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Re:	Call for inputs for commentary of p802.16e/D1	
Abstract	This contribution describes Enhanced Handover Mechanism for supporting Active BS Set in IEEE P802.16e/D1-2004.	
Purpose	Discuss and Adopt enhanced feature of p802.16e/D1	
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The Concept of Idle mode Operation in IEEE 802.16e

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1 Introduction

The MAC state machines of the BS and MSS described in the current IEEE 802.16e draft have only AWAKE and SLEEP modes in which the network entities shall always maintain the logical and physical connections. These modes in the MAC state machine in IEEE 802.16e have two major disadvantages as follows.

- **Inefficient usage of air resources**

When an MSS turns on its power, it operates in the awake-mode. After some times passed without any valid user traffic in both Uplink and Downlink, the MSS can switch to the sleep mode. But the BS shall maintain these physical and logical resources to provide an always-on service to the MSS after the MSS succeeds network entry and initialization procedures. When the BS and/or MSS have nothing to send for the time being, they can transit to the sleep mode. Short sleep mode intervals and occupation of air resources have been regarded as one of the major problems of the present draft. Although a recent proposal IEEE 802.16e/D1-2004 has addressed this issue only by extending the sleep interval to 1024 frames, it did not present any suggestions to address the inefficient usage problem of air resources and the power conservation while the MSS operates in sleep mode. And also, the BS can efficiently allocate CIDs because assigned CIDs to the MSS can be reused immediately as soon as the BS and MSS enter to idle mode.

2 Proposed Idle Mode

This new proposal introduces idle mode that gives the MSS and the BS to operate in a simplified way while minimizing the wasted usage of air resources in the current version. Although implementation of idle mode is optional, it is recommended. The 802.16e MAC state machine should be in one of the following modes, and a basic principle of Awake mode and Sleep mode has been defined precisely as well as the proposed Idle-mode.

- ***Awake mode*** : the MSS and BS shall continuously process DL and/or UL traffics. It also performs handover to support the mobility.
- ***Sleep mode*** : the MSS may power down, scan neighbor BS(s), conduct handover/network re-entry or listen the broadcasting message
- ***Idle mode*** : the MSS and BS shall close all connections, all air resources (i.e. CIDs, UL/DL Bursts and so on) for MSS, but the MSS shall monitor down link periodically.

2.1 Transition Diagram with Idle Mode

The following figure 1 provides the overview of the MSS and BS modes and mode transitions.

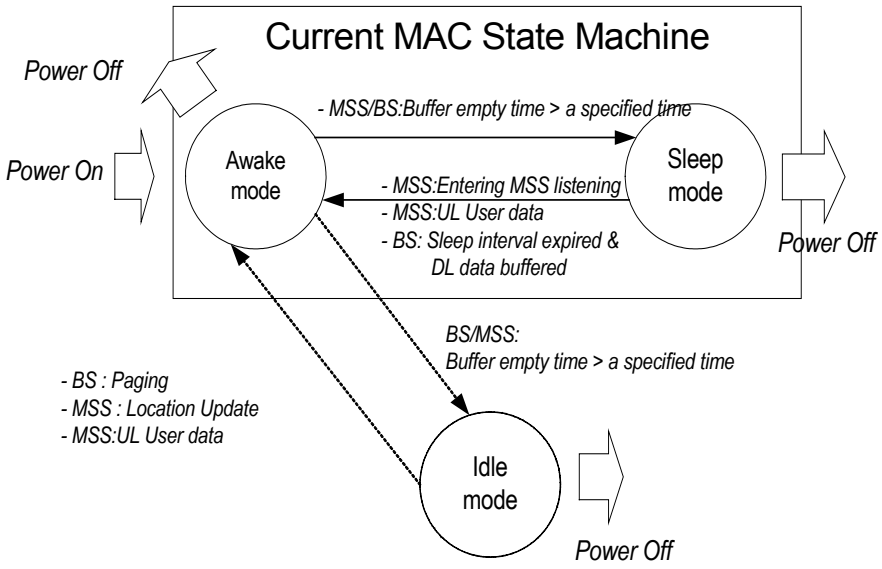

Figure 1 Mode Transition diagram of MAC state machine

2.2 Idle mode capability

Idle mode is a mode in which MSSs supporting mobility shall close all connections and only maintain its registered location. Idle mode is intended not only to conserve power of the MSSs but also to facilitate a light handover procedure while still staying disconnected to the network. Upon entering this mode from awake-mode, the MSS and BS shall perform the following procedures :

- Optional features and can be negotiated between BS and MSS
- Close all connections with BS
- Maintaining Registered location information
- The paging parameters
  - The rest interval (with the rest interval index)
  - The location information and parameters
- Other parameters
  - Idle handover parameters

In this mode, the MSS may maintain the upper layer connections like an IP connection with the network, but all air resources of the MSS and BS shall be released while in this mode. And the MSS shall performs the following procedures

- The MSS shall monitor the broadcast CID from the BS
- The MSS shall perform the idle handover procedures.
- The MSS shall update the overhead information from the BS

2.2 The changes for proposed Idle-mode

- MOB_NBR-ADV MAC management message
  - Add “Idle mode support indication” field
    - MODE_SUPPORTED field has been modified in order to indicate the BS’s capability
- REG-REQ MAC management message
  - Add ”Idle mode support indication” field in order to indicate the MSS’s capability
    - MODE_SUPPORTED
- REG-RSP MAC management message
  - Add ”Idle mode support indication” field in order to indicate the MSS’s capability
    - MODE_SUPPORTED
- MOB_IDL-REQ MAC management message
  - Mode change request
  - Required parameters
  - From the MSS
- MOB_IDL-RSP MAC management message
  - Mode change approval or reject
  - Negotiated parameters
  - From the BS

Upon entering idle mode from awake-mode, the MSS and the BS should agree with the paging parameters. For power conservation, the MSS shall monitor only the down link at a specific time and then go back to idle mode for a rest interval. Therefore the BS must know when the MSS will awaken and monitor the downlink if it has messages to send to the MSS. In addition, the BS has to know the location of the MSS. The MSS shall propose the preferred paging parameters in the MOB_IDLE-REQ message and the BS shall inform the negotiated paging parameters in the MOB_IDLE-RSP message.

In C802.16e-04/28 and 29, we introduce an efficient handover in idle mode in order to reduce the handover budget and also provide an idle handover determination algorithm. In addition, we also introduce paging and location update procedures to support the mobility for idle mode.

3 Proposed text changes

[In Page 43, Line 26, Append new sections after 6.4.17.3 Traffic indication signaling as follows]

6.4.18 Idle mode mode for mobility-supporting MSS (Optional)

Idle mode is a mode in which the MSS supporting mobility may close all the connections and maintain only its registered location. When the MSS enters Idle-mode, the BS may release every resource such as CIDs and the MSS may down the power consumption. When the MSS in Idle mode moves from the serving BS to the neighbor BS, the MSS may perform an idle handover and registration with location update using MOB_LU-REQ message. The MSS in Idle mode shall scan the BS with the strongest signal among the neighbor base stations listed in MOB_NBR-ADV message. The BS supporting Idle mode shall transmit MOB_NBR-ADV message to inform the MSS of the system information that is used for performing the idle procedures. Upon receiving the MOB_NBR-ADV message containing changed parameters, the MSS in Idle mode shall update the system parameters. In order to negotiate the support of Idle mode, during registration procedure, using REG-REQ, the MSS shall inform the BS whether the MSS can support Idle mode and informs the parameters used in Idle mode. When the BS transmit the REG-RSP message in response to a REG-REQ message containing Idle-mode related information, the BS shall include Idle-mode parameters in the RNG-RSP message.

6.4.18.1 Mode Transition

If the MSS want to transit to Idle mode, the MSS shall transmit MOB_IDL-REQ message. When the BS receives the MOB_IDL-REQ, the BS shall respond with MOB_IDL-RSP message including parameters for decision of listening period and location registration information. When the BS denies transition to Idle-mode, the MSS shall remain in awake-mode and retries the transition if needed. When the BS wants to let the MSS to transit to Idle mode, the BS can transmit unsolicited MOB_IDL-RSP message. If the MSS in sleep mode want to change to Idle-mode, it shall return to Awake-mode and transmit MOB_IDL-REQ message.

6.4.18.2 Operation in Idle mode

When an MSS awakens, it will check the frame number to ensure that it did not lose frame synchronization, and check the rest interval based on REST_INTERVAL_INDEX, the location information and idle handover parameters. The respective, fixed and periodic rest-interval for the MSS is obtained as followings

$$\text{Rest Interval} = 2^{REST\_INTERVAL\_INDEX} \ \textbf{modulo}\ \text{ONE\_PAGING\_CYCLE.}$$

The REST_INTERVAL_INDEX is transmitted by MOB_IDL-RSP message.

During the monitoring frame, if the MSS receives MOB_PAG-REQ message from BS, MSS shall enter the awake-mode and perform the network re-entry and the initialization procedure. If the MSS receives the MOB_NBR-ADV message with any changed parameter during Idle-mode, then the MSS shall updates the system parameters. If the change count value of the received MOB_NBR-ADV is not the same as the configuration change count in the previous MOB_NBRADV message, the MSS shall update the system parameters in this message.

[In Page 37, Line 1, Replace Figure 108a – MSS Awake Mode SDL Diagram with the following]

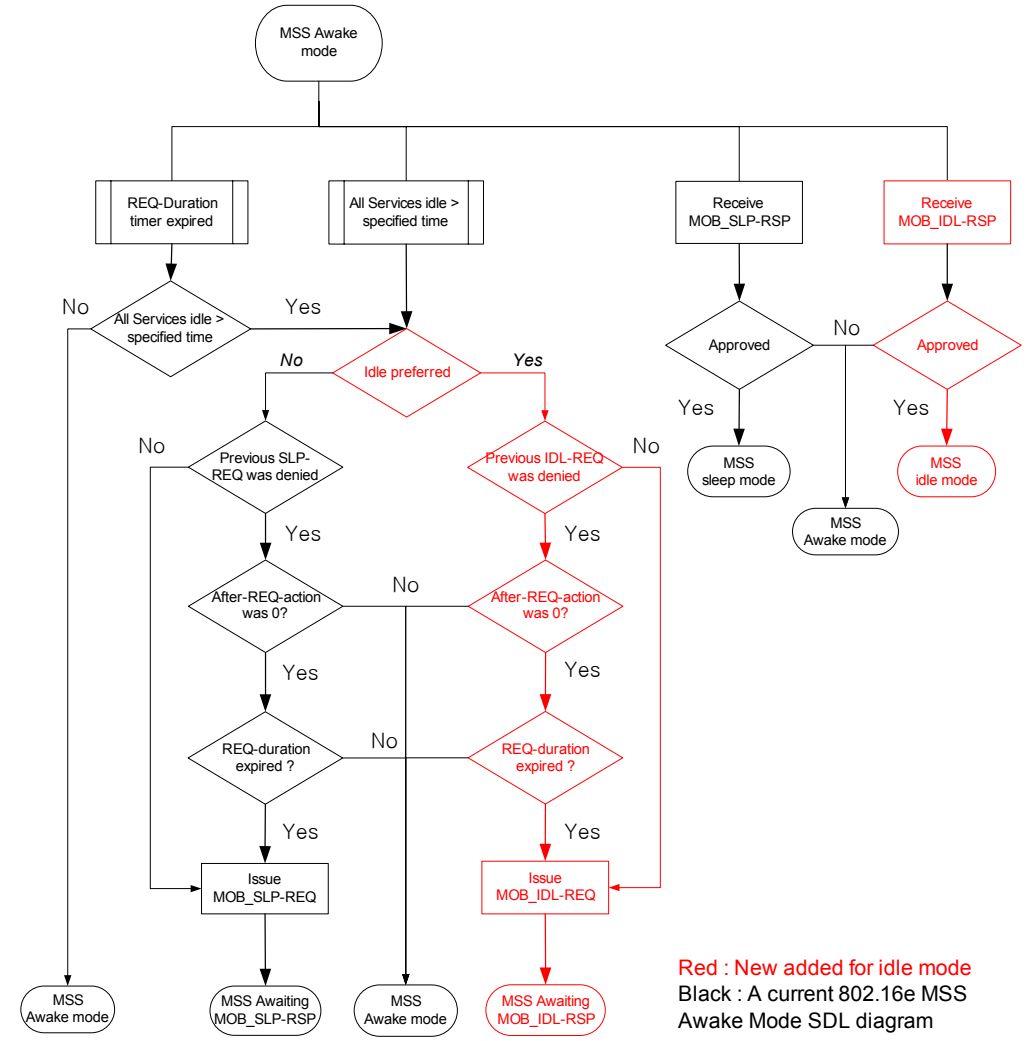

Figure. 108a - MSS Awake Mode SDL Diagram

[In Page 38, Line 1, Replace Figure 108b – MSS Awaiting Sleep Response SDL Diagram with the following]

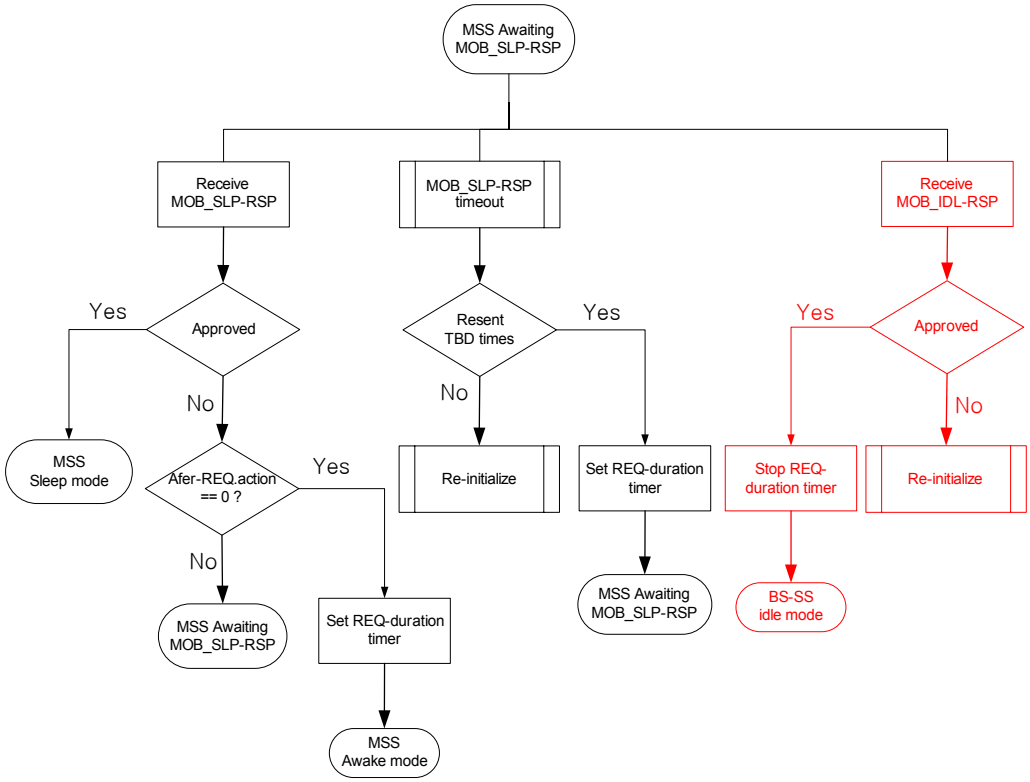

Figure.108b MSS Awaiting Sleep Response SDL Diagram

[In Page 38, Line 1, Replace Figure 108d – Typical MSS Listening SDL Diagram with the following]

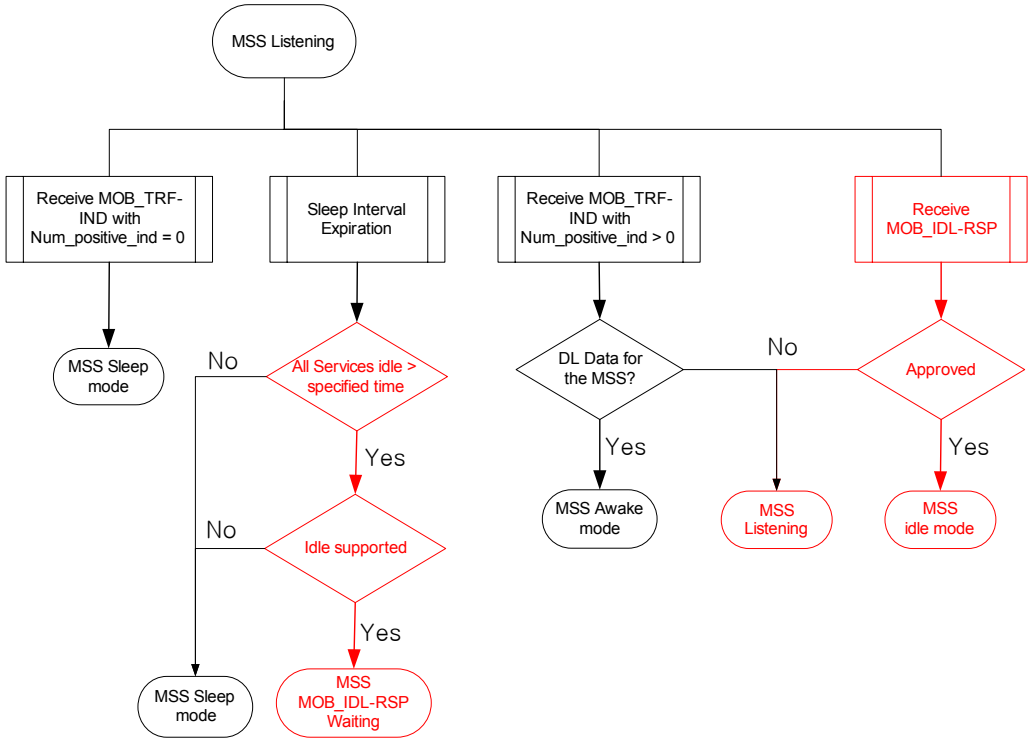

Figure 109d. Typical MSS Listening SDL Diagram

[In Page 43, Line 44, Insert Figures before the section 7.1 Architecture]

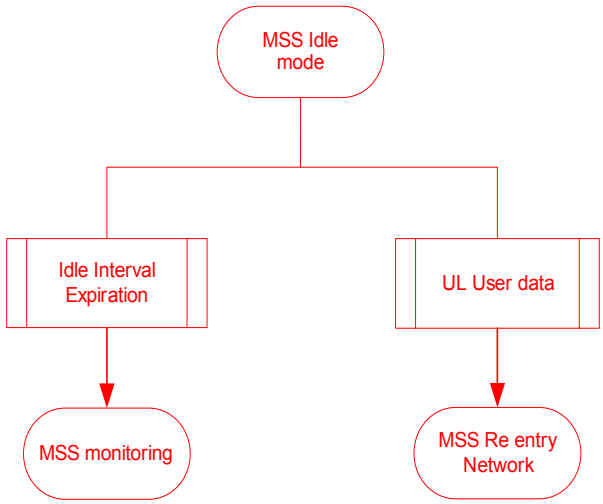

Figure.xxx - MSS Idle mode SDL Diagram

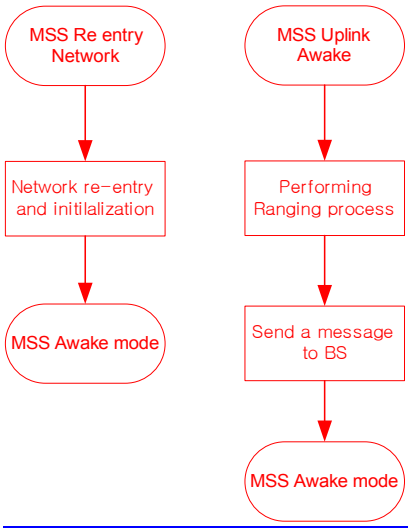

Figure.xxx+1 - MSS Re-entry and Uplink Awake SDL Diagram

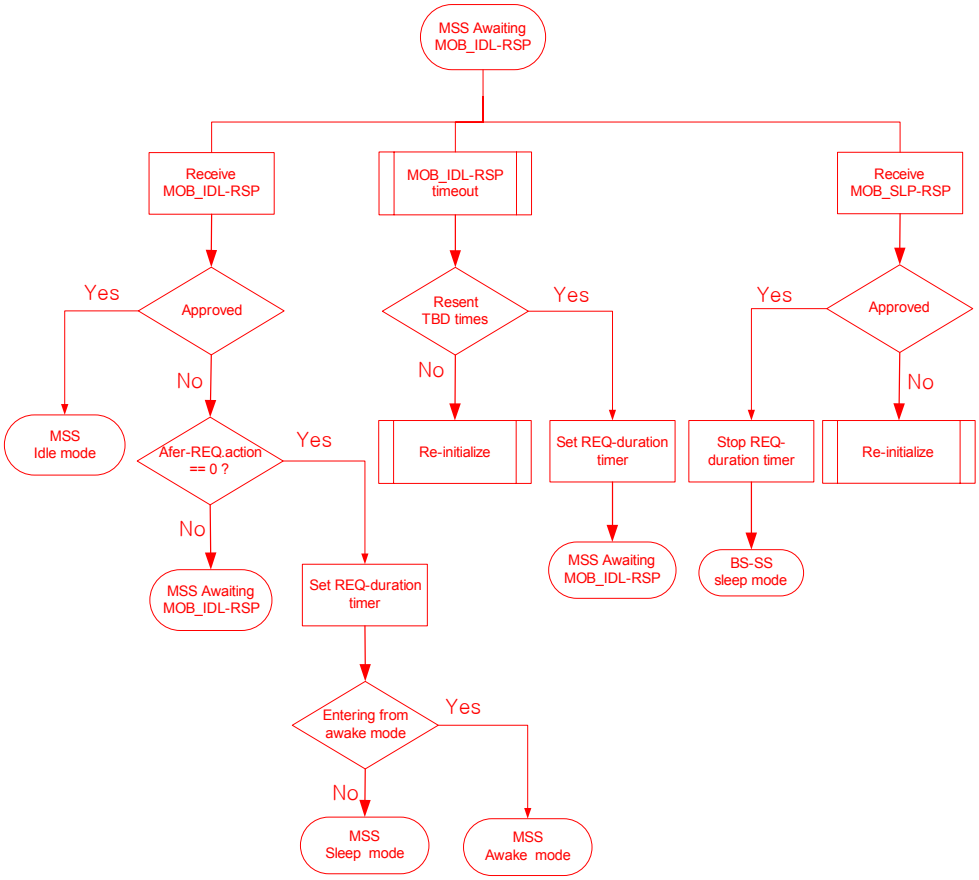

Figure xxx+1 - MSS Awaiting Idle Response SDL Diagram

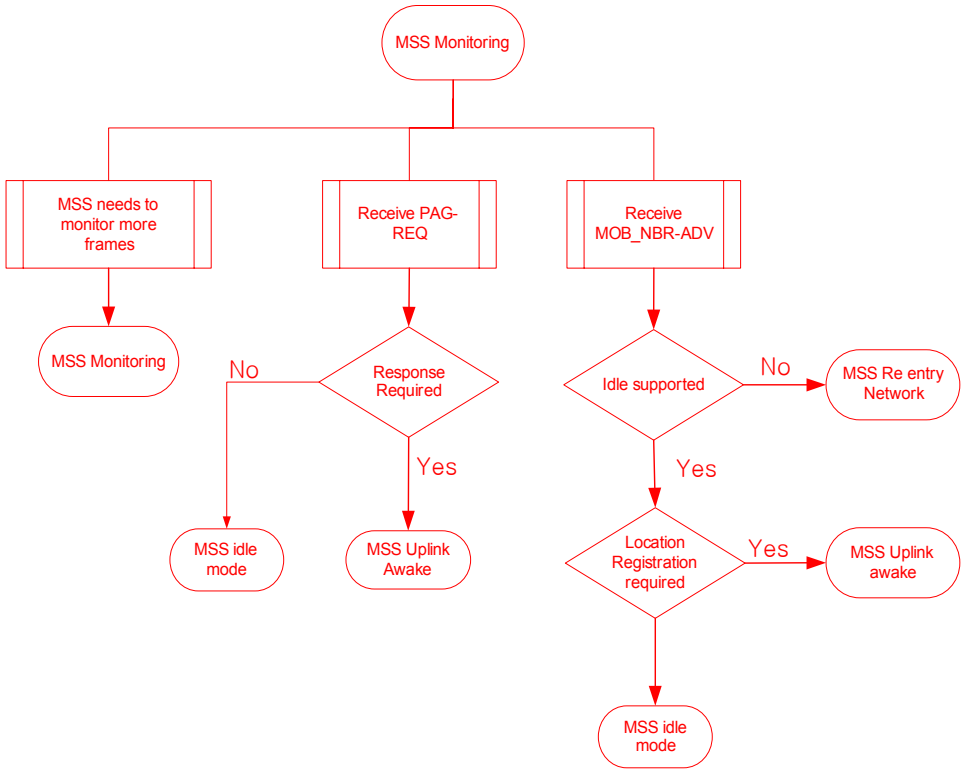

Figure xxx+2. - MSS Monitoring in Idle mode SDL Diagram

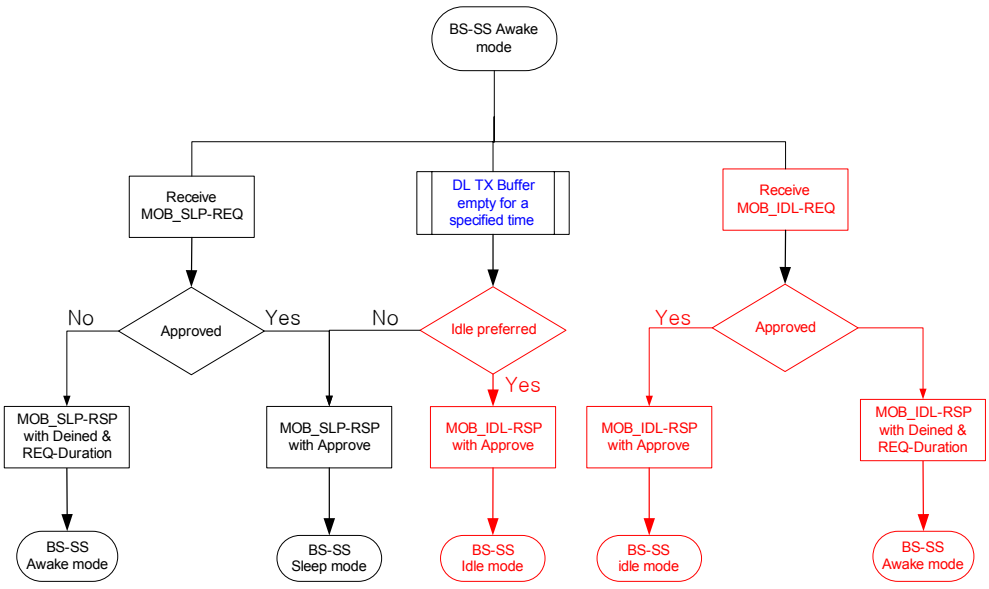

Figure xxx+3 - BS-SS Awake SDL Diagram

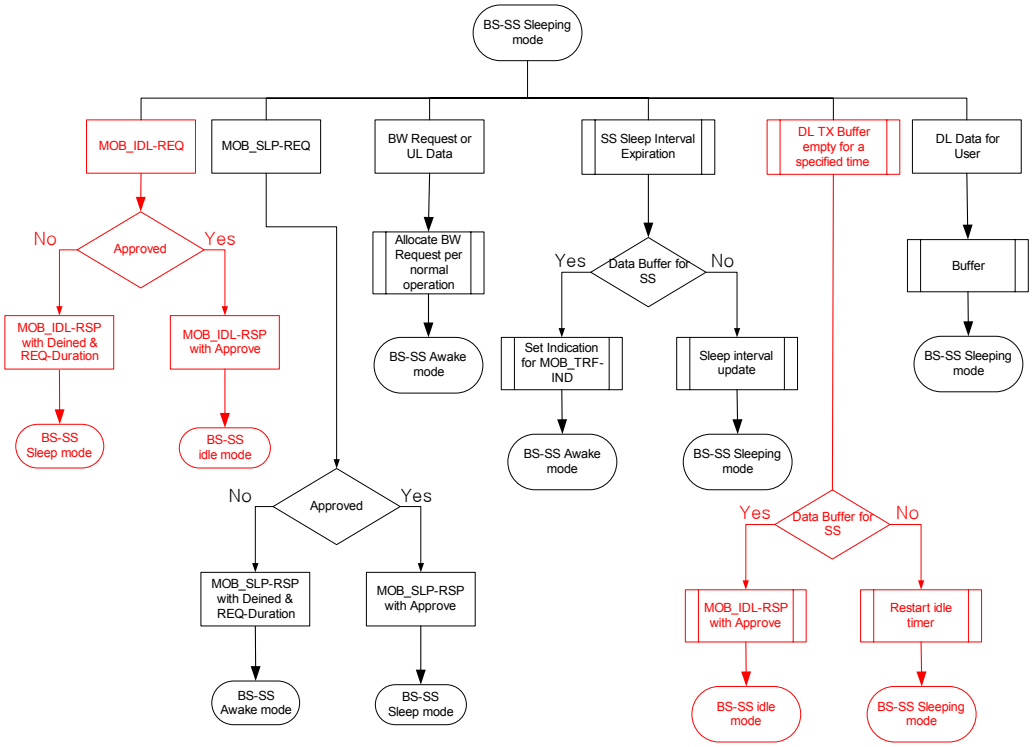

Figure xxx+4 - BS-SS Sleeping SDL Diagram

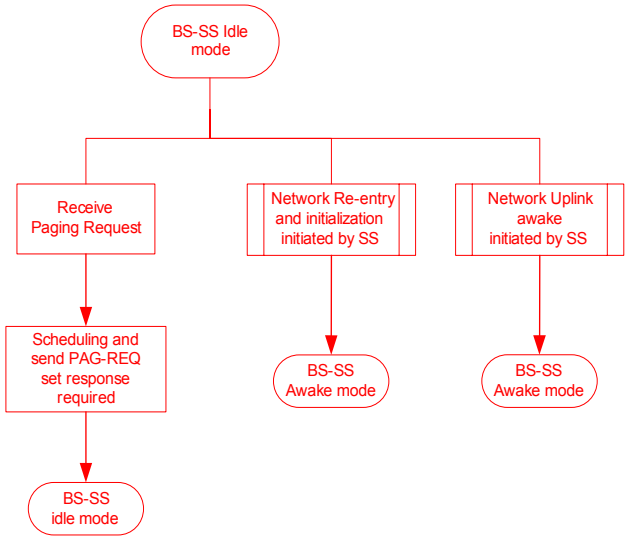

Figure xxx+5 - BS-SS Idle SDL Diagram

[In Page 18, Line 30, Insert new Message type after the Type 56 as follows]

6.4.2.3 MAC Management Messages

Table 14a. MAC Management Messages

Type	Message Name	Message Description	Connection
[…]	[…]	[…]	[…]
56	MOB_MSSHO-RSP	MSS HO response message	Basic
57	MOB_IDL-REQ	Idle request message	Basic
58	MOB_IDL-RSP	Idle response message	Basic
38, 59-255		Reserved	

[In Page 63. Line 42, Modify as follows]

11.4.2.13.1 ~~Sleep mode~~ Mode supported

This field indicates whether the MSS supports a sleep-mode and idle-mode. A bit value of 0 indicates “not supported” while 1 indicates “supported”.

Type	Length	Value	Scope
5.24.1	1	Bit #0: Mobility (handover) support Bit #1: Sleep-mode support Bit #2 : Idle-mode support	REG- REQ REG-RSP

When the **Mode Supported** value set to 2, i.e. the MSS support idle-mode, the following TLV may be included.

REST_INTERAL_INDEX : This value indicates the rest interval index for paging in Idle mode.

[In Page 25. Line 41, insert following sentence]

6.4.2.3.45 Neighbor Advertisement (MOB_NBR-ADV) message

For each advertised Neighbor BS, the following TLV parameters may be include.

Mode Supported : Same with 11.4.2.13.1.

When Mode Supported bit indicate support idle-mode, following TLV parameters may be included

PZONE-ID (8 bit) : A current serving cell's packet zone ID

MAX_REST_INTERVAL_INDEX (8bit) : BS (BS) shall set this field to the rest interval index permitted.

IH_T (8 bit) : When the MSS finds a target cell at which CINR is greater than a serving cell by IH_T, the MSS shall perform the idle handover procedure.

IH_GUARD(8 bit) : A guard timer for the idle handover,

[In Page 31. Line 4, Insert the following section]

6.4.2.3.53 Idle Request (MOB_IDL-REQ) Message

MSS supporting idle-mode uses the MOB_IDL-REQ message to request permission from the BS to enter idle-mode. The MOB_IDL-REQ message is sent from the MSS to the BS on the MSS's basic CID.

Table 85l - MOB_IDL-REQ Message Format

Syntax	Size	Notes
MOB_IDL-REQ_Message_Format() {		
Management message type = TBD	8 bits	
REST_INTERVAL_INDEX	4 bits	
Reserved	4 bitts	
}		

An MSS shall generate MOB_IDL-REQ messages in the format shown in Table 85l. The following parameters shall be included in the MOB_IDL-REQ message:

REST_INTERVAL_INDEX

Requested rest interval index.(measured in frame)

6.4.2.3.54 Idle Response (MOB_IDL-RSP) Message

The MOB_IDL-RSP message shall be sent from the BS to a MSS on the MSS's basic CID in response to an MOB_IDL-REQ message, or may be sent unsolicited. The MSS shall enter idle-mode using the parameters in the message. In the case where idle is denied (After-REQ-action=1), it is recommended that the BS provide unsolicited MOB_IDL-RSP message.

Table 85m - MOB_IDL-RSP Message Format

Syntax	Size	Notes
MOB_IDL-RSP_Message_Format() {		
Management message type = ??	8 bits	
Idle approved	1bits	0 : Idle Transition Denied 1 : Idle Transition approved
If(Idle approved == 0){		
After-REQ-action	1 bit	0: The MSS may retransmit the MOB_IDL-REQ after the time duration (REQ-duration) given by the BS in this message 1: The MSS shall not retransmit the MOB_IDL-REQ and shall wait the MOB_IDL-RSP from the BS
REQ-duration	4 bits	Time duration for case where After-REQ-action value is 0.
Reserved	2 bits	
} else{		
REST_INTERVAL_INDEX	4 bits	
TB_REGI_REQUIRED	1 bits	Timer-base registration required 0 : non-required 1 : required
if(TB_REGI_REQUIRED)		
{		
TB_REGI_INDEX	8bits	0 : reserved 1~255
}		

Reserved	2 bits	
}		
}		

An MSS shall generate MOB_IDL-RSP messages in the format shown in Table 85m. The following parameters shall be included in the MOB_IDL-RSP message:

Idle approved

The activation indication of the MSS when the MSS receives this message from the BS.

After-REQ-action

On MSS request to enter idle-mode rejected by the BS, indicate resource action

REQ-duration

Waiting value for the MOB_IDL-REQ message re-transmission (measured in frames)

REST_INTERVAL_INDEX

Start value for the rest interval index (measured in frames).

TB_REGI_REQUIRED

Timer based registration

TB_REGI_INDEX

If TB_REGI_REQUIRED is enabled, this value is used to compute the timer-based registration maximum count. Otherwise, this is omitted.