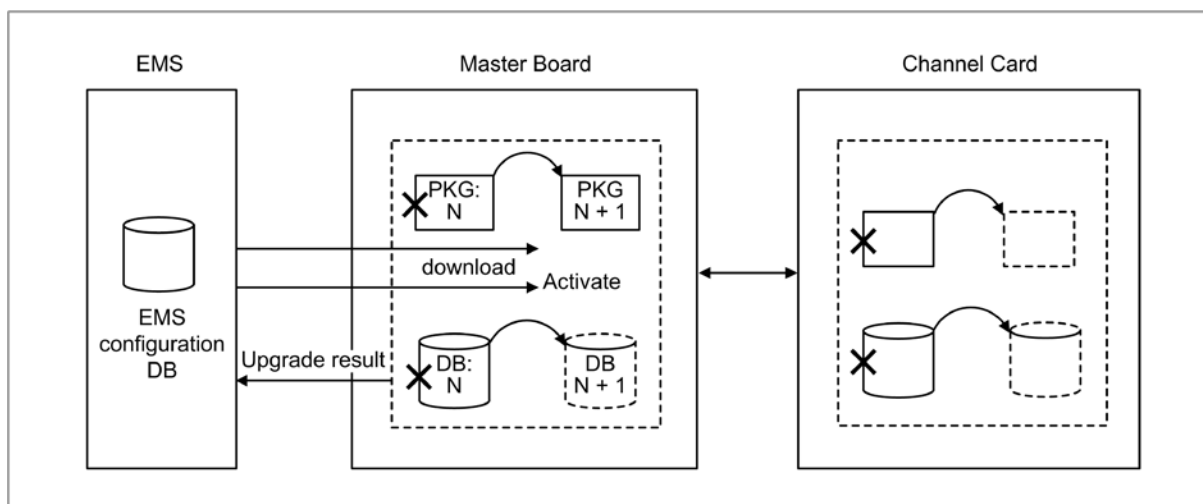
- Package upgrade
- Software unit update
- New package loading by system reset
- Software patch update

Package Upgrade

Package upgrade sub feature provides package level of software upgrade and includes download of new package, activation of the new package, and fallback to old package.

Package Download and Activation

The figure below depicts package upgrade details.



The old version N of package and version N of database is currently running in master board and all of the channel cards. The upgrade of package is separated into three phases such as, package download, DB migration, and package activation.

In package download phase, the NE downloads the new version N + 1 of package and new version N + 1 of database. The configuration data in version N database is imported to the N + 1 database in DB migration phase. The new version of package and database are not effective.

After new package is downloaded successfully, the operator can activate the new package at any time. As there is a short time of service interruption, the operator can choose the maintenance timeslot to do the package activation.

The applications running of old version of software is shutdown. Then, they are started again with the new version of software. After every application is started successfully, an activation success notification is sent to the EMS, which updates its local database for this NE. After that the EMS regards that the NE is running the new version of package.

If some error occurs during the new package activation before sending activation success notification, fallback is initiated to activate the old package.

The operator can also use system reboot mode to activate the new package. In this case, system is rebooted to load the new package from the EMS after sending package activation success notification. It is used to activate both the new version of package and new version of firmware. The firmware upgrade is described in feature "OAM-SW0401: FW Upgrade and Update"

Software Fallback

Software fallback is the downgrade of package from N + 1 version back to N version. There are two kinds of fallback according to on which scenario it is invoked. These are manual package fallback and automatic package fallback for activation failure.

After the new version of package is upgraded successfully, it is used for providing services (probably with new features). The operator monitors the running performance for the new package. In some cases, the operator may want to revert to the old version of package. Manual package fallback can be used in this case.

The operator can request the package activation of version N-1 against package version N. The NE shuts down the package version N and starts the applications with version N-1. The same activation procedure as package upgrade is used.

If some error happens during the activation of the new version of package in package upgrade procedure, the activation cannot continue. The NE cancels all the steps that have already been done for the activating of the new package. It restarts the application with the old version of package. This kind of fallback is triggered automatically because of package upgrade failure.

Delete Standby Old Package

After package upgraded successfully, the new version of package starts providing services. The old version of package is saved for package fallback. It can be deleted by the operator to free the occupied memory and RAM-disk space.

After the old version of package is deleted, if fallback is required, the operator has to download that version of package again.

Software Unit Update

Software unit update sub feature provides software unit level of update. Package is composed of software blocks, which provides basic services or functionalities at the application level. In application level, software block is the smallest unit. For example, some block is responsible for reporting/collecting performance data and some block is responsible for fault management, and so on.

Software unit update sub feature includes downloading of the new software file, activation of the new software file. The activation is done for all of the processing boards where the specified software unit is running or configured. For some software units, the update is not allowed. In that case, proper error reason is returned to the operator.

As different CPU architectures are used in the system, such as Octeon Plus Windriver (OPW) and Octeon Two Windriver (OTW), for the same software block, there are several software images. Each image is run in a specific CPU architecture.

Both software block level and software image level of update are supported. The new version of software is downloaded and updated by specifying either the software image name or software block name.

For the update of software image, only that specific image is downloaded and activated in the proper boards. For the update of software block, all the images related to that specific block are downloaded. The images are propagated to the related boards for activation. All the boards running that block are updated.

Download success notification is sent to the EMS after the download is completed. If failure happens, error notification with proper reason also is reported to the operator. Software down/start notification is sent to the EMS during the new software activation.

New Package Loading by System Reset

This sub feature provides software upgrade functionality by system reset. After getting the software package, it is installed to the specified directory according to installation manual. During system reset, those installed software files are downloaded to the NE.

In the EMS local database, the package version information is saved for each NE. During system reset, the NE gets the version information from the EMS. From the version information, the NE generates the directory name in which the new software files have to be saved. Then, the NE downloads the software files from that directory and starts the applications using the downloaded files.

During the software download, for each software image, its checksum is calculated. The result is compared to the official released checksum value. If the image file is destroyed or is copied wrongly, the values differ. In this way, the package consistency can be protected.

Software Patch Update

Software Patch Update sub feature provides software patch level update. Here software patch means the bundle of software units. For this, downloading of patch release image and activation of them are needed similarly to that of software package upgrade. After the patch is downloaded, the patch download success notification is sent to the EMS. After the new patch is downloaded successfully, the operator can activate the new patch at any time. After the patch is activated, the patch activation success notification is sent to EMS. Updated software patch version is displayed through CLI command.

SYSTEM OPERATION

This section describes how to configure the feature in Samsung system and provides associated key parameters, counters, and KPIs.

How to Activate

This section provides the information that you need to configure the feature.

Preconditions

There are no specific preconditions to activate this feature. However, purpose of this feature is software upgrade or update, therefore, the software to apply must be prepared before upgrade or update action.

Activation Procedure

To activate this feature, do the following:

- Package Upgrade
 - Run [ENB] download-package RPC command to download a package onto the NE.
 - Run [ENB] update-package to update a package on the NE.
 - Run [ENB] restore-package to restore software package.

- Run [ENB] delete-passive-package to delete the package versions that are not used by the NE.
- Run [MCE] download-package RPC command to download a package onto the NE.
- Run [MCE] update-package to update a package on the NE.
- Run [MCE] restore-package to restore software package.
- Run [MCE] delete-passive-package to delete the package versions that are not used by the NE.
- Software Unit Update
 - Run [ENB] download-software to download a software unit onto the NE.
 - Run [ENB] download-software-batch to download the software recorded in a batch file onto the NE.
 - Run [ENB] update-software to update the software unit on the NE.
 - Run [ENB] update-software-batch to perform a batch update of software units on the NE.
 - Run [MCE] download-software to download a software unit onto the NE.
 - Run [MCE] download-software-batch to download the software recorded in a batch file onto the NE.
 - Run [MCE] update-software to update the software unit on the NE.
 - Run [MCE] update-software-batch to perform a batch update of software units on the NE.
- Software Patch Update
 - Run [ENB] download-patch to download a patch onto the NE.
 - Run [ENB] update-patch to update a patch on the NE.
 - Run [MCE] download-patch to download a patch onto the NE.
 - Run [MCE] update-patch to update a patch on the NE.
- Software Version Display
 - Run [ENB] retrieve-package-inventory to retrieve software version running in the system.
 - Run [MCE] retrieve-package-inventory to retrieve software version running in the system.

Deactivation Procedure

This feature is used only for software upgrade or update. So this feature does not need to be deactivated.

Key Parameters

This section describes the key parameters for activation, deactivation, and configuration of the feature.

Activation Parameters

This feature is used only for software upgrade or update. So this feature does not need to be deactivated.

To activate the feature, run the associated commands and set the key parameters.

Parameter Descriptions of download-package

| Parameter | Description |
|-----------------|--|
| package-version | This parameter is the package version to download. Up to 128 bytes can be entered. |
| release-version | This parameter is the release version to download. Up to 128 bytes can be entered. |
| invocation-id | This parameter is the command execution result ID assigned at the time of command execution. This is recorded in the result notification after the command execution is complete and it is used to receive the command execution result notification from the GUI. |

Parameter Descriptions of update-package

| Parameter | Description |
|-----------------|--|
| package-version | This parameter is the package version to update. |
| release-version | This parameter is the release version to update. |
| activation-mode | This parameter is the method for updating the package. The package can be applied by rebooting the system or by resetting the Software Units while the OS continues to run. <ul style="list-style-type: none"> REBOOT: The package is applied by rebooting the system. AP_RESET: The package is applied by resetting the application software. |
| invocation-id | This parameter is the command execution result ID assigned at the time of command execution. This is recorded in the result notification after the command execution is complete and is used to receive the command execution result notification from the GUI. |

Parameter Descriptions of restore-package

| Parameter | Description |
|-----------------|---|
| package-version | This parameter is the package version to restore. |
| release-version | This parameter is the release version to restore. |
| invocation-id | This parameter is the command execution result ID assigned at the time of command execution. This is recorded in the result notification after the command execution is complete and is used to receive the command execution result notification from the GUI. |

Parameter Descriptions of delete-passive-package

| Parameter | Description |
|-----------|-------------|
| (None) | - |

Parameter Descriptions of download-software

| Parameter | Description |
|--------------------|--|
| software-unit-name | This parameter is the name of the software unit recorded in the Software list. The name entered contains both the directory name and the file name. Up to 128 bytes can be entered. |
| invocation-id | This parameter is the command execution result ID assigned at the time of command execution. This is recorded in the result notification after the command execution is complete and it is used to receive the command execution result notification from the GUI. |

Parameter Descriptions of download-software-batch

| Parameter | Description |
|---------------|--|
| batch-file | This parameter is the name of the batch file. The name entered contains both the directory name and the actual file name. Up to 128 bytes can be entered. |
| invocation-id | This parameter is the command execution result ID assigned at the time of command execution. This is recorded in the result notification after the command execution is complete and it is used to receive the command execution result notification from the GUI. |

Parameter Descriptions of update-software

| Parameter | Description |
|--------------------|---|
| software-unit-name | This parameter is the name of the software unit to update. The name entered for the software unit must only be the actual file name excluding the directory name. Up to 128 bytes can be entered. |
| invocation-id | This parameter is the command execution result ID assigned at the time of command execution. This is recorded in the result notification after the command execution is complete and is used to receive the command execution result notification from the GUI. |

Parameter Descriptions of update-software-batch

| Parameter | Description |
|---------------|---|
| batch-file | This parameter is the name of the batch file. The name entered contains both the directory name and the actual file name. Up to 256 bytes can be entered. |
| invocation-id | This parameter is the command execution result ID assigned at the time of command execution. This is recorded in the result notification after the command execution is complete and is used to receive the command execution result notification from the GUI. |

Parameter Descriptions of download-patch

| Parameter | Description |
|-----------------|--|
| release-version | This parameter is the release version to download. Up to 128 bytes can be entered. |
| invocation-id | This parameter is the command execution result ID assigned at the time of command execution. This is recorded in the result notification after the command execution is complete and it is used to receive the command |

| Parameter | Description |
|-----------|---|
| | execution result notification from the GUI. |

Parameter Descriptions of update-patch

| Parameter | Description |
|-----------------|--|
| release-version | This parameter is the release version to update. |
| activation-mode | This parameter is the method for updating the patch. The patch can be applied by rebooting the system or by resetting the software units while the OS continues to run. <ul style="list-style-type: none"> • REBOOT: The patch is applied by rebooting the system. • AP_RESET: The patch is applied by resetting the application software. |
| invocation-id | This parameter is the command execution result ID assigned at the time of command execution. This is recorded in the result notification after the command execution is complete and is used to receive the command execution result notification from the GUI. |

Counters and KPIs

There are no specific counters or Key Performance Indicators (KPIs) associated with this feature.

REFERENCE

[1] 3GPP TS 32.531 Telecommunication management; Software management (SwM); Concepts and Integration Reference Point (IRP) Requirements

OAM-SW0304, Automatic SW Upgrade by User Policy

INTRODUCTION

This feature provides the functionality of upgrading software package version or updating software patch version automatically by defining operator specific upgrade/update policies. In the user defined policies, the operator can specify the different conditions to upgrade/update the software package/patch version of NEs.

BENEFIT

With this feature, the operator can easily and conveniently upgrade the software and it reduces the operator's intervention by performing automatic software upgrade based on the pre-configured policy.

DEPENDENCY

None

LIMITATION

- "Process Disabled" rollback policy is limited in call processing application.
- The rollback is triggered by the event corresponding rollback policy, however, it can be caused by reasons not related to the new software.

FEATURE DESCRIPTION

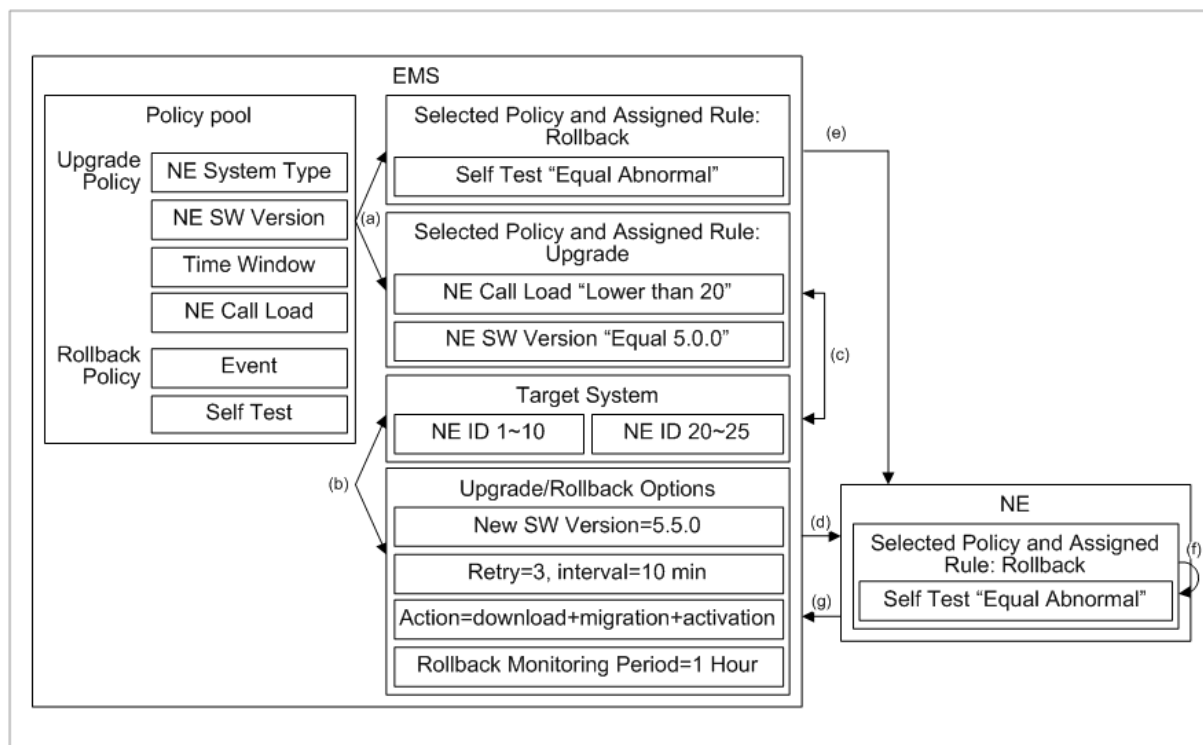
This feature allows the operator to select the policies from policy pool and configure the matching criteria values for each of the selected policies. The EMS/NE keeps monitoring these configured policies and takes the proper action when the policies match with the criteria values.

This feature can be enabled or disabled in LSM GUI menu (Configuration | Software | Package Upgrade | NE status | Policy ON/OFF). When this feature is enabled, the operator should specify the list of NEs on which this feature should be enabled and the maintenance time slot (LSM GUI menu: Configuration | Software | Package Upgrade | NE status | Upgrade | Execute Schedule). By default, all the NEs managed by the EMS are selected when this feature is enabled.

The operational flow for this feature is as follows:

- 1 The operator enables this feature.
- 2 The operator selects the list of NEs for this feature to be enabled.
- 3 The operator set the maintenance time slot.

The figure below depicts the Policy selection and configuration scenario.



Software Upgrade Procedure

The following procedures are to upgrade the software:

1 Selects the upgrade policies from the pool.

Sample Policies are: NE System Type, NE software Version, NE call load, and Upgrade time window.

- NE System Type policy indicates the type (example: MACRO OUTDOOR DIST) of the system for the upgrade. The operator can specify the criteria of NE system type for requesting software upgrade.
- NE SW Version policy indicates the running software version of the NE. The operator can specify the criteria of NE package version/patch version for requesting software upgrade.
- NE call load policy indicates the number of connected users. The operator can specify the criteria of NE call load, and number of attached UEs for requesting software activation.
- Upgrade time window policy indicates the timeframe to initiate the software upgrade. The operator can specify the criteria of scheduled period for requesting software upgrade. This time window should be within maintenance time slot.

2 Configure the matching criteria values for the selected policies

For example, if the upgrade is needed to be done for MACRO OUTDOOR DIST running with 5.0.0 version to 5.5.0 during 01:00 AM-02:00 AM when the number of calls is less than 20 then the following matching criteria need to be configured:

NE System Type (SW Upgrade Criteria < NE Type) = MACRO OUTDOOR DIST

NE Software Version (SW Upgrade Criteria < NE Version) = 5.0.0 r-01

NE call load (Call Load Criteria For Activation < ConnNoAvg) = 20

Upgrade time window (SW Upgrade Criteria < Time Window) = 06/28/2015 01:00 AM-06/28/2015 02:00 AM

This time window should be within the maintenance time slot.

- 3 Selects the Target NEs for the upgrade. These target NEs should be within the list of NEs selected for the feature activation.
- 4 Selects the upgrade options: New Software version (For example, 5.5.0 r-01), Number of retries (3), interval between retries (10 min), upgrade actions (Download/PLD migration/Activation/Download + PLD migration/PLD migration + Activation/Download + PLD migration + Activation)

If an upgrade action fails in the first attempt then the same action is repeated for configured number of retries with the configured interval between the retries.

The EMS has an internal mechanism to perform the upgrades on multiple NEs in the configured period, so that the EMS resources are not overloaded.

The EMS keeps monitoring these upgrade policies and triggers the upgrade actions when the policy criteria match.

Software Upgrade Procedure (involving rollback)

The following procedures are to roll-back the software:

- 1 Selects the rollback policies from the pool in addition to the upgrade policies.

Policies monitored by NE:

Sample Policies are: Event (Process Disabled), Self-Test (EMS connectivity test)

Event (Process Disabled) policy allows the operator to select application process in the NE to be monitored.

Self-Test (EMS connectivity test) policy allows the NE to verify the connectivity with EMS after the upgrade.

Policies monitored by EMS:

Sample Policies are: NE Service Status (No call)

NE Service Status (No call) policy allows the EMS to monitor all the cells for no call condition after the upgrade.

- 2 Configures the matching criteria values for the selected policies

For example, if the rollback is needed to be done when some process in the NE is disabled or connection is lost between the NE and EMS, then the following matching criteria need to be configured:

Event (Rollback Criteria < Process Disabled)

Self-Test (Rollback Criteria < EMS connection test)

For example, if the NE needs to execute rollback when there are no calls in the NE, then the following matching criteria need to be configured:

NE Service Status (Rollback Criteria < Sleeping Cell Detected Alarm)

- 3 Selects the Target NEs same as step 3 in software upgrade procedure.
- 4 Set rollback options in addition to the upgrade options: Rollback monitoring period (For example, 1 hour).

Rollback monitoring period option allows the NE/EMS to monitor the rollback policies for this period and perform the rollback when they match.

"Policies monitored by NE" are downloaded to target NEs and they are preserved even if the NEs are restarted or new package is installed. The NEs keep monitoring these policies and rollback to the previous working software package when the policy criteria match. Rollback result is notified to the EMS.

"Policies monitored by EMS" are not downloaded to target NEs. Instead, the EMS keeps monitoring these policies and rollback to the previous working software package when the policy criteria match.

Upgrade/Rollback log Management

Status of the automatic software package upgrades/patch updates/rollback tasks is displayed to the operator. Status includes the list of NEs that are doing software upgrade, NEs that have been upgraded successfully, NEs that failed to be upgraded, and NEs that are waiting to be upgraded.

Log is maintained in the EMS for this feature. This log includes the time that the upgrade/rollback is executed, the upgrade/rollback result, the upgrade/rollback options, the policies used for this upgrade/rollback, the conditions that make the policy be matched. The operator can query the upgrade history information (in the log file) within the specified period about the NEs that have been upgraded/rollback successfully or failed, or the NEs that have not been upgraded/rollback.

SYSTEM OPERATION

This section describes how to configure the feature in Samsung system and provides associated key parameters, counters, and KPIs.

How to Activate

This section provides the information that you need to configure the feature.

Preconditions

There are no specific preconditions to activate this feature.

Activation Procedure

There is no specific activation parameter for this feature. It can be used by GUI in Package Upgrade.

- Click [Software] in LSM

- Click [Package Upgrade]
- Select TARGETs and click [Search]
- Use [Policy] tab in [NE Status] window.

This feature does not need to be activated.

Deactivation Procedure

This feature does not need to be deactivated, because it is used only in software upgrade procedure.

Key Parameters

This section describes the key parameters for activation, deactivation, and configuration of the feature.

Activation/Deactivation Parameters

There are no specific Activation/Deactivation parameters associated with this feature.

Configuration Parameters

To configure the feature settings, run the associated commands and set the key parameters.

Parameter Descriptions of rollback-info

| Parameter | Description |
|------------------------|--------------------------------|
| connection-check-timer | connection check timeout value |
| connection-check-count | connection check retry count |

Counters and KPIs

There are no specific counters or Key Performance Indicators (KPIs) associated with this feature.

REFERENCE

None

OAM-SW0401, FW Upgrade and Update

INTRODUCTION

This feature provides the functionality of updating new firmware to the NE. The firmware types that can be updated are: booter, kernel, rfs_raw, rfs, post, Common Programmable Logic Device (CPLD), and Universal Clock Receiver (UCR). For BS, it can also include Radio Unit (RU), Antenna Line Device (ALD), External Alarm Interface Unit (EAIU), and Fan Control Module (FCM).

BENEFIT

With this feature, the operator can remotely update the firmware of the NE.

DEPENDENCY

None

LIMITATION

- For activation of the new firmware, the related board has to be reset. During the initialization, that board cannot provide service normally.
- The new functions developed in release N are only applicable for firmware update from release N to release N + 1.

FEATURE DESCRIPTION

The term "software" mentioned in 3GPP OAM standard documents includes both software and firmware in the NE system. The software upgrade and update is described in feature "OAM-SW0301 Software Upgrade and update". The firmware upgrade and update is described in this document.

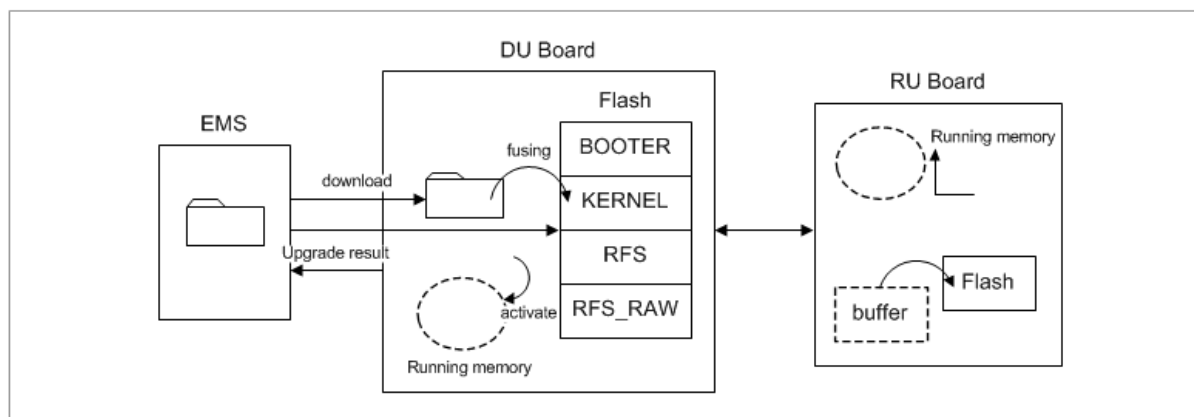
This feature has the following main functions:

- Single firmware image update
- Firmware update by batch file
- Processing boards auto fusing
- Firmware version mismatch audit
- Firmware validity check
- Change NE firmware

Single Firmware Image Update

This function provides the firmware image level of update. It can be used to update a specific firmware type to a specific hardware board. For example, the new version of booter firmware type can be updated to the LTE eNB channel card board assembly channel card in slot 1.

The figure below depicts the updating of a single firmware image.



The firmware update procedure is divided into two steps: new firmware downloading and new firmware fusing. After getting the download request, OAM software downloads the specified firmware image from the EMS. The image is saved in the local RAM disk in the DU board.

For DU board firmware update, in the firmware fusing step, the OAM software erases the related partition in flash memory and writes the downloaded image to that related partition in the flash memory. The running memory is not changed for the firmware fusing. To activate the new firmware, the specified board has to be reset to reload the firmware in flash memory to the running memory.

For CPLD firmware type, the related board is reset immediately and automatically after the firmware fusing.

For firmware update of RU board in Base Station, in the firmware fusing step, DU board splits the image into pieces and transfer those pieces to RU one by one. After transferring is completed, RU writes the received image to its flash memory after image verification.

During RU re-initialization, it reloads the saved image in flash memory to the running memory to activate the new firmware. After the firmware fusing is completed, the NE sends the firmware update notification to the EMS.

Firmware Update by Batch File

This function provides the functionality of updating a list of firmware images to a list of hardware boards. For example, the new version of board RFS firmware type is updated to eNB Channel Processor (ECP) board in slot 1 and slot 2, and then new version of board BOOTER firmware type is updated to ECP in slot 3.

After getting the batch update request, the OAM software downloads all the required firmware images from the EMS. Then, the OAM software does the firmware fusing for the specified board using the specified firmware image.

Each line in the batch file specifies the firmware image and the board that it is updated. The firmware fusing for those boards is done one by one. For each one, the firmware update notification is sent to the EMS.

There is one GUI window in the EMS for firmware update. The EMS generates the batch file according to operator's request and sends the batch file to the NE for batch update. See EMS User Manual for the related operation of the EMS.

Since CPLD firmware update reboots the board automatically, if CPLD firmware types are included in the batch update, they are updated at the last step. If both master board CPLD firmware and slave boards CPLD firmware are included, master board CPLD firmware update is executed after slave boards. Multiple CPLD firmware types for one board are fused together so that board reset is executed only once.

Processing Boards Auto Fusing

This function provides firmware update for obsolete boards automatically during the initialization of boards. During board initialization, if the auto fusing feature is enabled from the EMS, the NE downloads the recommended firmware version file from the EMS. Then, it compares the recommended firmware version with the current running firmware version in this board and active software package.

If there is version mismatch for some firmware type and the recommended firmware is compatible with active software package, the NE downloads the firmware image for that firmware type from the EMS and does the firmware fusing for that board. Currently only processing boards are supported for the auto fusing functionality. However, CPLD firmware type is not supported for auto fusing.

Firmware Version Mismatch Audit

This function provides the functionality to compare the current firmware version in the system to the recommended firmware version. After new firmware images are installed to the EMS, the firmware version information is extracted from them to create a firmware version file.

The firmware version file is downloaded to the NE when the firmware version audit function is started. The currently running firmware version in the system is compared with the version information in the downloaded file. If version mismatch is found, the NE sends firmware mismatch notification to the EMS.

The firmware version audit function can be enabled or disabled by CLI command. If enabled, it is run in the following cases:

- It is run periodically
- After the NE finishes system initialization
- When the operator enables this function by CLI command
- When some boards finish initialization during system running

Firmware Validity Check

This function provides the functionality to check the validity of the firmware image requested to be updated. The name of the firmware image is saved in the tail part of the file during the build of the image, which is not changed when the image file is renamed. During the firmware update, the image name saved in the tail part of the file is checked according to hardware type to be updated.

For each hardware type, the name of its firmware image is saved in the firmware list configuration file. The permitted firmware name of the specified hardware type is compared with the firmware name extracted from the tail part of the image file. If the names mismatch, error is returned to the operator instead of fusing with wrong firmware image. In this way, human error can be minimized.

Change NE Firmware

This function provides the functionality to compare the current firmware version in the system with the recommended firmware version in the EMS and update all the firmware types whose version is different. If the firmware version is the same, no update is executed at all.

As the update of CPLD firmware automatically resets the board, and the update of DSP EEPROM firmware resets the DSP, which causes service downtime, optional flags for including CPLD/DSP EEPROM are supported. If those flags are set to "false", they are not updated even if the version is different. Besides those flags, firmware activation flag is also supported to allow the operator to decide whether firmware activation should be done or not after the firmware update.

SYSTEM OPERATION

This section describes how to configure the feature in Samsung system and provides associated key parameters, counters, and KPIs.

How to Activate

This section provides the information that you need to configure the feature.

Preconditions

The communication condition of the device that is going to perform a function has to be normal.

Activation Procedure

To activate this feature, do the following:

- 1 Single Firmware Image Update
 - Use the command [ENB] download-firmware to download a firmware onto the NE.
 - Use the command [MCE] download-firmware to download a firmware onto the NE.
 - Use the command [ENB] update-firmware to update the firmware.
 - Use the command [MCE] update-firmware to update the firmware.
- 2 Firmware Update by Batch File
 - Use the command [ENB] download-firmware-batch to download the firmware recorded in a batch file onto the NE.
 - Use the command [MCE] download-firmware-batch to download the firmware recorded in a batch file onto the NE.
 - Use the command [ENB] update-firmware-batch to perform a batch update of the firmware.
 - Use the command [MCE] update-firmware-batch to perform a batch update of the firmware.
- 3 Change NE Firmware
 - Use the command [ENB] update-radio-unit-firmware to update the RRH

Firmware.

- Use the command [ENB] update-antenna-line-device-firmware to update the Antenna Line Device (ALD) firmware.

4 Firmware Automatic Update for newly added NE or HW

- Check FW Auto Fusing, FW Fusing At H/W Change flag in the "Package Upgrade" window.

Deactivation Procedure

To deactivate this feature, do the following:

- 1 to 3) This feature does not need to be deactivated.
- 4) Uncheck FW Auto Fusing, FW Fusing At H/W Change flag

Key Parameters

This section describes the key parameters for activation, deactivation, and configuration of the feature.

Activation/Deactivation Parameter

There are no specific Activation/Deactivation parameters associated with this feature.

Configuration Parameters

To configure the feature settings, run the associated commands and set the key parameters.

1 Single Firmware Image Update

Parameter Descriptions of download-firmware

| Parameter | Description |
|--------------------|---|
| firmware-unit-name | This parameter is the name of the Firmware Unit. The name entered contains both the directory name and the actual file name. Up to 128 bytes can be entered. |
| invocation-id | This parameter is the command execution result ID assigned at the time of command execution. This is recorded in the result notification after the command execution is complete and is used to receive the command execution result notification from the GUI. |

Parameter Descriptions of update-firmware

| Parameter | Description |
|--------------------|---|
| firmware-unit-name | This parameter is the name of the Firmware Unit. Up to 256 bytes can be entered. |
| apply-unit-type | This parameter is the type of the Unit to update firmware. The Unit type can be UMP or ECP. It varies by the system configuration. |
| apply-unit-id | This parameter is the ID of the Unit to update the Firmware Unit. If one or more Units of the same name exist within the eNB, this ID identifies each unit. |

| Parameter | Description |
|---------------|---|
| apply-side | This parameter is the side information for updating firmware. If the target unit for firmware update is in redundancy configuration, A_SIDE, B_SIDE or BOTH can be selected for the update. If the Unit Type selected does not support redundancy configuration, NONE should be selected. |
| apply-action | This parameter is the action to perform after the firmware update. Although a reset is required to activate the new firmware after the firmware update, the firmware may be updated without performing the reset to prevent repeated resets. |
| invocation-id | This parameter is the command execution result ID assigned at the time of command execution. This is recorded in the result notification after the command execution is complete and is used to receive the command execution result notification from the GUI. |

2 Firmware Update by Batch File

Parameter Descriptions of download-firmware-batch

| Parameter | Description |
|---------------|---|
| batch-file | This parameter is the name of the batch file. The name entered contains both the directory name and the actual file name. Up to 128 bytes can be entered. |
| invocation-id | This parameter is the command execution result ID assigned at the time of command execution. This is recorded in the result notification after the command execution is complete and is used to receive the command execution result notification from the GUI. |

Parameter Descriptions of update-firmware-batch

| Parameter | Description |
|------------------|---|
| batch-file | This parameter is the name of the batch file. The name entered contains both the directory name and the actual file name. Up to 256 bytes can be entered. |
| apply-action | This parameter is the action to perform after the firmware update. Although a reset is required to activate the new firmware after the firmware update, the firmware may be updated without performing the reset to prevent repeated resets. |
| maximum-cpu-load | This parameter is the maximum CPU load when applying the firmware. |
| invocation-id | This parameter is the command execution result ID assigned at the time of command execution. This is recorded in the result notification after the command execution is complete and is used to receive the command execution result notification from the GUI. |

3 Change NE Firmware

Parameter Descriptions of update-radio-unit-firmware

| Parameter | Description |
|---------------------------------|---|
| firmware-unit-name | This parameter is the name of the Firmware Unit. Up to 256 bytes can be entered. |
| connected-digital-unit-board-id | This parameter is the board ID of the DU, which is connected to the RRH. For example, if the RRH is connected to channel card #0, connected-digital-unit-board-id is 0. |

| Parameter | Description |
|--------------------------------|---|
| connected-digital-unit-port-id | This parameter is the port ID of the DU, which is connected to the RRH. For example, if the RRH is connected to port #0 of the channel card, connected-digital-unit-port-id is 0. |
| apply-action | This parameter is the action to perform after the firmware update. Although a reset is required to activate the new firmware after the firmware update, the firmware may be updated without performing the reset to prevent repeated resets. |
| invocation-id | This parameter is the command execution result ID assigned at the time of command execution. This is recorded in the result notification after the command execution is complete and is used to receive the command execution result notification from the GUI. |

Parameter Descriptions of update-EEPROM-firmware

| Parameter | Description |
|--------------------|---|
| firmware-unit-type | Indicates Firmware Unit Type for which the fusing needs to be activated. |
| firmware-unit-name | This parameter is the name of the Firmware Unit. Up to 256 bytes can be entered. |
| processor-unit-id | This parameter is the ID of the Processor Unit. |
| firmware-unit-id | This parameter is the ID of the Firmware Unit. |
| invocation-id | This parameter is the command execution result ID assigned at the time of command execution. This is recorded in the result notification after the command execution is complete and is used to receive the command execution result notification from the GUI. |

Parameter Descriptions of update-antenna-line-device-firmware

| Parameter | Description |
|---------------------------------|---|
| firmware-unit-name | This parameter is the name of the Firmware Unit. Up to 256 bytes can be entered. |
| connected-digital-unit-board-id | This parameter is the board ID of the DU connected to the RRH, which is connected to the ALD. For example, if the RRH connected to the ALD is connected to channel card #0, connected-digital-unit-board-id is 0. |
| connected-digital-unit-port-id | This parameter is the port ID of the DU connected to the RRH, which is connected to the ALD. For example, if the RRH connected to the ALD is connected to port #0 of the channel card, connected-digital-unit-port-id is 0. |
| antenna-line-device-id | This parameter is the ID of the ALD to update the firmware. |
| antenna-line-device-type | This parameter is the type of the ALD to update the firmware. <ul style="list-style-type: none"> ret-type: Remote Electrical Tilting tma-type: Tower Mounted Amplifier |
| invocation-id | This parameter is the command execution result ID assigned at the time of command execution. This is recorded in the result notification after the command execution is complete and is used to receive the command execution result notification from the GUI. |

Counters and KPIs

There are no specific counters or Key Performance Indicators (KPIs) associated with this feature.

REFERENCE

None

OAM-SW0601, SW Block Management

INTRODUCTION

This feature provides the functionality of monitoring the status of software blocks. If any software block is in abnormal status, it takes corrective action to recover from abnormal condition. During the recovery, related notifications are sent to the EMS.

BENEFIT

This feature guarantees the stable operation of software without the operator's intervention.

DEPENDENCY

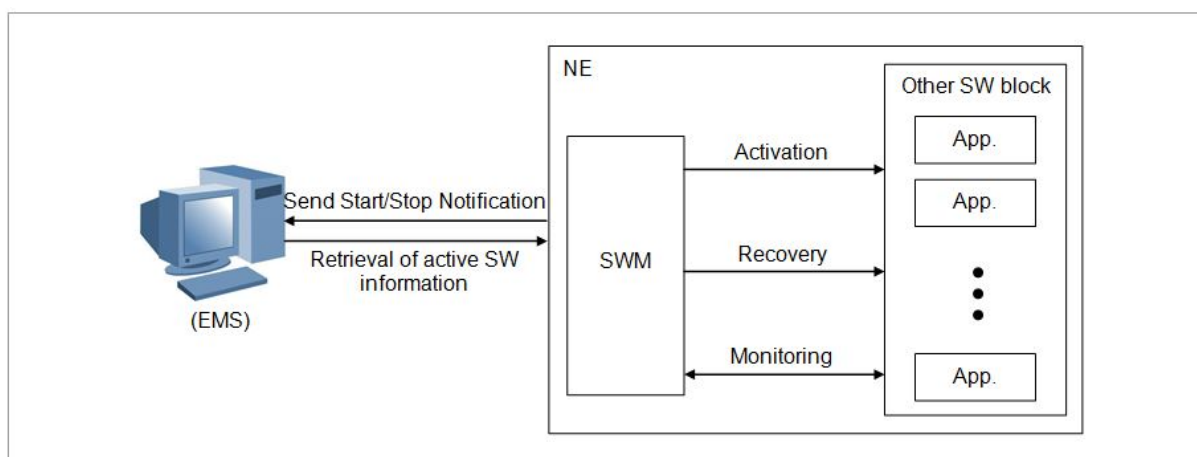
None

LIMITATION

None

FEATURE DESCRIPTION

This feature provides functionality of monitoring the status of software blocks. See the figure below for the detailed flow of the software block monitoring.



After installation and activation of the software blocks for the system or board initialization procedure, the status of all of the activated software blocks is checked periodically.

Several methods are used for determining whether the software blocks are normal or not:

- The monitoring block exchanges heartbeat message with all the activated

software blocks

- The monitoring block monitors the SIGCHLD signal as the parent process of all the other software blocks
- The monitoring block checks the status for all threads of any software blocks for the following abnormal status: dead lock, dead task, infinite loop, stopped task, and zombie task.

If any block is found to be in abnormal status, the monitoring block restarts it. The related software stop notification and software start notification is sent to the EMS.

The status information for the active software blocks can be retrieved by using CLI command "**RTRV-~~ACT-SW~~**" or "retrieve-active-software", which includes the image file name, image file size, checksum value, activation time, deactivation count, software version, and running status.

SYSTEM OPERATION

This section describes how to configure the feature in Samsung system and provides associated key parameters, counters, and KPIs.

How to Activate

This feature is enabled and the operator cannot disable.

Key Parameters

There are no specific parameters associated with this feature.

Counters and KPIs

There are no specific counters or Key Performance Indicators (KPIs) associated with this feature.

REFERENCE

None

OAM-SW0701, LMT (Local Maintenance Terminal) Loading

INTRODUCTION

This feature provides the functionality of loading the NE even if the EMS is in offline status and there is no package and configuration data saved in local storage of the NE.

Generally, the NE loads the latest package from the EMS during initialization. After loading is completed successfully, the NE backs up the running package to its local storage. If the EMS is not available or the local storage has same version of package as in the EMS, the NE may load the package from its local storage.

However, if the EMS is not available and there is no valid package saved in NE local storage, the NE has to be loaded with an external laptop PC (or LMT). After the NE and LMT are configured correctly, the NE downloads the image files and configuration data from the LMT. The software blocks are started one by one after the download is completed, which is same as the loading from the EMS.

BENEFIT

With this feature, the operator can download software package files and configuration data to the NE when the EMS is not working normally.

DEPENDENCY

Others

- For this feature, the NE needs to download package files and configuration data from the LMT via File Transfer Protocol (FTP). FTP server service shall be available in LMT.

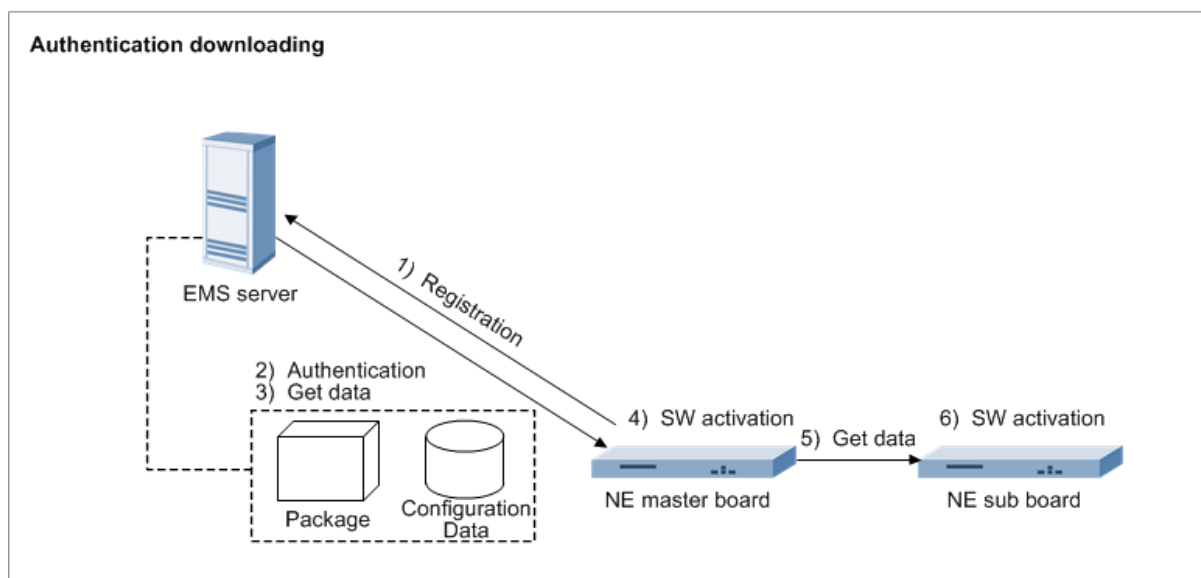
LIMITATION

If LMT loading is performed through the internal port, ENV re-configuration for communication with remote EMS is needed.

FEATURE DESCRIPTION

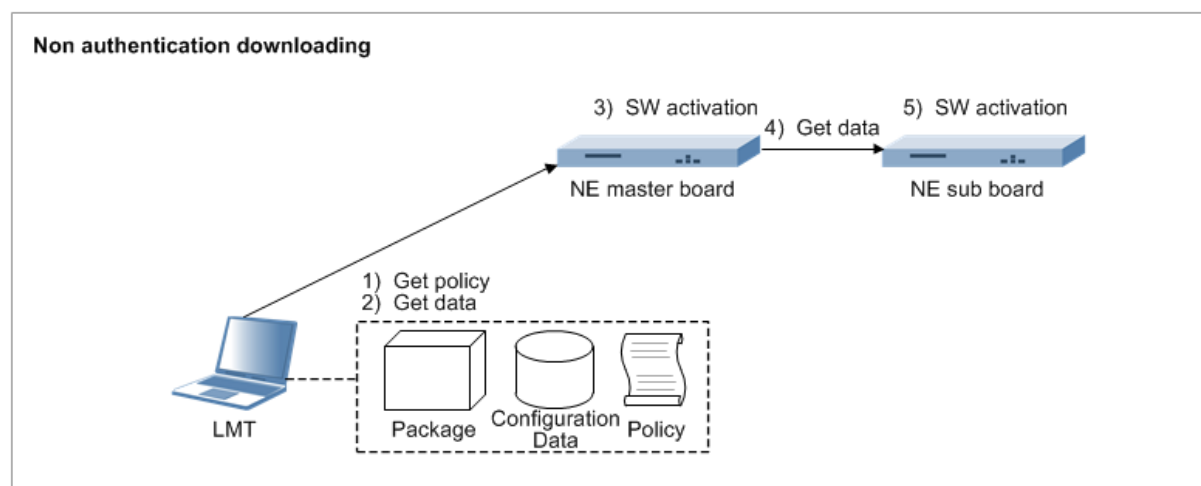
For bringing the NE up, there are two types of downloading methods: authentication downloading and non-authentication downloading. Generally, authentication downloading method is used. The NE sends registration request to the EMS, which sends back the registration response message to the NE. In the registration response message, the downloading required information is included: package version, release version, configured air interface technology, and time zone information.

The figure below depicts authentication downloading process.



However, if the EMS is not available during the system is downloading, non-authentication downloading has to be used.

The figure below depicts non authentication downloading process.



Downloading method depends on the configuration of environment variable in non-volatile memory. By default, the authentication downloading method is configured.

If the non-authentication downloading is configured by changing the value of environment variable by using CLI command "**CHG-ENV-INF**" or "change-environment", OAM software in NE does not send registration request to the server IP. Here the server IP is configured as LMT IP address. Instead, the OAM software downloads the system policy file from the specific directory of the LMT. The required information for downloading the NE is saved in that file.

The information saved in system policy file includes NE package version, release version, configured air interface technology, and time zone. They are similar as the information received by registration response message.

According to the information, the OAM software downloads the required software list file, the required block images, and database files. After that, the downloading procedure is same as the authentication downloading.

For the LMT downloading to be successful, it has to be configured correctly. The FTP server has to be configured with proper FTP user ID and password. The package has to be installed in the correct directory. The database files are copied from the backup version stored in EMS. A port for LMT downloading can be configured internal or external through CLI command "**CHG-LMTPORT-CONF**". See the LMT downloading manual for those configuration steps.

After the master board starts up successfully, the other boards and devices are loaded with the same procedure as authentication downloading method.

SYSTEM OPERATION

This section describes how to configure the feature in Samsung system and provides associated key parameters, counters, and KPIs.

How to Activate

This section provides the information that you need to configure the feature.

Preconditions

Ensure that the following conditions are met before enabling this feature:

- Prepare Server that includes package image for LMT Loading.

Activation Procedure

To activate this feature, do the following to set related ENV:

- 1 Execute change-environment RPC, and set "AUTH" ENV as "no".
- 2 Execute change-environment RPC, and set "PINGSKIP" ENV as "1".
- 3 Execute change-environment RPC, and set "LMT_LOADING" ENV as "external".

Deactivation Procedure

To deactivate this feature, do the following to delete related ENV:

- 1 Execute change-environment RPC, and set "AUTH" ENV as "".
- 2 Execute change-environment RPC, and set "PINGSKIP" ENV as "".
- 3 Execute change-environment RPC, and set "LMT_LOADING" ENV as "".

Key Parameters

This section describes the key parameters for activation, deactivation, and configuration of the feature.

Activation/Deactivation Parameters

There are no specific Activation/Deactivation parameters associated with this feature.

Configuration Parameters

To configure the feature settings, run the associated commands and set the key parameters.

Parameter Descriptions of change-environment

| Parameter | Description |
|-------------------|---|
| unit-type | This parameter is the unit type to set ENV. |
| unit-id | This parameter is the unit ID to set ENV. |
| subunit-id | This parameter is the sub-unit ID to set ENV. |
| environment-name | This parameter is the ENV name to set ENV. In case of LMT Loading, ENV name is "LMT_LOADING". |
| environment-value | This parameter is the value to be set. |

Counters and KPIs

There are no specific counters or Key Performance Indicators (KPIs) associated with this feature.

REFERENCE

None

Chapter 12 Test Management

OAM-TM0101, Test Management

INTRODUCTION

This feature is a management function for a test. The purpose of testing is to get information about the functionality and performance of network elements subject to the test. The operator can run it by on demand or by pre-defined schedule.

BENEFIT

This feature enables the operator to check whether the NE is normal or not. On-line test is performed without operator intervention.

DEPENDENCY

None

LIMITATION

None

SYSTEM IMPACT

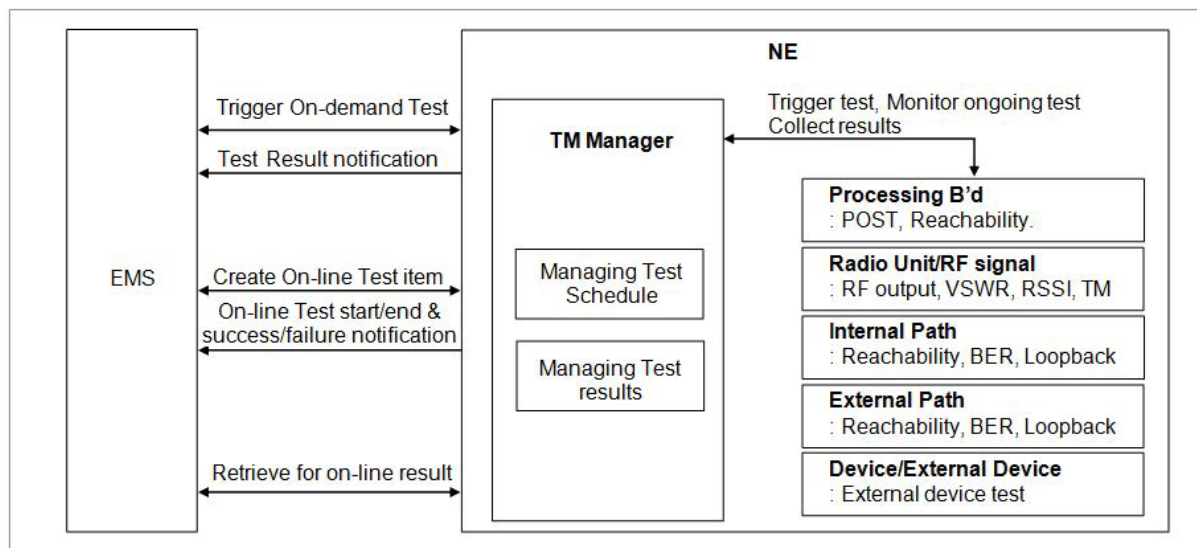
The implementation of this feature does not have any impact on the network.

FEATURE DESCRIPTION

Test management provides the commands to check whether the internal/external connection paths, self-configuration test, and resources are normal. This execution is done by both the on-demand test and the on-line test scheduled by the operator.

On-demand test is test method triggered by operator's CLI command. In case of on-demand test, test jobs are executed as soon as it is received. The request is sent to the desired NE and the NE sends the trigger response to the operator as OK/NOK. If response is OK, the specific test is performed. After on-demand test, the NE transfers notification of the test result to the EMS. If test result is failed, it displays the error reason for the test failure.

Test Management and test object are depicted in the figure below.



On-line test is test method automatically triggered by pre-defined schedule. On-line test item is issued by the operator. This request is received by the NE. The NE stores all the requested test items and sends the response to the operator. The operator can now perform the on-line test by configuring the start time and the end time for the specified test item. The NE starts performing the specific test when the scheduled start time matches the current time of the system. When the test is completed, result notification is sent to the operator. On-line test is executed up to 10 item information per test item at the same time. The result of test can be stored up to 30 per test item.

The types of on-line test that can be performed on the system are external ping test, internal ping test, trace route test, traffic path test, Tx power, and RSSI test. The types of on-line test can be varied according to system.

For on-line test, the operator needs to set the below parameters:

- Test state: This specifies the state of the on-line test scheduler.
- Test Start Time: This specifies the on-line test start time.
- Test End Time: This specifies the on-line test end time.
- Test Period: This specifies the on-line test interval in seconds

SYSTEM OPERATION

This section describes how to configure the feature in Samsung system and provides associated key parameters, counters, and KPIs.

How to Activate

This feature is executed by pre-defined schedule or user command.

The operator can perform the Diagnosis test on the Network element in two ways:

- Periodic Online Test (Pre-defined schedule)

- Online tests allow the operator to configure diagnosis tests to run on periodic basis.
- It provides facility for the operator to schedule periodic tests to run from a specified time till the configured end time.
- The corresponding test needs to be registered using [ENB, MCE, IBS] online-test-schedule. This would enable the test to be performed when the actual time occurs for the test to be performed.
- Once registered, the test can be modified using [ENB, MCE, IBS] online-test-schedule.
- Once registered, the test can be deleted using [ENB, MCE, IBS] online-test-schedule.
- By using the below command, set the test items in advance.
 - ◆ [ENB, MCE, IBS] external-ping-info
 - ◆ [ENB, MCE, IBS] trace-route-info
 - ◆ [ENB, MCE, IBS] internal-ping-info
 - ◆ [ENB] tx-power-info
- On-Demand Test (User command)
 - On-Demand tests allow the operator to execute diagnostic commands at the moment.
 - See other features in Test Management.

Key Parameters

This section describes the key parameters for configuration of the feature.

Configuration Parameters

To configure the feature settings, run the associated commands and set the key parameters.

Parameter Descriptions of [ENB, MCE, IBS] online-test-schedule

| Parameter | Description |
|-------------------|--|
| online-test-id | The online test schedule registration ID. Up to 50 tests can be registered. |
| state | The scheduler status of the online test. Only when the state is RUN_ONLINE, the scheduler is activated and the test is performed at the set period. |
| test-item | The type of online tests that can be performed on the system. |
| test-item-info-id | The ID used for identifying the information registered for the online test. |
| period | The online test execution period (seconds). |
| start-time | It is the start time for online tests. START_TIME must be earlier than END_TIME. The time input format is YYYY/MM/DD_HH:MM. If it is not entered, the current time is entered by default and the test specified in test ID is performed immediately. For example, 2010/03/29_19:18 |

| Parameter | Description |
|-----------|--|
| end-time | It is the end time for online tests. END_TIME must be later than the current time and later than START_TIME. The time input format is YYYY/MM/DD_HH:MM. If it is not entered, the online test is performed for 6 hours from the current time by default. For example, 2010/03/29_19:18 |

Counters and KPIs

There are no specific counters or Key Performance Indicators (KPIs) associated with this feature.

REFERENCE

None

OAM-TM0201, Internal Path Test

INTRODUCTION

This feature is to diagnose the internal communication path by ping test from the given NE master board (source) to all the operator-specified slave boards.

BENEFIT

This feature enables the operator to easily locate faulty connectivity between master board and the specified slave boards.

DEPENDENCY

HW dependency: This feature is supported at only the processing board not the device board such as RU.

LIMITATION

None

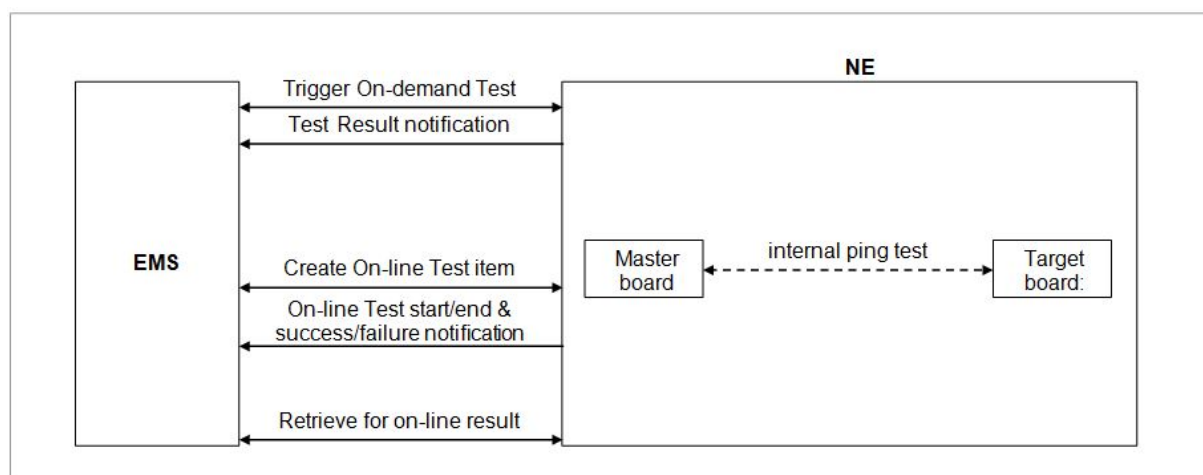
SYSTEM IMPACT

The implementation of this feature does not have any impact on the network.

FEATURE DESCRIPTION

Internal path test provides the ability to test the Inter Processor Communication (IPC) paths between the main board and the sub board. This execution is done by both the on-demand test and the on-line test scheduled by the operator.

The figure below depicts the Internal Path Test procedure.



The operator can execute the Internal Path Test by using **test-internal-ping** command. When performing the test, the operator needs to select the target board. The NE notifies of test result to the EMS when the test is completed. If the result of the test is abnormal, the result is displayed as "NOK" with the reason.

SYSTEM OPERATION

This section describes how to configure the feature in Samsung system and provides associated key parameters, counters, and KPIs.

How to Activate

This section provides the information that you need to configure the feature.

Preconditions

There are no specific preconditions to activate this feature.

Activation Procedure

Run [ENB, MCE, IBS] **test-internal-ping** to execute the Internal Path test.

Deactivation Procedure

The feature does not need to be deactivated.

Key Parameters

This section describes the key parameters for activation and deactivation of the feature.

Activation Parameters

To activate or deactivate the feature, run the associated commands and set the key parameters.

Parameter Descriptions of [ENB, MCE, IBS] **test-internal-ping**

| Parameter | Description |
|-----------|--|
| unit-type | The type of the target processor board on which the internal ping test is to be performed. |
| unit-id | The ID of the target board on which the internal ping test is to be performed. |

Counters and KPIs

There are no specific counters or Key Performance Indicators (KPIs) associated with this feature.

REFERENCE

None

OAM-TM0202, External Path Test

INTRODUCTION

The functionality of the External Path Test performs a ping test from the system to the specified destination for checking connectivity.

BENEFIT

The External Path Test enables the operator to easily locate faulty connectivity between system and the specified destination.

DEPENDENCY

None

LIMITATION

None

SYSTEM IMPACT

The implementation of this feature does not have any impact on the network.

FEATURE DESCRIPTION

The External Path Test provides the ability to test the connectivity between the system and the specified destination. The external ping test and trace route test is used for external path test. Test execution is done by both the on-demand test and the on-line test scheduled by the operator.

External Ping Test

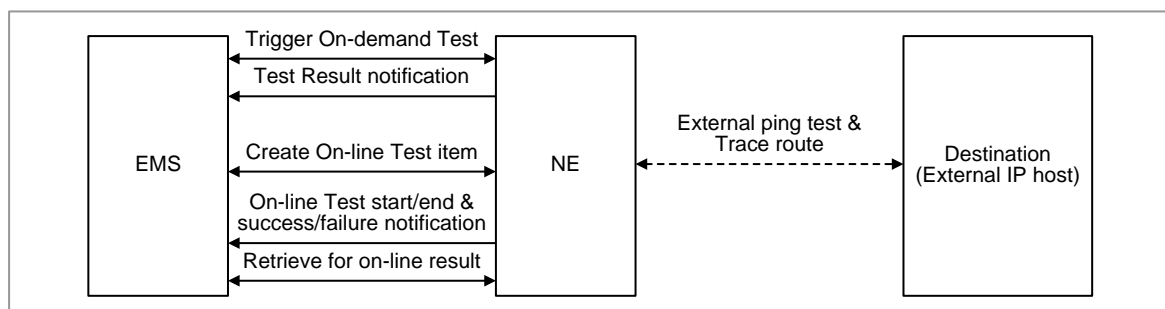
The External Path Test provides the ability to test the network connection between the system and the specified destination. In the external ping test, ICMP packet is created and a ping test is run with this to monitor the performance of an external interface. When performing the external ping test, the operator can enter the destination IP version, IP address, DSCP, packet size, packet number per second, and duration. As a test result, packet delay, packet delay minimum, maximum, average and packet loss, packet loss threshold, Round Trip Time (RTT) threshold, and RTT jitter threshold are notified to the EMS.

Trace Route Test

The Trace Route Test provides the ability to test the network path between the system and the specified destination. When performing the trace route test, the operator can enter the destination IP address. It can identify a problematic network in terms of the external path. For the trace route test, the destination IP version can

be specified optionally, and DSCP value can be specified. The test results are evaluated as normal only if all hops along the path to the destination are normal. If the test result is NOK, it means that the path to the target is disconnected. As a test result, destination IP addresses, source IP address, hop address, and delay time are notified to the EMS.

The figure below depicts the External Path Test procedure.



On-demand test is the test method that is triggered by operator's CLI command. If the external destinations have the same virtual IP address, the operator must enter VR ID for identifying the specified destination. In case of external ping test or trace route test, test jobs are executed as soon as it is received. After on-demand test, the NE transfers notification of test result to the EMS.

On-line test is the test method that is automatically triggered by periodic schedule. In case of external ping test or trace route test, the operator can configure start time, test item, and period for on-line test through CLI command. Therefore, the NE can periodically execute of test function according to pre-defined schedule. After on-line periodic test, the NE transfers notification of test result per every schedule of on-line test. The NE stores the history of test results for on-line test. The operator can retrieve the history of on-line test result. On-line test is executed up to 10 test item at the same time. The result of test can be stored up to 30 per test item.

SYSTEM OPERATION

This section describes how to configure the feature in Samsung system and provides associated key parameters, counters, and KPIs.

How to Activate

This section provides the information that you need to configure the feature.

Preconditions

There are no specific preconditions to activate this feature.

Activation Procedure

Run **[ENB, MCE, IBS] test-external-ping** or **[ENB, MCE, IBS] test-trace-route** to execute the External Path test.

Deactivation Procedure

The feature does not need to be deactivated.

Key Parameters

This section describes the key parameters for activation and deactivation of the feature.

Activation Parameters

To activate or deactivate the feature, run the associated commands and set the key parameters

Parameter Descriptions of [ENB, MCE, IBS] test-external-ping

| Parameter | Description |
|---------------------|---|
| dest-ip-version | This is IP Version of destination IP address. |
| dest-ipv4-address | This is a destination address IPv4 for external ping test. |
| dest-ipv6-address | This is a destination address IPv6 for external ping test. |
| dscp | This parameter is the Differentiated Services Code Point (DSCP), which is specified to allocate services of different levels on the network traffic |
| packet-size | This parameter is the packet size to transmit while performing the External Ping Test. The input range is 56 bytes to 1024 bytes |
| packet-per-sec | This parameter is the packet count to transmit each second while performing the External Ping Test |
| try-sec | This parameter is the time for performing the External Ping Test |
| source-option | This is an option for using Source IP Address (USED_FLAG_OFF: 0, USED_FLAG_ON: 1). If USED_FLAG_ON is selected, the source IP address is used to user input address. Otherwise it applies to automatically. |
| source-ip-version | This is IP Version of source IP address. |
| source-ipv4-address | This is a source address IPv4 for external ping test. |
| source-ipv6-address | This is a source address IPv6 for external ping test. |
| vr-id | This is a virtual routing ID for external ping test. |

Parameter Descriptions of [ENB, MCE, IBS] test-trace-route

| Parameter | Description |
|--------------------------|---|
| destination-ip-version | This is IP Version of destination IP address. |
| destination-ipv4-address | This is a destination address IPv4 for trace route test. |
| destination-ipv6-address | This is a destination address IPv6 for trace route test. |
| vr-id | This is a virtual routing ID for trace route test. |
| dscp | This parameter is the Differentiated Services Code Point (DSCP), which is specified to allocate services of different levels on the network traffic |

Counters and KPIs

There are no specific counters or Key Performance Indicators (KPIs) associated with this feature.

REFERENCE

None

OAM-TM0301, CPRI Loopback Test

INTRODUCTION

With this feature, you can diagnose the Common Public Radio Interface (CPRI) path between DU and RU in MBS, local and remote loopbacks between DU and RU, using the remote type (RU_MGT, RU_MAPPER).

BENEFIT

This feature can be used to verify the faulty section between the DU and RU.

DEPENDENCY

- HW dependency:
 - Not Supported: The Split function option 2 for Massive MIMO Access Unit
 - The support of this feature is determined according to the system type.
- Others: Before executing the CPRI loopback test, the target cell that is related with target RU must be in lock state. In cascade configuration, cells of all RUs that are connected to target RU must be in lock state.

LIMITATION

None

SYSTEM IMPACT

The implementation of this feature does not have any impact on the network.

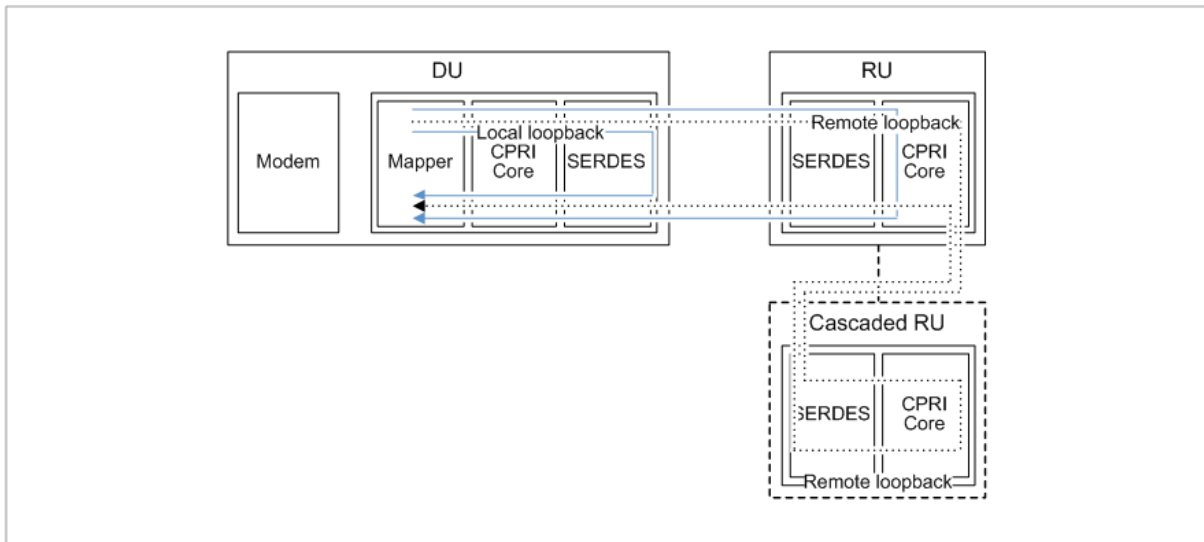
FEATURE DESCRIPTION

The CPRI Loopback Test is performed on connection paths between the DU and RU or within the DU. The test can be done by on-demand test.

The following two types of loopback test are supported:

- Local loopback within the DU
- Remote loopback between the DU and RU (RU_MGT, RU_MAPPER)

The local and remote loopback tests are depicted in the figure below.



The operator can execute the CPRI Loopback Test by using **test-loopback** command. When performing the test, the operator needs to select the type target board, port, and test type. Before executing the CPRI loopback test, the cell grown in the target RU must be in locked state. If the CPRI loopback test is executed normally, the result is notifications.

The Local Loopback Test is performed between DU_MAPPER and DU_MGT. Remote loopback test is performed between the DU and RU. The operator can select the type of remote loopback test among the two types (RU_MGT, RU_MAPPER).

For the Remote Loopback Test, local loopback test and remote loopback test are performed sequentially. The test result is evaluated as normal only if the results from both the local and remote loopback tests are normal.

SYSTEM OPERATION

This section describes how to configure the feature in Samsung system and provides associated key parameters to customize the configuration settings.

How to Activate

This section provides the information that you need to configure the feature.

Preconditions

Ensure that the following condition is met before enabling this feature:

- At least one RU has to be connected with DU for the loopback test.

Activation Procedure

Run **[ENB] test-loopback** to execute loopback test.

Deactivation Procedure

The feature does not need to be deactivated.

Key Parameters

This section describes the key parameters for activation and deactivation of the feature.

Activation/Deactivation Parameters

To activate or deactivate the feature, run the associated commands and set the key parameters.

Parameter Descriptions of [ENB] test-loopback

| Parameter | Description |
|---------------------------------|--|
| loopback-type | This leaf is the Loopback type to test. <ul style="list-style-type: none"> • du-management: Packets are looped back at the management in the FPGA/SOC of the DU where CPRI frames are converted to physical signals. • ru_management: Packets are looped back at the management in the FPGA of the RRH where physical signals are converted to CPRI frames as opposed to du-management. • ru-mapper: Packets are looped back at the MAPPER in the FPGA of the RRH where CPRI signals are converted to I/Q signals |
| unit-type | This is the type of the target processor board on which the DU-RU loop back test is to be performed. |
| connected-digital-unit-board-id | This is a target Board ID. It is used to perform DU-RU loop back test on specific board ID. |
| connected-digital-unit-port-id | This is a target Port ID. It is used to perform Loopback test on specific Port ID. |
| cascade-radio-unit-id | This is a cascade ID of the DU port connected to the target unit to test |

Counters and KPIs

There are no specific counters or Key Performance Indicators (KPIs) associated with this feature.

REFERENCE

None

OAM-TM0302, CPRI BER Test

INTRODUCTION

This feature is to diagnose CPRI path between the DU and RU in MBS; Bit Error Rate (BER) calculation at specific RU optic port on the provided board through communication link between DU and RU.

BENEFIT

This feature is used to prevent failures by testing the system and to verify link quality.

DEPENDENCY

HW dependency: The support of this feature is determined according to the system type.

LIMITATION

None

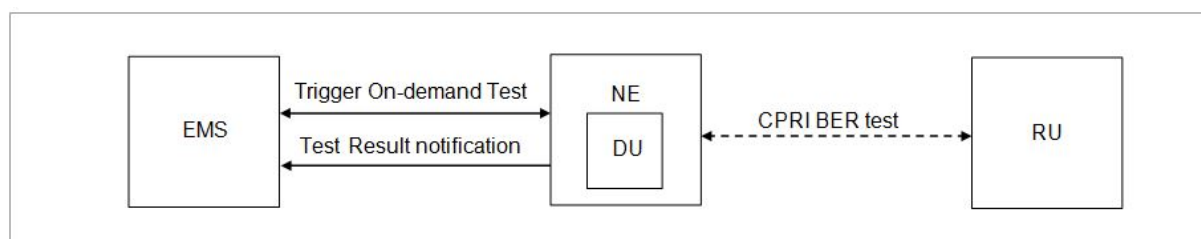
SYSTEM IMPACT

The implementation of this feature does not have any impact on the network.

FEATURE DESCRIPTION

The CPRI BER Test is performed on connection paths between the DU and RU or in the DU. This test can be executed on service and up to the available target port ID at the same time. When performing the CPRI BER test, the operator can enter type and ID of target board, port ID, the number of iterations and interval period (in minutes) between two consecutive BER tests.

The figure below depicts the CPRI BER Test procedure.



The test performs the bit error rate calculation test at specific RRU optic port on the given board through communication Link between the DU and RU. BER is defined as the ratio of erroneous bits to total number of transmitted bits. BER is calculated by checking the Bit Interleaved Parity (BIP) of the received CPRI frame. Notifications are transferred to the EMS at every specified interval. BER

results are accumulated until the test ends.

SYSTEM OPERATION

This section describes how to configure the feature in Samsung system and provides associated key parameters, counters, and KPIs.

How to Activate

This section provides the information that you need to configure the feature.

Preconditions

There are no specific preconditions to activate this feature

Activation Procedure

Run **[ENB] test-ber** to execute Bit Error Rate test.

Deactivation Procedure

The feature does not need to be deactivated.

Key Parameters

This section describes the key parameters for activation and deactivation of the feature.

Activation Parameters

To activate or deactivate the feature, run the associated commands and set the key parameters.

Parameter Descriptions of **[ENB] test-ber**

| Parameter | Description |
|---------------------------------|--|
| unit-type | This is the type of the target processor board on which the BER test is to be performed. |
| connected-digital-unit-board-id | This is target Board ID. It is used to perform BER test on specific board ID. |
| connected-digital-unit-port-id | This is target Port ID. It is used to perform BER test on specific Port ID. |
| cascade-radio-unit-id | This is target Cascade ID. It is used to perform BER test on specific Port ID. |
| iteration | It carries count of BER test report. It signifies how many times to perform the BER test. |
| interval | It carries interval of BER test. This is the time duration gap between two iterations. (Unit: min) |

Counters and KPIs

There are no specific counters or Key Performance Indicators (KPIs) associated with this feature.

REFERENCE

None

OAM-TM0303, CPRI Optic Length Test

INTRODUCTION

This feature measures the optic length between the DU and RU or cascaded RUs.

BENEFIT

This function is used to verify CPRI length without external device.

DEPENDENCY

HW dependency: The support of this feature is determined according to the system type.

LIMITATION

None

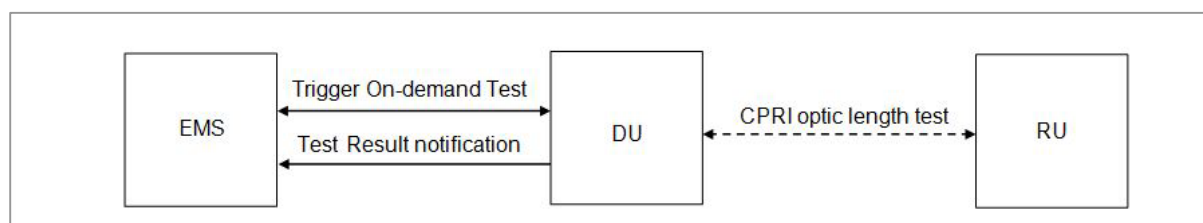
SYSTEM IMPACT

The implementation of this feature does not have any impact on the network.

FEATURE DESCRIPTION

The CPRI Optic Length Test provides information on the section connected through the optical link between the DU and RU. This test is executed by gathering data such as round-trip time between the DU and RU. CPRI optic length is calculated using round-trip time data and RU delay in the DU. The real round-trip time is obtained by subtracting self-delay of RU from the round-trip time. CPRI optic length is calculated by multiplying velocity and the real round-trip time/2. Depending on type of fiber, the velocity can be different value.

CPRI optic length test is depicted in the figure below.



In CPRI Optic Length Test, the operator selects the processing board and the port that are connected to the RU. After on-demand test, the NE transfers notification of test result, such as CPRI optic length, to the EMS.

SYSTEM OPERATION

This section describes how to configure the feature in Samsung system and provides associated key parameters, counters, and KPIs.

How to Activate

This section provides the information that you need to configure the feature.

Preconditions

There are no specific preconditions to activate this feature

Activation Procedure

Run **[ENB] test-optic-distance** to execute the Optic Length Test.

Deactivation Procedure

The feature does not need to be deactivated.

Key Parameters

This section describes the key parameters for activation and deactivation of the feature.

Activation Parameters

To activate or deactivate the feature, run the associated commands and set the key parameters.

Parameter Descriptions of **[ENB] test-optic-distance**

| Parameter | Description |
|---------------------------------|--|
| unit-type | This is the type of the target processor board on which the Optic Delay test is to be performed. |
| connected-digital-unit-board-id | This is a target Board ID. It is used to perform the Optic Delay test on specific board ID. |
| connected-digital-unit-port-id | This is a target Port ID. It is used to perform the Optic Delay test on specific Port ID. |

Counters and KPIs

There are no specific counters or Key Performance Indicators (KPIs) associated with this feature.

REFERENCE

None

OAM-TM0401, Tx Power and Rx Path Test

INTRODUCTION

This feature tests the Tx path and Rx path of the RU by measuring the Tx RF output and the Received Signal Strength Indicator (RSSI) level.

BENEFIT

This feature enables the operator to verify whether Tx power of RU is normal or not and value of RSSI.

DEPENDENCY

None

LIMITATION

Only on-demand test is available on MMU. (Online test is not available on MMU)

SYSTEM IMPACT

The implementation of this feature does not have any impact on the network.

FEATURE DESCRIPTION

The Tx Power and Rx Path Test is used to measure the base station Tx RF power and RSSI levels.

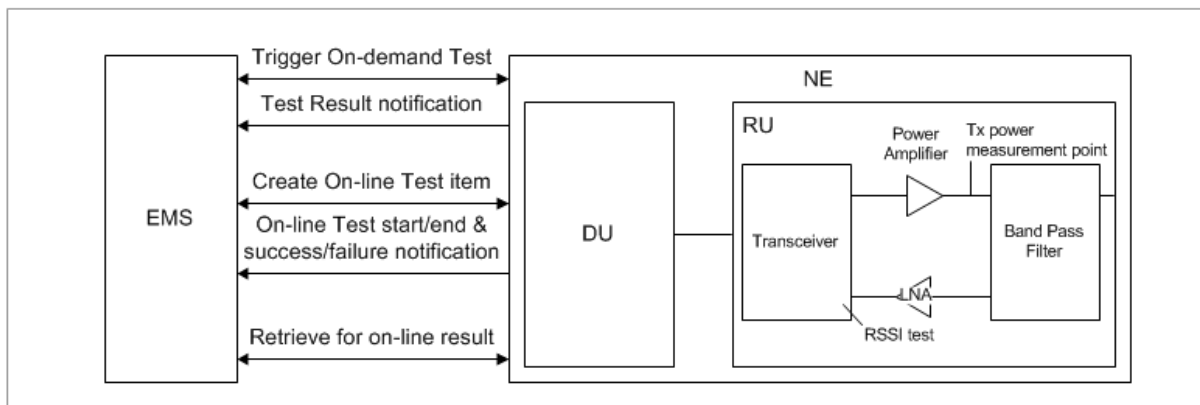
Tx Power Test

The Tx Power Test is executed per the Tx path of the RU. The Tx RF power is measured at rear stage of power amplifier in the RU. The measured RF value is transformed to dBm and it is checked with the threshold ranges. The test displays both the measured power and whether it is normal or not. It requires the actual RU to be connected to the system.

RSSI Test

The RSSI Test is executed per the Rx path of the RU. The RSSI level is measured at transceiver in the RU and the measured value is displayed. The test requires actual RU to be connected to the system.

The Tx Power and Rx Path test are depicted in the figure below.



On-demand test is performed to check the transmission signal strength of the RU. The operator can check the transmitted output RF power value to verify the signal strength of the Radio Unit. When performing the Tx Power and Rx Path Test, the operator selects the RU for which the actual Tx power test is performed. After on-demand test, the NE transfers the notification of test result to the EMS such as event time, RSSI per carrier, and Tx power per path.

The TX Power and RSSI Test can be performed on-line, which is executed within the scheduled time configured in command. Based on the scheduled start time and end time, base station transfers notification of test result per every schedule of on-line test. The NE stores the history of test results for on-line test. The operator can retrieve the history of on-line test result. On-line test is executed up to 10 test item at the same time. The result of test can be stored up to 30 per test item.

SYSTEM OPERATION

This section describes how to configure the feature in Samsung system and provides associated key parameters, counters, and KPIs.

How to Activate

This section provides the information that you need to configure the feature.

Preconditions

There are no specific preconditions to activate this feature

Activation Procedure

Run **[ENB] test-tx-power** to execute the Tx Power and Rx Path Test.

Deactivation Procedure

The feature does not need to be deactivated.

Key Parameters

This section describes the key parameters for activation, deactivation, and configuration of the feature.

Activation Parameters

To activate or deactivate the feature, run the associated commands and set the key

parameters.

Parameter Descriptions of [ENB] test-tx-power

| Parameter | Description |
|---------------------------------|---|
| unit-type | This is the connected board type of the target RU to test. The board type varies by the system configuration. |
| connected-digital-unit-board-id | This is the board ID of the DU connected to the target unit to test. |
| connected-digital-unit-port-id | This is the port ID of the DU connected to the target unit to test. |
| cascade-radio-unit-id | This is the cascade ID of the RRH port connected to the target unit to test. |

Counters and KPIs

There are no specific counters or Key Performance Indicators (KPIs) associated with this feature.

REFERENCE

None

OAM-TM0402, VSWR Test

INTRODUCTION

This feature is to measure the return loss and verify the RF output power transmission to antenna.

BENEFIT

This feature enables operator to check the normalcy of the transmit path to antenna remotely.

DEPENDENCY

Others: Threshold of RF output for VSWR test can be different values according to system type.

LIMITATION

None

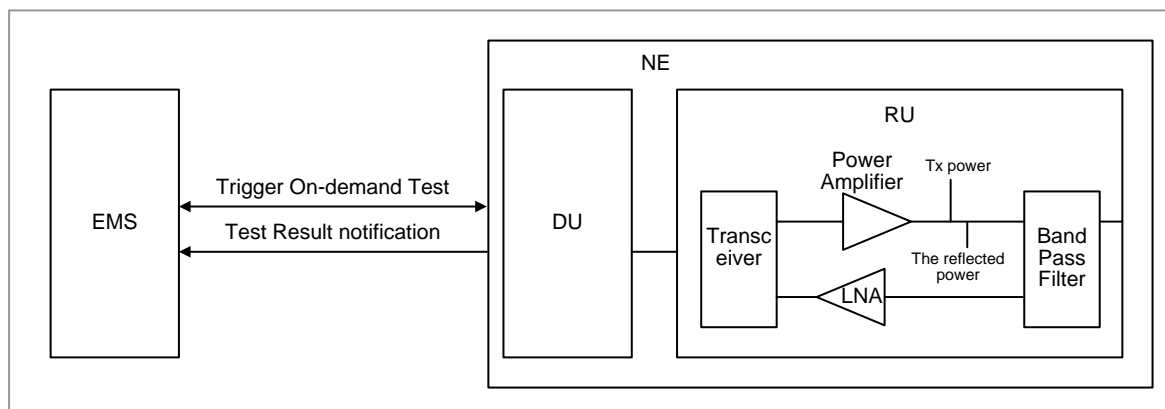
SYSTEM IMPACT

The implementation of this feature does not have any impact on the network.

FEATURE DESCRIPTION

The Voltage Standing Wave Ratio (VSWR) test is performed by the operator for verifying antenna connection. The test is executed per RF path. The return loss is the ratio of the Tx power and the reflected power in decibels. The greater the return loss value is, the less the power loss is. Tx power is measured at rear stage of power amplifier and the reflected power is measured in front of duplexer. VSWR is the ratio of the amplitude of voltage at a maximum voltage point and the amplitude of voltage at a neighboring minimum voltage point. The less VSWR value is, the less the power loss is. Return loss and VSWR are identical indicators of the reflected wave, with the only difference in the method of calculation. To execute the VSWR test, the state of the test cell must be unlock. The level of RF output for the VSWR test can be different values according to the system type. When the RF output is less than the specific level, the test is not executed and the system notifies the operator of error message. This execution is done by both the on-demand test and the on-line test scheduled by the operator.

The figure below depicts the VSWR Test procedure.



On-demand test is performed to check the VSWR of the antenna. When performing the VSWR test, the operator selects RU for which the actual VSWR test is performed. After on-demand test, the NE transfers notification of test result to the EMS such as return loss per path, VSWR per path, and so on. If test result is failed, it displays the error reason for test failure.

SYSTEM OPERATION

This section describes how to configure the feature in Samsung system and provides associated key parameters, counters, and KPIs.

How to Activate

This section provides the information that you need to configure the feature.

Preconditions

There are no specific preconditions to activate this feature

Activation Procedure

Run **[ENB] test-vswr** to execute the VSWR Test.

Deactivation Procedure

The feature does not need to be deactivated.

Key Parameters

This section describes the key parameters for activation and deactivation of the feature.

Activation Parameters

To activate or deactivate the feature, run the associated commands and set the key parameters.

Parameter Descriptions of **[ENB] test-vswr**

| Parameter | Description |
|-----------|---|
| unit-type | This is the connected board type of the target RU to test. The board type varies by the system configuration. |

| Parameter | Description |
|---------------------------------|--|
| connected-digital-unit-board-id | This is the board ID of the DU connected to the target unit to test. |
| connected-digital-unit-port-id | This is the port ID of the DU connected to the target unit to test. |
| cascade-radio-unit-id | This is the cascade ID of the RRH port connected to the target unit to test. |

Counters and KPIs

There are no specific counters or Key Performance Indicators (KPIs) associated with this feature.

REFERENCE

None

OAM-TM0501, TM (Test Model) Test

INTRODUCTION

This feature enables you to check the conformance by artificially generating traffic, and then measuring the output properties. The DU (DSP) specifies the property items defined in the standard (E-UTRAN test models) for RF property tests. The RF output originated from the DSP can be verified.

BENEFIT

With this feature, you can verify the accuracy of RF power and the transmitted signal quality.

DEPENDENCY

None

LIMITATION

TM test causes service outage.

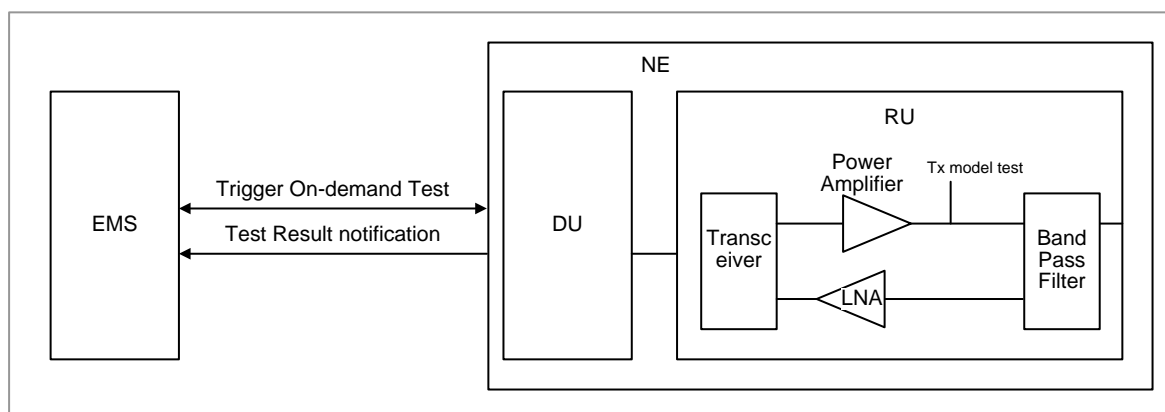
SYSTEM IMPACT

The implementation of this feature does not have any impact on the network.

FEATURE DESCRIPTION

To perform the TM (Test Model) Test, the administrative state must be unlocked and the operational state must be enabled. Moreover, TM test at MME communication failure also can be supported. The traffic corresponding to the specified model type is generated. You can connect a measuring instrument to the output terminal to check whether the traffic is actually generated.

The figure below depicts the TM (Test Model) Test procedure.



You can trigger the on-demand test by CLI command. Six different types of model tests are supported and the setup of the physical channels for transmitter tests is according to one of these types:

- Test Model 1.1 (E-TM1.1) is used for the eNB output power, transmitter intermodulation, Reference Signal (RS) absolute accuracy, and unwanted emissions.
- Test Model 1.2 (E-TM1.2) is used for the Adjacent Channel Leakage Ration (ACLR) and operating band unwanted emissions.
- Test Model 2 (E-TM2) is used for the Total power dynamic range (the lower OFDM symbol power limit at minimum power), EVM of single 64QAM PRB allocation (at minimum power), and frequency error (at minimum power).
- Test Model 3.1 (E-TM3.1) is used for the Total power dynamic range (the upper OFDM symbol power limit at maximum power with all 64QAM PRBs allocated), frequency error, and EVM for 64QAM modulation (at maximum power).
- Test Model 3.2 (E-TM3.2) is used for the frequency error and Error Vector Magnitude (EVM) for 16QAM modulation.
- Test Model 3.3 (E-TM3.3) is used for the frequency error and EVM for QPSK modulation.

The signals defined in 3GPP TS 36.141 are transmitted to the base station output according to the selected type.

When performing the TM test, you can specify the target cell number and the ID of property item. You can also stop the test. The base station transfers the start and result notifications of the test. For multiple carriers in the RU, you can configure different PCIDs for each carrier.

SYSTEM OPERATION

This section describes how to configure the feature in Samsung system and provides associated key parameters, counters, and KPIs.

How to Activate

This section provides the information that you need to configure the feature.

Preconditions

Ensure that the following condition is met before enabling this feature:

- RU that is connected to the DU to proceed with the TM test.

Activation Procedure

Run **[ENB] test-model** to execute the TM (Test Model) Test.

Deactivation Procedure

The feature does not need to be deactivated.

Key Parameters

This section describes the key parameters for activation and deactivation of the feature.

Activation/Deactivation Parameters

To activate or deactivate the feature, run the associated commands and set the key parameters.

Parameter Descriptions of [ENB] test-model

| Parameter | Description |
|------------------|---|
| cell-number | The cell number for which the model test is to be performed. |
| model-id | This is the ID of the property item defined in the standard for performing the model test. The signals defined in 3GPP TS 36.141 are transmitted to the BS output according to the type selected. |
| physical-cell-id | The PC ID for which the model test to be performed. |

Counters and KPIs

There are no specific counters or Key Performance Indicators (KPIs) associated with this feature.

REFERENCE

[1] 3GPP TS 36.141 "Evolved Universal Terrestrial Radio Access (E-UTRA); Base Station (BS) conformance testing"

OAM-TM0502, OCNS (Orthogonal Channel Noise Simulator) Test

INTRODUCTION

The Samsung Orthogonal Channel Noise Simulator (OCNS) Test provides the functionality to generate artificial load when a load is required for the field test.

BENEFIT

This feature helps the operator estimate the effect of increased load in the field. It can make the field test more efficient in cost and time by simplifying the testing and reducing the number of real User Equipment (UE).

DEPENDENCY

None

LIMITATION

None

SYSTEM IMPACT

The implementation of this feature does not have any impact on the network.

FEATURE DESCRIPTION

The feature provides the functionality to generate artificial load when load is required for the field test. For activating OCNS, the operational state of target cell should be enabled.

OCNS is the function transmitting the artificial DL signal for a test without a real UE. OCNS makes DL signal by generating random packets and allocating RBs for virtual UE.

For all traffic symbols within DL subframe, RBs are occupied by the generated random packet according to OCNS load setting. Control channel such as PDCCH, PCFICH, and PHICH within the control signal region are transmitted regardless of OCNS setting. SYNC and PBCH are also transmitted as the control channel. Thus, the real UE can connect to the cell with OCNS loading.

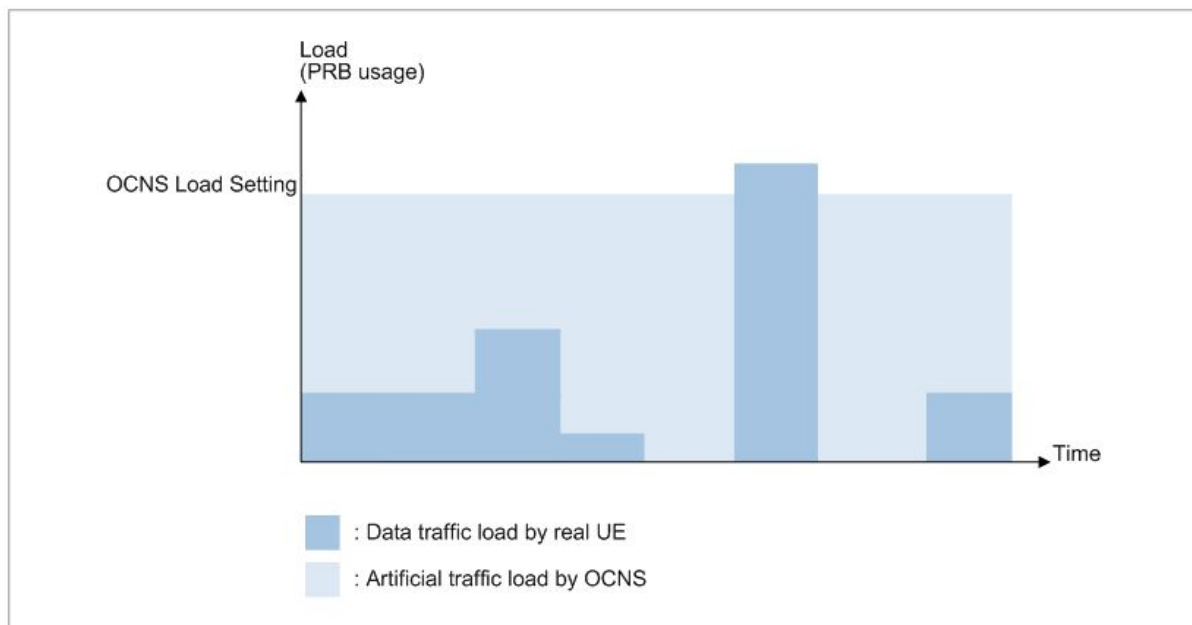
This feature generates the artificial load to meet the target load level, which is configured by the operator, based on the real UE load. When a real UE requires data traffic, resource allocation for the real UE has to perform regardless of OCNS loading. To do resource allocation for real UEs, data traffic of real UEs has priority over that of virtual UE generated by OCNS.

The feature fills up the number of Physical Resource Blocks (PRBs) up to the

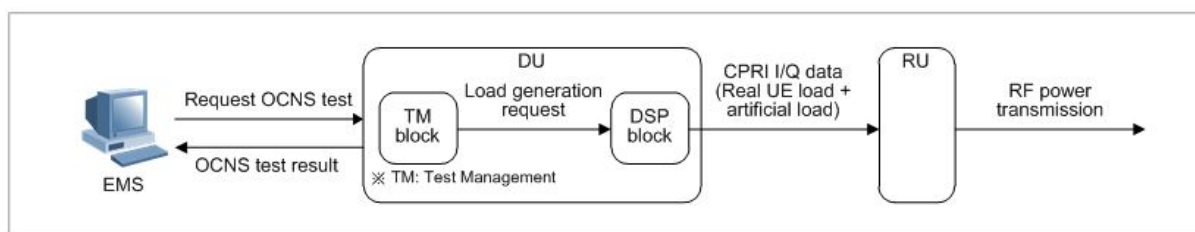
required level. First of all, RB allocation for real UEs is performed with no consideration of OCNS loading.

If the number of RBs for real UEs is less than OCNS load setting, the OCNS load of virtual UE is added to meet OCNS load setting. For example, if OCNS load is set to 50 % for 10 MHz BW and number of RBs for real UEs is 15 (= 15 RBs/50 RBs = 30 %), 10 RBs (= 10 RBs/50 RBs = 20 %) is allocated to OCNS load. If the number of RBs for real UEs is more than OCNS load setting, the OCNS load of virtual UE is not added. Down Link (DL) power is transmitted on the target load level.

RB allocation with OCNS is depicted in the figure below.



The operation scenario of this feature is depicted in the figure below.



If the EMS operator enters the OCNS test execution command, the DSP block in the DU generates the load and transfers it to the Radio Unit (RU). Then the RF power related to that load is transmitted to the air interface.

In addition to the target load level, the operator can configure the modulation type. QPSK, 16QAM and 64QAM can be used for this feature. The cell load can be from 0 % to 100 % by step of 10 %.

SYSTEM OPERATION

This section describes how to configure the feature in Samsung system and provides associated key parameters, counters, and KPIs.

How to Activate

This section provides the information that you need to configure the feature.

Preconditions

There are no specific preconditions to activate this feature

Activation Procedure

Run **[ENB] test-ocns** to execute the Noise Simulator.

Deactivation Procedure

The feature does not need to be deactivated.

Key Parameters

This section describes the key parameters for activation and deactivation of the feature.

Activation Parameters

To activate or deactivate the feature, run the associated commands and set the key parameters.

Parameter Descriptions of **[ENB] test-ocns**

| Parameter | Description |
|-------------|--|
| cell-number | The cell number for which the OCNS is to be set. |
| modulation | The modulation type. Available modulation types are QPSK, 16QAM, 64QAM and 256QAM |
| cell-load | The load ratio for the cell on which the OCNS is set. The range is between 0 % and 100 % in intervals of 10. If 100, the maximum noise load is used. |

Counters and KPIs

There are no specific counters or Key Performance Indicators (KPIs) associated with this feature.

REFERENCE

None

OAM-TM0504, Remote Spectrum Analysis

INTRODUCTION

This feature provides a means to retrieve the transmit (Tx) and receive (Rx) signals spectrum of BS through the EMS Spectrum Analyzer GUI. The EMS fetches the captured sampling data from BS and depicts the information in a graphical view.

BENEFIT

The Remote Spectrum Analysis feature provides an interface to check the Tx and Rx signals spectrum of BS remotely without site visit and the RF measurement equipment. The operator can use the measured Rx data to analyze the UL interference while the cell is in locked state.

DEPENDENCY

HW dependency: This feature depends on the Radio Unit (RU) board type.

LIMITATION

- The captured sampling data (time domain) in RU exists in DL/UL subframe at every interval.
- The spectrum analysis result provided in this feature is less accurate than the output data of RF measurement equipment.
- The Spectrum Analyzer function can only be active on one RU, one antenna path, and one direction (uplink or downlink) per eNB.

SYSTEM IMPACT

The implementation of this feature does not have any impact on the network.

FEATURE DESCRIPTION

This feature allows the operator to select the target BS, RU, and Tx/Rx path for spectrum analysis. The EMS and BS acquire the sampling data. The functions of each entity for this feature are as follows.

EMS

The EMS provides the Spectrum Analyzer GUI (see the LSM-CM0801 Spectrum Analyzer feature for details) to:

- Select the target BS, RU, and Tx/Rx path, and configure the conditions such as reference power level, log scale, and timer.
- Display the spectrum analysis result in a graph, which shows the power level in frequency domain. The GUI supports both displaying analysis result in real-

time and displaying the result stored in the EMS.

When the operator activates this feature, the EMS requests the sampling data from BS at every pre-configured interval.

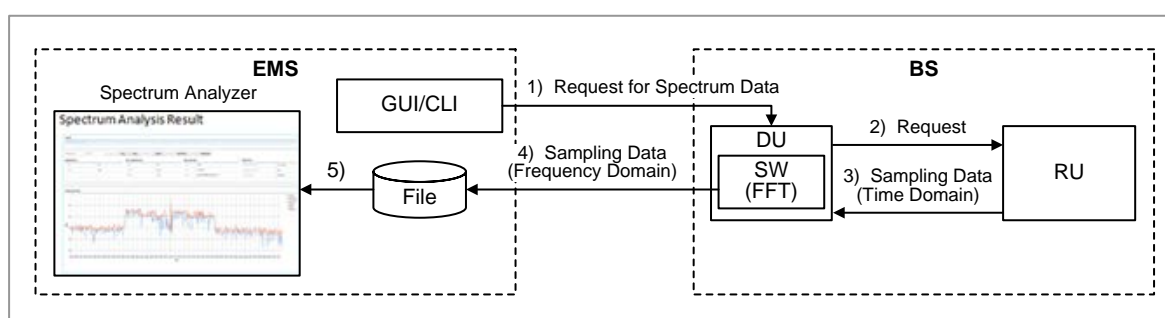
DU in BS

When the feature is triggered by the EMS, the DU requests the sampling data from RU. The DU converts the time domain sampling data received from RU to frequency domain sampling data by performing Fast Fourier Transform (FFT) calculation, and transfers the data (frequency domain) to the EMS.

RU in BS

When the feature is triggered by DU, the RU makes and transfers the sampling data (time domain) to DU.

The figure below depicts the interaction between the EMS and BS while collecting the spectrum data.



The event flow indicated in figure above is as follows:

- 1 When the operator activates this feature either by a command through Spectrum Analyzer GUI or CLI in EMS, the EMS requests the sample data of selected RU and Tx/Rx path.
- 2 The DU requests time domain sampling data from RU.
- 3 On receiving DU request, the RU makes and transfers time domain sampling data to the DU. The captured sample data exists in a DL/UL subframe.
- 4 The DU converts the time domain sampling data received from RU to frequency domain sampling data by performing Fast Fourier Transform (FFT) calculation and transfers the frequency domain data to the EMS.
- 5 The EMS displays the spectrum analysis result in a graph and stores the sampling data received from BS in a file.

SYSTEM OPERATION

This section describes how to configure the feature in Samsung system and provides associated key parameters, counters, and KPIs.

How to Activate

This section provides the information that you need to configure the feature.

Preconditions

Ensure that the following condition is met before enabling this feature:

- RU device must be present.

Activation Procedure

- Run **[ENB] upload-txsa-information** to retrieve the TX spectrum of the specific RU.
- Run **[ENB] upload-rxsa-information** to retrieve the RX spectrum of the specific RU.

Deactivation Procedure

This feature does not need to be deactivated.

Key Parameters

This section describes the key parameters for activation, deactivation, and configuration of the feature.

Activation/Deactivation Parameters

To activate the feature, run the associated commands and set the key parameters.

Parameter Descriptions of [ENB] upload-txsa-information

| Parameter | Description |
|---------------------------------|---|
| connected-digital-unit-board-id | This is the board ID of the DU, which is connected to the RU |
| connected-digital-unit-port-id | This is the port ID of the DU, which is connected to the RU |
| cascade-radio-unit-id | This is the cascade ID of the DU port, which is connected to the RU |
| path-id | This is the path ID of the RRH to measure the waveform information |

Parameter Descriptions of [ENB] upload-rxsa-information

| Parameter | Description |
|---------------------------------|---|
| connected-digital-unit-board-id | This is the board ID of the DU, which is connected to the RU |
| connected-digital-unit-port-id | This is the port ID of the DU, which is connected to the RU |
| cascade-radio-unit-id | This is the cascade ID of the DU port, which is connected to the RU |
| path-id | This is the path ID of the RRH to measure the waveform information |

Counters and KPIs

There are no specific counters or Key Performance Indicators (KPIs) associated with this feature.

REFERENCE

None

Chapter 13 Time and Clock Synchronization Management

OAM-TS0101, NTP based Time Synchronization

INTRODUCTION

Network Time Protocol (NTP) is a protocol used to synchronize time between systems in the network. For the time synchronization, Network Element (NE) acts as NTP client to communicate with one of the configured NTP servers (EMS is one default NTP server).

BENEFIT

Samsung NE working as an NTP client can synchronize system time with standard time (UTC time: Universal Time Coordinated).

DEPENDENCY

None

LIMITATION

None

SYSTEM IMPACT

The implementation of this feature does not have any impact on the network.

FEATURE DESCRIPTION

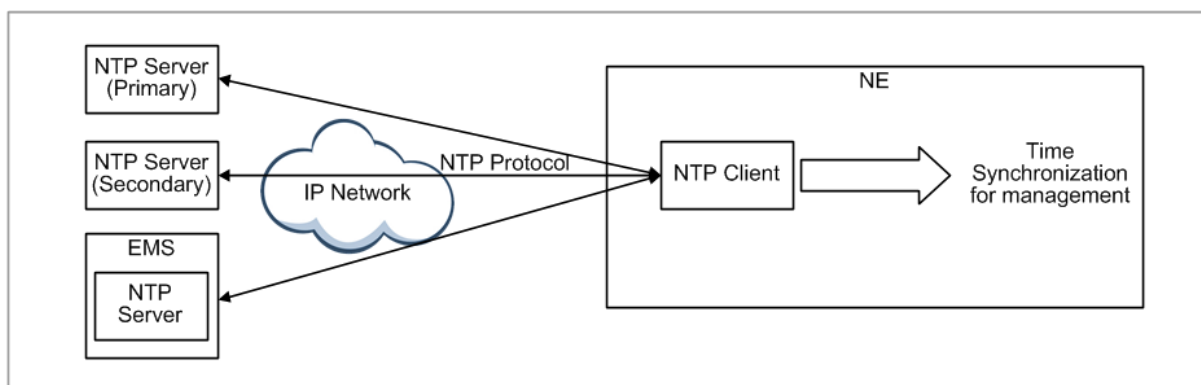
In the time synchronization procedure, Samsung NE acts as NTP client. It communicates with one of the configured NTP servers by NTPv4 protocol in management plane. Samsung NE acquires the standard Universal Time Coordinated (UTC) information from the NTP server. UTC information is calculated based on the NTP response message from the NTP server. It is polled periodically from the NTP message.

The EMS, which is including an embedded NTP server is configured as a default NTP server. Except EMS, maximum two NTP servers can be configured by operator command. One is configured as primary NTP server, and the other is configured as secondary NTP server.

At every NTP update period, Samsung NE attempts to communicate with NTP server. Attempting sequence is in the order of primary server, secondary server, and EMS. If communication with any of NTP servers is successful, Samsung NE exchanges NTP protocol messages with it. Samsung NE attempts to communicate with the next NTP server only if it fails to communicate with the server that has higher priority. If all of the NTP servers cannot be communicated with Samsung NE, it generates NTP failure alarm and reports to EMS. At this time, Samsung NE can operate normally based on the internal clock even though the connection with all NTP servers is failed.

During the authentication procedure in system initialization, Samsung NE receives the time zone information configured for all the NEs from EMS. Based on this time zone information, Samsung NE determines the local time offset and generates local time. Local time is calculated by NTP time synchronization procedure with UTC time information. If the daylight saving time (summer time) is effective in this time zone, it is also included in the local time calculation.

NTP synchronization is depicted in the figure below.



SYSTEM OPERATION

This section describes how to configure the feature in Samsung system and provides associated key parameters, counters, and KPIs.

How to Activate

This section provides the information that you need to configure the feature.

Preconditions

There are no specific preconditions to activate this feature.

Activation Procedure

The operator can set the ntp-info to assign NTP server to the eNB.

Deactivation Procedure

This feature does not need to be deactivated.

Key Parameters

This section describes the key parameters for activation, deactivation, and configuration of the feature.

Activation/Deactivation Parameters

There are no specific Activation/Deactivation parameters associated with this feature.

Configuration Parameters

To configure the feature settings, set the key parameters.

Parameter Descriptions of NTP information (managed-element common-management time-sync-service ntp-info).

| Parameter | Description |
|-------------------|--|
| server-type | NTP server type <ul style="list-style-type: none"> primary-server: Primary NTP Server. secondary-server: Secondary NTP Server. |
| server-ip-address | This parameter is the IP address of the NTP server that NE would perform time synchronization with. <ul style="list-style-type: none"> IP version |

Parameter Descriptions of NTP period (managed-element common-management time-sync-service).

| Parameter | Description |
|-----------------|---------------------------------|
| ntp-sync-period | NTP Time Synchronization Period |

Parameter Descriptions of NTP Status (retrieve-ntp-status).

| Parameter | Description |
|-------------|--|
| server-type | NTP server type <ul style="list-style-type: none"> primary-server: Primary NTP Server secondary-server: Secondary NTP Server |
| sync-status | Status of NTP Server |

Counters and KPIs

There are no specific counters or Key Performance Indicators (KPIs) associated with this feature.

REFERENCE

[1] [RFC 5905] Mills, D., Martin, J., Burbank, J., and W. Kasch, "Network Time Protocol Version 4: Protocol and Algorithms Specification", RFC 5905, June 2010.

OAM-TS0401, IEEE1588 based Synchronization Management

INTRODUCTION

The IEEE1588v2 standard defines a protocol to enable precise synchronization of clocks in measurement and to control systems. These systems are implemented with technologies such as network communication, local computing, and distributed objects. Samsung NE supports the IEEE1588 based clock synchronization for bearer/control plane through IP network.

BENEFIT

This feature provides functionality to acquire system clock with IEEE1588v2 protocol through IP network.

DEPENDENCY

- HW dependency
 - To support this feature, IEEE1588v2 grand master and Ethernet interface must be provided in the IP network to interwork with Samsung NE, which acts as IEEE1588v2 slave. The support of this feature is determined according to the NE board type.
 - The holdover time is dependent on the NE board type.
- Others: The clock performance depends on the network condition.

LIMITATION

None

SYSTEM IMPACT

The implementation of this feature does not have any impact on the network.

FEATURE DESCRIPTION

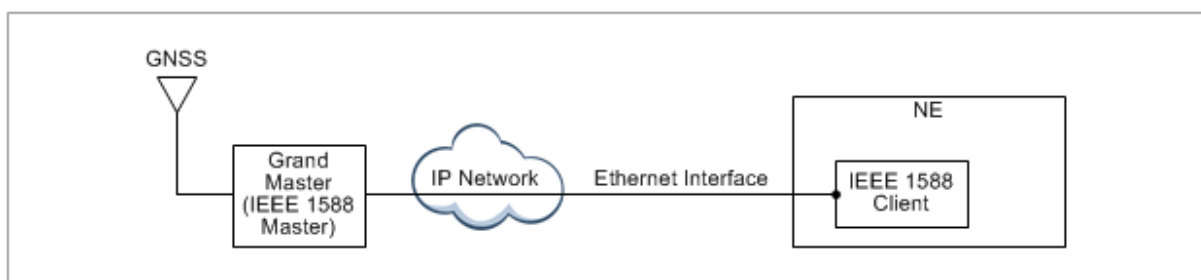
Cellular communication system requires synchronization to support the communication with MS or handover between systems. Samsung NE supports the IEEE1588v2 based clock synchronization for bearer/control plane, in which the IEEE1588v2 protocol can be used to get the synchronization information through IP network.

The Precision Time Protocol (PTP) is a time-transfer protocol defined in IEEE Standard 2008 (IEEE Standard for a Precision Clock Synchronization Protocol for Networked Measurement and Control Systems, Approved March 27, 2008) that allows precise synchronization of networks (for example, Ethernet). The goal of

this protocol is to have a set of slave devices determine the offset between time measurements on their clocks and on a master device, and to have a set of slave devices adjust the local clock rate and the local time (UTC, Universal Time Coordinated).

To support the proper IEEE1588v2 protocol operation, it is necessary that Samsung NE communicate with valid IEEE1588v2 grand master to get time stamp information. IEEE1588v2 grand master must be provided in the IP network and Samsung NE acts as IEEE1588v2 client. Ethernet interface must be provided to transmit and receive the IEEE1588v2 protocol packets between the IEEE1588v2 grand master and Samsung NE through IP network. The IP network should be designed to minimize the variation in the traffic load. IEEE1588v2 synchronization supports phase synchronization and frequency synchronization (IEEE1588v2_phase, IEEE1588v2_frequency).

Samsung NE also provides the holdover function that provides continuous service even when IEEE1588v2 signal is not available due to temporary interruption or link failure after Samsung NE successfully acquired clock locking status. According to the NE board type and synchronization mode (phase/frequency), the holdover time is determined.



The management of IEEE1588v2 based synchronization consists of the following two major functionalities:

Clock Source Management

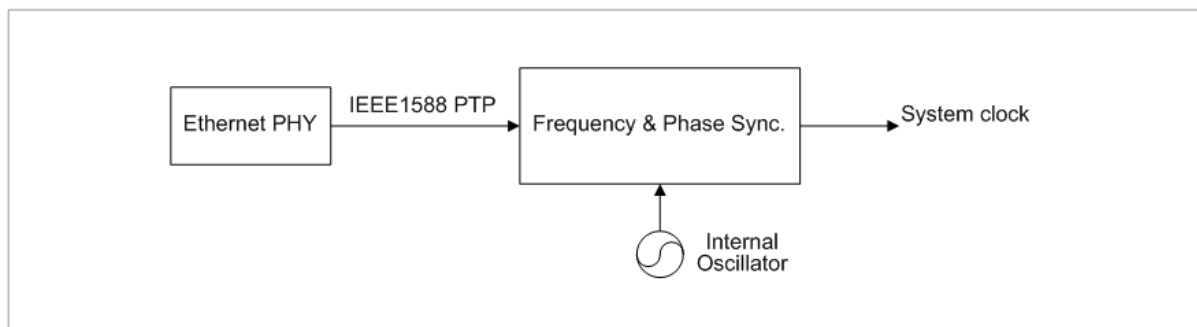
Samsung NE supports the information of IEEE1588v2 clock source state such as locking state, device state and so on.

If the IEEE1588v2 clock source is fail due to locking failure, IEEE1588v2 module's abnormal status, holdover exceed and so on. Samsung NE generates related alarms and reports to EMS. According to the generated IEEE1588v2 alarm type and alarm severity, Samsung NE may shutdown the radio wave to avoid the interference to other system and controls the clock LED of NE board to alert the operator for the error condition.

IEEE1588v2 Grand Master Management

Samsung NE supports the interworking with maximum two IEEE1588v2 grand masters, which are specified as primary and secondary respectively. To communicate with IEEE1588v2 grand master successfully, IEEE1588v2 grand master IP address should be configured. The operator can set/change and retrieve the IP address of primary and secondary IEEE1588v2 grand master server with command.

If Samsung NE fails to collect information from the IEEE1588v2 grand master clock due to IEEE1588v2 grand master failure or Ethernet interface failure, the related alarms are generated and reported to the EMS.



SYSTEM OPERATION

This section describes how to configure the feature in Samsung system and provides associated key parameters, counters, and KPIs.

How to Activate

Preconditions

Ensure that the following conditions are met before enabling this feature:

- IEEE1588 clock source must be present in management-element hardware-management digital-unit clock-unit clock-source-info clock-source
- To use hybrid mode, Sync-E clock must be supported.

Activation Procedure

To activate this feature, do the following:

- Run `managed-element ip-system ip-interface external-interfaces [IF_NAME] ipv4 (or ipv6)-address [IP] [IP_PREFIX] ieee1588 true` at valid IP address.
- Run `management-element hardware-management digital-unit clock-unit ptp-info` and configure PTP parameters.
- Run `management-element hardware-management digital-unit clock-unit ptp-info grand-master-info` and configure valid GM (grandmaster) parameters.

Deactivation Procedure

This feature does not need to be deactivated.

Key Parameters

This section consists of the following two optional subsections:

Configuration Parameters

To configure this feature, run the associated commands and set the key parameters.

Parameter Descriptions of `managed-element ip-system ip-interface external-interfaces [IF_NAME] ipv4 (or ipv6)-address [IP] [IP_PREFIX] ieee1588`

| Parameter | Description |
|-----------|--|
| ieee1588 | This parameter determines whether to enable or disable IEEE 1588 protocol in IP address: <ul style="list-style-type: none"> • false: IEEE 1588 protocol is deactivated. • true: IEEE 1588 protocol is activated. |

Parameter Descriptions of managed-element hardware-management digital-unit clock-unit ptp-info

| Configuration Parameters Example | |
|----------------------------------|--|
| Parameter | Description |
| ptp-profile | This parameter determines profile of PTP. <ul style="list-style-type: none"> • telecom-2008: IEEE 1588v2 profile. • itu-g8265-1: ITU-T G.8265.1 profile. • itu-g8275-1: ITU-T G.8275.1 profile. • itu-g8275-2: ITU-T G.8275.2 profile. |
| ptp-domain-telecom | This is PTP domain number used for IEEE 1588v2 profile. Range from 0 to 127 (default: 0). |
| ptp-domain-g8265-1 | This is PTP domain number used for ITU-T G.8265.1 profile Range from 4 to 23 (default: 4) |
| ptp-domain-g8275-1 | This is PTP domain number used for ITU-T G.8275.1 profile Range from 24 to 43 (default: 24) |
| ptp-domain-g8275-2 | This is PTP domain number used for ITU-T G.8275.2 profile Range from 44 to 63 (default: 44) |
| ptp-hybrid-mode | This parameter determines whether to enable or disable PTP hybrid mode with Sync-E |

To configure the GM IP version and address, GM must be capable of providing the master function for IEEE 1588. At least, one GM IP address that is same with current GM IP version must be entered. If GM IP address is changed, IEEE 1588 clock may be reinitialized. It is possible to configure two GM IP addresses for each GM IP version. Run the associated commands and set the key parameters.

Parameter Descriptions of managed-element hardware-management digital-unit clock-unit ptp-info grand-master-info

| Parameter | Description |
|---------------------|---|
| ip-version | This is the GM IP version. <ul style="list-style-type: none"> • ipv4: GM IP version is configured IPv4. • ipv6: GM IP version is configured IPv6. |
| first-ipv4-address | This is first GM IPv4 address for IEEE 1588 operation. |
| second-ipv4-address | This is second GM IPv4 address for IEEE 1588 operation. |
| first-ipv6-address | This is first GM IPv6 address for IEEE 1588 operation. |
| second-ipv6-address | This is second GM IPv6 address for IEEE 1588 operation. |

Counters and KPIs

There are no specific counters or Key Performance Indicators (KPIs) associated with this feature.

REFERENCE

- [1] IEEE Standard for a Precision Clock Synchronization Protocol for Networked Measurement and Control Systems
- [2] ITU-T G.8261 Timing and synchronization aspects in packet networks
- [3] ITU-T G.8265.1 Precision time protocol telecom profile for frequency synchronization
- [4] ITU-T G.8275.1 Precision time protocol telecom profile for phase/time synchronization with full timing support from the network
- [5] ITU-T G.8275.2 Precision time protocol telecom profile for phase/time synchronization with partial timing support from the network

OAM-TS0601, Clock Switchover

INTRODUCTION

This feature provides functionality of clock source switchover. For Samsung NE configured with multiple clock sources, the current clock source can be switched over to another clock source if the current clock source fails or the other clock source can provide higher quality.

BENEFIT

This feature provides clock switchover functionality in case of the current clock source fails or another clock source can provide higher quality.

DEPENDENCY

- HW dependency
 - To support this feature, UCR (Universal Clock Receiver) must be equipped in the main board of DU at base station. (The clock source type and the combination case of clock switchover are dependent on the NE board.)
 - The support of this feature is determined according to the NE board type.
- Prerequisite Features
 - OAM-TS0201, GNSS based Synchronization Management
 - OAM-TS0401, IEEE1588 based Synchronization Management
 - OAM-TS0501, SyncE based Synchronization Management

LIMITATION

The clock switchover between clock source of frequency mode and clock source of phase mode is not supported.

SYSTEM IMPACT

The implementation of this feature does not have any impact on the network.

FEATURE DESCRIPTION

Cellular communication system requires synchronization to support communication with MS or handover between systems. Samsung NE supports the clock synchronization with multiple clock sources for bearer/control plane as following:

- Base Station (eNB): GNSS (GPS, GPS + GLONASS dual mode), Synchronous Ethernet (SyncE), IEEE1588v2

The clock sources can support frequency mode synchronization or phase mode synchronization, or both. According to the synchronization mode the clock sources can support, they are classified into two groups as follows:

- Phase mode: GNSS_phase (GPS_phase, GPS + GLONASS dual mode_phase), IEEE1588v2_phase
- Frequency mode: GNSS_frequency (GPS_frequency, GPS + GLONASS dual mode_frequency), IEEE1588v2_frequency, SyncE



Only LMD board can support GNSS_frequency mode.

In phase mode or frequency mode, several clock sources can be configured in the NE system according to the system configuration. Up to three clock sources can be configured for base station.

The table below outlines examples for clock source configuration in a DU at base station.

| Cases | 1 st Source | 2 nd Source | 3 rd Source |
|--------|------------------------|------------------------|------------------------|
| Case 1 | GNSS_phase | IEEE1588v2_phase | - |
| Case 2 | IEEE1588v2_phase | GNSS_phase | - |
| Case 3 | GNSS_frequency | IEEE1588v2_frequency | - |
| Case 4 | GNSS_frequency | SyncE | - |
| Case 5 | IEEE1588v2_frequency | SyncE | - |
| Case 6 | IEEE1588v2_frequency | SyncE | GNSS_frequency |
| ... | ... | ... | ... |

For each clock source configured in the NE system, its related parameters such as hold-off time, priority level, restore time, and quality-level can be configured by operator command. The priority of each clock source can also be configured. Please see the related feature description documents about the management of each clock source in detail.

- OAM-TS0201, GNSS based synchronization management
- OAM-TS0401, IEEE1588 based synchronization management
- OAM-TS0501, SyncE based synchronization management

Among the configured clock sources in the NE system, the current clock source can be switched over to another clock source if the current clock source fails or the target clock source can provide better quality. The clock switchover can only be executed to another clock source, which has the same synchronization mode as the current clock source. It means that clock source supporting frequency synchronization mode can only be switched over to another clock source supporting frequency synchronization mode. The switchover to different synchronization mode is not supported. To support the clock switchover, Universal Clock Receiver (UCR) as clock module must be equipped in the NE system.

For the clock switchover, two execution modes can be configured by operator: auto mode and forced mode. If auto mode is configured, the switchover of clock source is executed automatically based on the quality level and priority of the

configured clock sources. If forced mode is configured, the switchover of clock source can only be executed by operator command.

The selection of primary clock source is based on the configured quality level of clock sources. If the values of quality level of the clock sources are equal, the configured priority is used. If both the configured quality level and priority are equal, clock sources is selected randomly.

When the primary reference clock source fails, the reference clock source is changed to the holdover state. The normal operation can be supported for the holdover duration defined by the reference clock source. After the holdover timer expires or other clock alarm is generated (such as locking fail or UCR function fail) during hold-off time, the reference clock source is automatically switched over to another clock source, which has the highest level of quality among all the other available clock sources. When the failed clock source is available again and keeps normal for a specified period, which is defined by the parameter restore time, the switch over to this clock source is executed (Revertive mode).

SYSTEM OPERATION

This section describes how to configure the feature in Samsung system and provides associated key parameters, counters, and KPIs.

How to Activate

This section provides the information that you need to configure the feature.

Preconditions

Two or more clock sources should be present in clock-source-info.

Activation Procedure

If at least one of clock source "lock-out-enable is OFF", then this function is running.

Deactivation Procedure

To deactivate Clock switchover, change lock-out-enable to ON except only one clock source.

Key Parameters

This section describes the key parameters for activation, deactivation, and configuration of the feature.

Activation/Deactivation Parameters

To activate or deactivate the feature, run the associated commands and set the key parameters.

Parameter Descriptions of **clock-source-info**

| Parameters | Description |
|---------------|--|
| clock-source | This leaf describes the clock mode, which has to be included in the clock resource list. |
| quality-level | This leaf describes the quality level of the clock source. The operator has to |

| Parameters | Description |
|-----------------|--|
| | set the quality level of the clock source with the care for the environment of the clock sources. |
| lock-out-enable | This leaf indicates the lock-out status of the clock source. If this field is ON then this clock source is excluded from the clock source list. |
| priority-level | This leaf describes the priority level of the clock source. The operator has to set the priority level of the clock source with the care for the environment of the clock sources. |
| holdoff-time | This leaf describes the hold-off time for switching the clock source when the previous clock source has alarms. |
| restore-time | This leaf describes the restore-time for rollback clock source. If the higher quality level clock source maintains normal status for restore-time, system clock is set back to clock source, which has higher quality level. |

Configuration Parameters

To configure the feature settings, run the associated commands and set the key parameters.

Parameter Descriptions of [MACRO INDOOR DIST] **clock-source-info**.

| Parameter | Description |
|----------------|--|
| clock-source | This leaf describes the clock mode that has to be included in the clock source list. |
| quality-level | This leaf describes the quality level of the clock source. The operator has to set the quality level of the clock source with the care for the environment of the clock sources. |
| priority-level | This leaf describes the priority level of the clock source. The operator has to set the priority level of the clock source with the care for the environment of the clock sources. |
| holdoff-time | This leaf describes the hold-off time for switching the clock source when the previous clock source has alarms. |
| restore-time | This leaf describes the restore-time for rollback clock source. If the higher quality level clock source maintains normal status for restore-time, system clock is set back to clock source that has higher quality level. |

Counters and KPIs

There are no specific counters or Key Performance Indicators (KPIs) associated with this feature.

REFERENCE

[1] ITU-T G.781 SERIES G: TRANSMISSION SYSTEMS AND MEDIA, DIGITAL SYSTEMS AND NETWORKS

[2] Digital transmission systems-Terminal equipment-Principal characteristics of multiplexing equipment for the synchronous digital hierarchy

Chapter 14 Etc

OAM-ET0101, VSWR Supervision

INTRODUCTION

This feature provides functionality to change the threshold value for occurrence and clearance of the Voltage Standing Wave Ratio (VSWR) related alarm by measuring return loss on the antenna path in Radio Unit (RU).

The VSWR of each RF path (return loss) on RU antenna is monitored periodically. If the value is over a specific threshold, the VSWR alarm is reported to the EMS.

The threshold value for the VSWR alarm can be specified by the operator.

BENEFIT

This feature helps the operator customize the criteria of VSWR alarm occurrence and clearance.

DEPENDENCY

Only the base station supports this feature. The support of this feature depends on the hardware type and firmware version of the hardware.

LIMITATION

VSWR fault monitoring is available only when the transmit power on each antenna path in RU is more than 30 dBm (1 W).

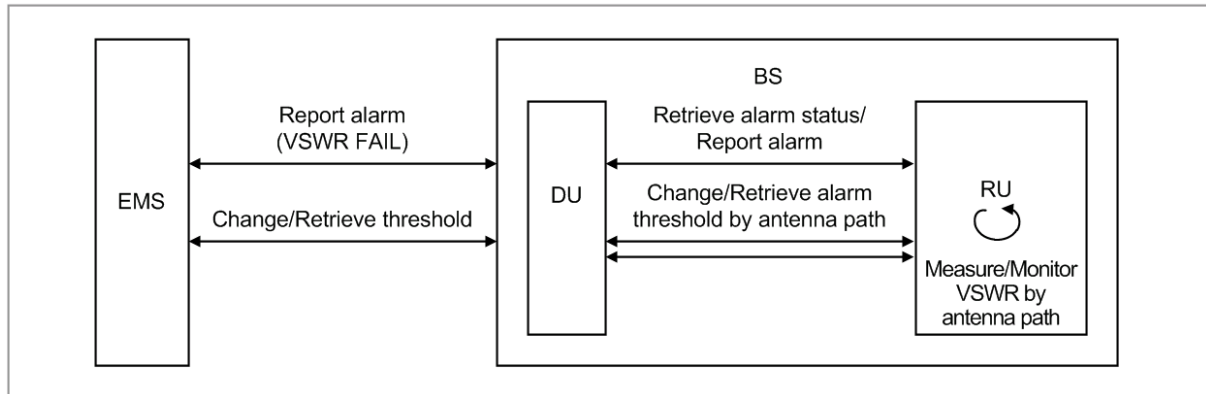
SYSTEM IMPACT

None

FEATURE DESCRIPTION

The VSWR is a measure of how power is delivered well to antenna. If the value is large, it means a lot of power is lost during the transferring from RU to the specific antenna. If it is over the specific threshold, the alarm is reported to the operator.

The figure below depicts the detailed message flow of the VSWR supervision procedure.



SYSTEM OPERATION

This section describes how to configure the feature in Samsung system and provides associated key parameters, counters, and KPIs.

How to Activate

This section provides the information that you need to configure the feature.

Preconditions

There are no specific preconditions to activate this feature

Activation Procedure

This feature is executed by user command.

Run **[BBU] radio-unit-info** and set **rx-vswr-fail-alarm-switch** to on.

Deactivation Procedure

This feature is executed by user command.

Run **[BBU] radio-unit-info** and set **rx-vswr-fail-alarm-switch** to off.

Key Parameters

This section describes the key parameters for activation, deactivation, and configuration of the feature.

Activation/Deactivation Parameters

To activate or deactivate the feature, run the associated commands and set the key parameters.

Parameter Descriptions of **[BBU] radio-unit-info**

| Parameter | Description |
|---------------------------|---|
| rx-vswr-fail-alarm-switch | This leaf is a function on/off of RX VSWR fail alarm for RRH. |

Configuration Parameters

To configure the feature settings, run the associated commands and set the key parameters.

Parameter Descriptions of [BBU] **radio-unit-info**

| Parameter | Description |
|----------------------------------|--|
| rx-vswr-fail-alarm-threshold | This leaf is the RX VSWR fail alarm threshold on Rx port of RRH used by the RRH. |
| rx-vswr-fail-alarm-detect-period | This leaf is the period for RX VSWR fail alarm detection used by the RRH. |

Counters and KPIs

There are no specific counters or Key Performance Indicators (KPIs) associated with this feature.

REFERENCE

None

OAM-ET0102, RSSI Supervision

INTRODUCTION

This feature provides functionality to change the threshold value of the Received Signal Strength Indicator (RSSI) alarm. The RSSI of each RF path on Radio Unit (RU) antennas is monitored periodically. If the value is below or over the threshold specified by the operator, RSSI alarm is reported to the EMS.

BENEFIT

This feature helps the operator customize the criteria of RSSI alarm occurrence and clearance.

DEPENDENCY

Only the base station supports this feature. The support of this feature depends on the hardware type and firmware version of the hardware.

LIMITATION

None

SYSTEM IMPACT

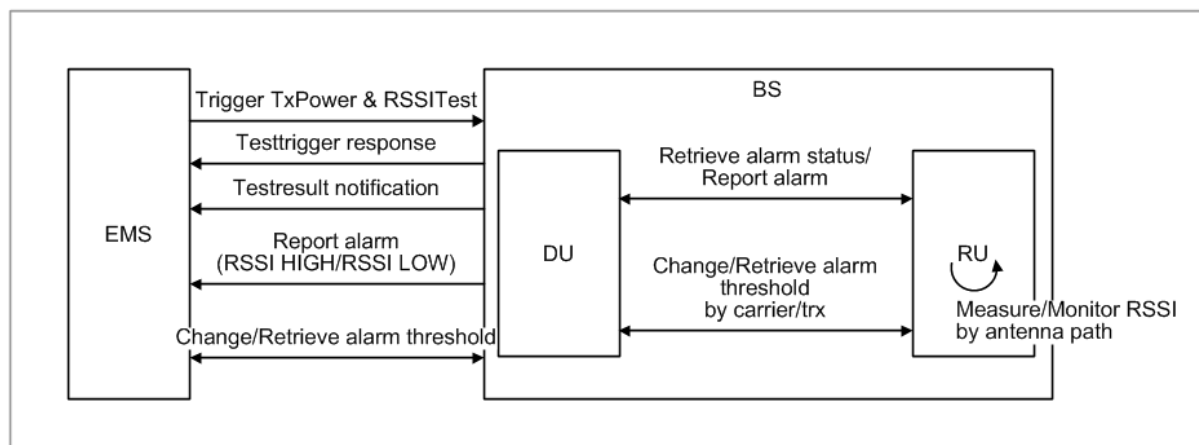
The implementation of this feature does not have any impact on the network.

FEATURE DESCRIPTION

Received Signal Strength Indicator (RSSI) is a measurement of the power present in a received radio signal. If it is over or below the specific threshold, the alarm is reported to the EMS.

In addition to the functionality of RSSI fault monitoring, the measured RSSI value can be displayed by operator command too, which is described in the OAM-TM0401 Tx Power & Rx Path Test.

The figure below depicts the operation of the RSSI supervision procedure.



SYSTEM OPERATION

This section describes how to configure the feature in Samsung system and provides associated key parameters, counters, and KPIs.

How to Activate

This feature runs automatically, and it cannot be disabled.

Key Parameters

This section describes the key parameters for activation, deactivation, and configuration of the feature.

Configuration Parameters

To configure the feature settings, run the associated commands and set the key parameters.

Parameter Descriptions of [ENB] radio-unit-info

| Parameter | Description |
|--|---|
| connected-digital-unit-board-type | This parameter is the unit type of the DU, which is connected to the RRH. |
| connected-digital-unit-board-id | This parameter is the board ID of the DU, which is connected to the RRH. |
| connected-digital-unit-port-id | This parameter is the port ID of the DU, which is connected to the RRH. |
| cascade-radio-unit-id | This parameter is the cascade ID of the DU port, which is connected to the RRH. |
| carrier-control-info/rssi-high-alarm-threshold | This threshold value detects the Received Signal Strength Indication (RSSI) high alarm on the RRH. If the threshold value is exceeded, the RSSI high alarm is generated. The valid range is determined according to the RRH type. |
| carrier-control-info/rssi-low-alarm-threshold | This threshold value detects RSSI low alarms on the RRH. If the threshold value is not reached, the RSSI low alarm is generated. The valid range is determined according to the RRH type. |

Counters and KPIs

There are no specific counters or Key Performance Indicators (KPIs) associated with this feature.

REFERENCE

None



802 eNB (OAM)
Feature Description for Release 8.5.0

Document Version 2.0

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