Project	**IEEE 802.16 Broadband Wireless Access Working Group <http://ieee802.org/16>**	
Title	**Sleep Mode and Handoff corrections for Task Group e**	
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Re:	Task Group Review of IEEE 802.16e-03/07r3 IEEE 802.16 Task Group e	
Abstract	This document provide corrections per given actions points given at session #26	
Purpose		
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Sleep Mode and Handoff corrections for Task Group e

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1. General

This document contains modified text as per action points given at meeting #26.

2. Proposed changes:

1.3.1.2.3.1.3 Ranging and uplink parameters adjustment

~~For MSS's that have used their scanning interval to do ranging with target BS this stage should be immediate. Otherwise, this stage is similar to the one performed~~An MSS may perform ~~at~~an initial network entry as specified in 6.2.9. During this stage the MSS is assigned a new basic and primary management CID in the target BS. If the MSS has used scanning interval(s) to do preliminary ranging with target BS, and if the target BS received HO-notification message that contains the MAC address of the MSS, (see section C.2.4 "Backbone network HO procedures") the BS may choose, instead of waiting for initial ranging request in MAINT region, to allocate non-contention transmission opportunity for the MSS.

As opposed to ~~initial~~regular network entry, where ~~this stage~~initial ranging is performed on contention basis, here the ranging opportunity may be allocated individually ~~by the BS~~ based on an MSS's 48-bit MAC address ~~identifier. This identifier is~~assuming this identifier was forwarded to the target BS via the backbone network ~~(see section Backbone network HO procedures)~~. Allocation of non-contention ranging opportunity~~This~~ is done using the Fast_UL_ranging_IE() (see Fast ranging (Paging) Information Element) in the UL-MAP. ~~When an initial ranging opportunity is not allocated individually, this procedure defaults to the one specified for initial network entry.~~

6. MAC CPS

6.4 Data/Control Plane

6.4.2 MAC PDU formats

6.4.2.3 MAC Management messages

Change Sections 6.4.2.3.40 as follows:

6.4.2.3.40 Sleep Request message (MOB_SLP-REQ)

SS supporting sleep-mode uses the MOB_SLP-REQ message to request permission from the BS to enter sleep-mode. The MOB_SLP-REQ message is sent from the SS to the BS on the SS's basic CID.

Table 56aa—Sleep-Request (MOB_SLP-REQ) message format

Syntax	Size	Notes
SLP-REQ_Message_Format() {		
Management message type = 45	8 bit	
initial-sleep window	6 bit	
final-sleep window	10 bit	
~~listening interval~~	~~8 bit~~	
}		

Parameters shall be as follows:

~~Min~~Initial-sleep window
Requested start value for the sleep interval (measured in frames).
~~Max~~Final-sleep window
Requested ~~stop~~final value for the sleep interval (measured in frames).
~~Listening interval~~
~~Requested listening interval (measured in frames).~~

Change Sections 6.4.2.3.41 as follows:

6.4.2.3.41 Sleep Response message (M0B_SLP-RSP)

TThe MOB_SLP-RSP message shall be sent from BS to a MSS on the SS's basic CID in response to an MOB_SLP-REQ message, or may be sent unsolicited. The SS shall enter sleep-mode using the parameters indicated in the message.

Table 56ab—Sleep-Response (MOB_SLP-RSP) message format

Syntax	Size	Notes
MOB_SLP-RSP_Message_Format() {		
Management message type = 46	8 bit	
Sleep-approved	1 bit	0: Sleep-mode request denied 1: Sleep-mode request approved
If (Sleep-approved == 0) {		
Reserved	7 bit	
} else {		
start frame	7 bit	lower byte of the frame number, in which the SS shall enter into sleep mode
initial-sleep window	6 bit	
final-sleep window	10 bit	
~~listening interval~~	~~8 bit~~	
}		
}		

Parameters shall be as follows:

Sleep approved
Defines whether or not the request to enter sleep-mode has been approved by the BS.
Start-time
The number of frames (not including the frame in which the message has been received) until the SS shall enter the first sleep-interval.
~~**Min**~~**Initial-sleep window**
Start value for the sleep interval (measured in frames).
~~**Max**~~**Final-sleep window**
~~Stop~~Final value for the sleep interval (measured in frames).
~~**Listening interval**~~
~~Value for the listening interval (measured in frames).~~

Change Sections 6.4.2.3.48 as follows:

6.4.2.3.48 BS HO Response (MOB_BSHO-RSP) message

~~Either an MSS or a~~The BS shall transmit an MOB_BSHO-RSP message upon reception of MOB_HO-REQ message or in an unsolicited manner. The message shall be transmitted on the basic CID.

Table 56ai—MOB_BSHO-RSP Message Format

Syntax	Size	Notes
MOB_BSHO-RSP_Message_Format() {		

Management Message Type = 53	8 bits	
Estimated HO time	8 bits	
N_Recommended	8 bits	
For (j=0 ; j<N_NEIGHBORS ; j++) {		
Neighbor BS-ID	48 bits	
service level prediction	8 bits	~~This parameter exists only when the message is sent by the BS~~
}		
}		

A BS ~~or MSS~~ shall generate MOB_BSHO-RSP messages in the format shown in Table 56ai. The following parameters shall be included in the MOB_BSHO-RSP message,

Estimated HO time – Estimated number of frames starting from the frame following the reception of the MOB_BSHO-RSP message until the HO ~~will~~may take place. A value of zero in this parameter signifies that this parameter should be ignored.

N_Recommended – Number of recommended neighbor BS

For each recommended neighbor BS, the following parameters shall be included,

Neighbor BS-ID – Same as the **Base Station ID** parameter in the DL-MAP message of neighbor BS

Service level prediction – This value indicates the level of service the MSS can expect from this BS. the following encodings apply:

0 = No service possible for this MSS.

1 = Some service is available for the MSS.

2 = Service with QoS specified at ASA server (for the MSS identified by the 48-bit MAC address) is available.

Renumber section 6.4.2.3.49 as 6.4.2.3.50, change 'Management Message Type' to 55 in table 56aj and insert new section 6.4.2.3.49 as follows:

6.4.2.3.49 MSS HO Response (MOB_MSSHO-RSP) message

An MSS shall transmit an MOB_MSSHO-RSP message upon reception of MOB_MSSHO-REQ message. The message shall be transmitted on the basic CID.

Table 56ai1—MOB_MSSHO-RSP Message Format

Syntax	Size	Notes
MOB_MSSHO-RSP_Message_Format() {		
Management Message Type = 54	8 bits	

Estimated HO time	8 bits	
N_Recommended	8 bits	
For (j=0 ; j<N_NEIGHBORS ; j++) {		
Neighbor BS-ID	48 bits	
}		
}		

An MSS shall generate MOB_MSSHO-RSP messages in the format shown in Table 56ai. The following parameters shall be included in the MOB_MSSHO-RSP message,

Estimated HO time – Estimated number of frames starting from the frame following the reception of the MOB_BSHO-RSP message until the HO may take place. A value of zero in this parameter signifies that this parameter should be ignored.

N_Recommended – Number of recommended neighbor BS

For each recommended neighbor BS, the following parameters shall be included,

Neighbor BS-ID – Same as the **Base Station ID** parameter in the DL-MAP message of neighbor BS

Change Sections 6.4.16.1 - 6.4.16.3 as follows:

6.4.16 Sleep-mode for mobility-supporting SS

6.4.16.1 Introduction

Sleep-mode is a mode in which SS's supporting mobility may power down. Sleep-mode is intended to enable mobility-supporting SS's to minimize their energy usage while staying connected to the network. Implementation of ~~power-save~~sleep-mode is optional.

An SS that supports sleep-mode can be in one of two modes:

— Awake
— Sleep

When an SS is in awake-mode, it is receiving and transmitting PDUs in a normal fashion. When the SS is in a sleep-mode, it does not send or receive PDUs. In sleep-mode the SS may power down.

Two intervals are defined:

Sleep-interval
A time duration, measured in whole frames, where the SS is in sleep-mode. During consecutive sleep periods the sleep-interval shall be updated using an exponentially increasing algorithm with adjustable minimum and maximum limits.

Listening-interval
Length, measured in whole frames, of the listening interval. During this interval the SS shall decide whether to stay awake or go back to sleep based on an indication from the BS. The Listening-interval duration is negotiated between the BS and the SS.

Before entering sleep-mode the SS shall inform the BS and obtain its approval. The BS may buffer (or it may drop) incoming PDUs addressed to the sleeping SS, and shall a send notification to the SS in it's awakening periods about whether data has been addressed for it.

An SS shall awake according to the sleep-interval and check whether there were PDUs addressed for it. If such PDUs exist, it shall remain awake. An SS may terminate sleep-mode and return to awake-mode anytime (i.e. there is no need to wait until the sleep-interval is over). If the BS receives an MPDU from an SS that is supposed to be in sleep-mode, the BS shall assume that the SS is no longer in sleep-mode.

Traffic inidcation message (TRF-IND) shall be sent by the BS on the broadcast CID periodically. If the number of positive indications is zero, the BS sends an empty indication message, that is, TRF-IND message with num-positive=0.

When its sleep-interval timeouts, the SS shalle awake to listen to the DL transmissions until it receives a TRF-IND message. If there is a positive indication to the SS, it shall remain awake. Otherwise, the SS may returns to its sleep-mode. The listening-interval parameter defines the number of frames the SS shall remain awake waiting for the TRF_IND message.

~~In this way, the listening interval parameter is no longer needed to be negotiated between SS and BS in the SLP-REQ and SLP-RSP messages. The interval between two TRF-IND messages sent by the BS is the maximum listening interval for all SS's supporting sleep-mode. It can be sent in the SLP-RSP message only.~~

Figure 123a shows the SDL for the SS in the awake state.

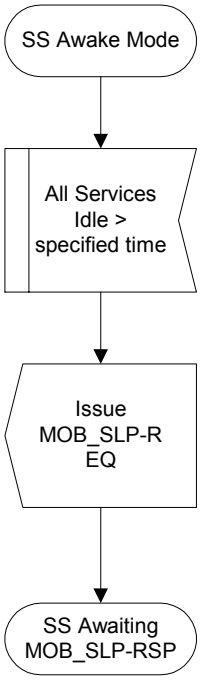

Figure 123a—SS Awaiting Sleep Response SDL Diagram

Figure 123b shows the SDL for the SS after it has sent an MOB_SLP-REQ message and is awaiting a response.

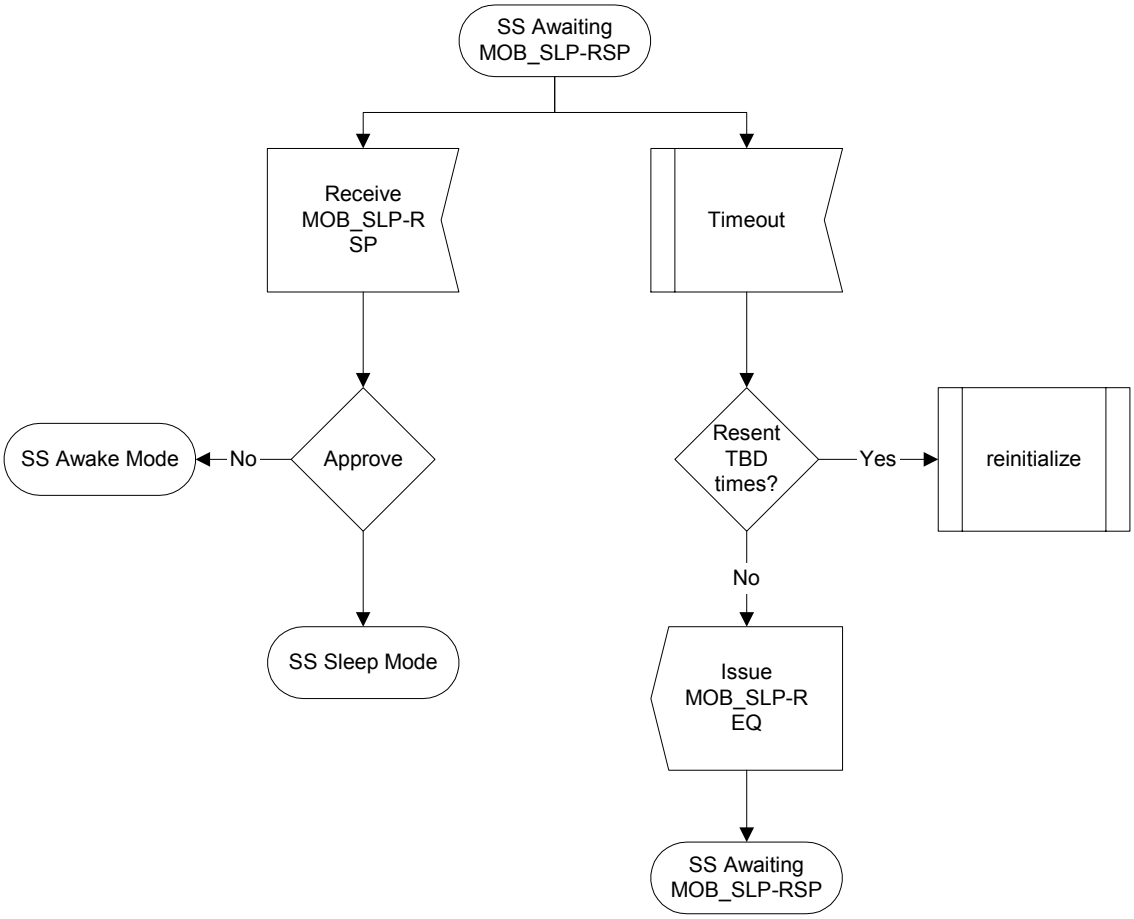

Figure 123b—SS Sleep Mode SDL Diagram

Figure 123c shows the SDL for the SS while in sleep-mode.

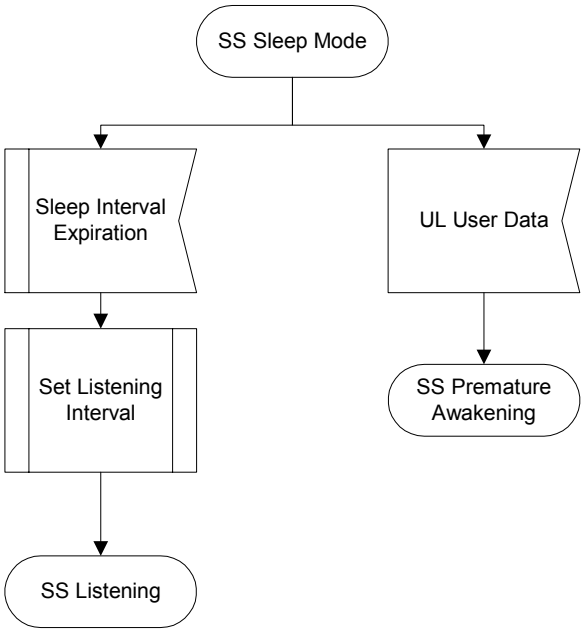

Figure 123c—SS Await Poll SDL Diagram

Figure 123d shows the SDL for when the SS is listening for an MOB_TRF-IND message from the BS.

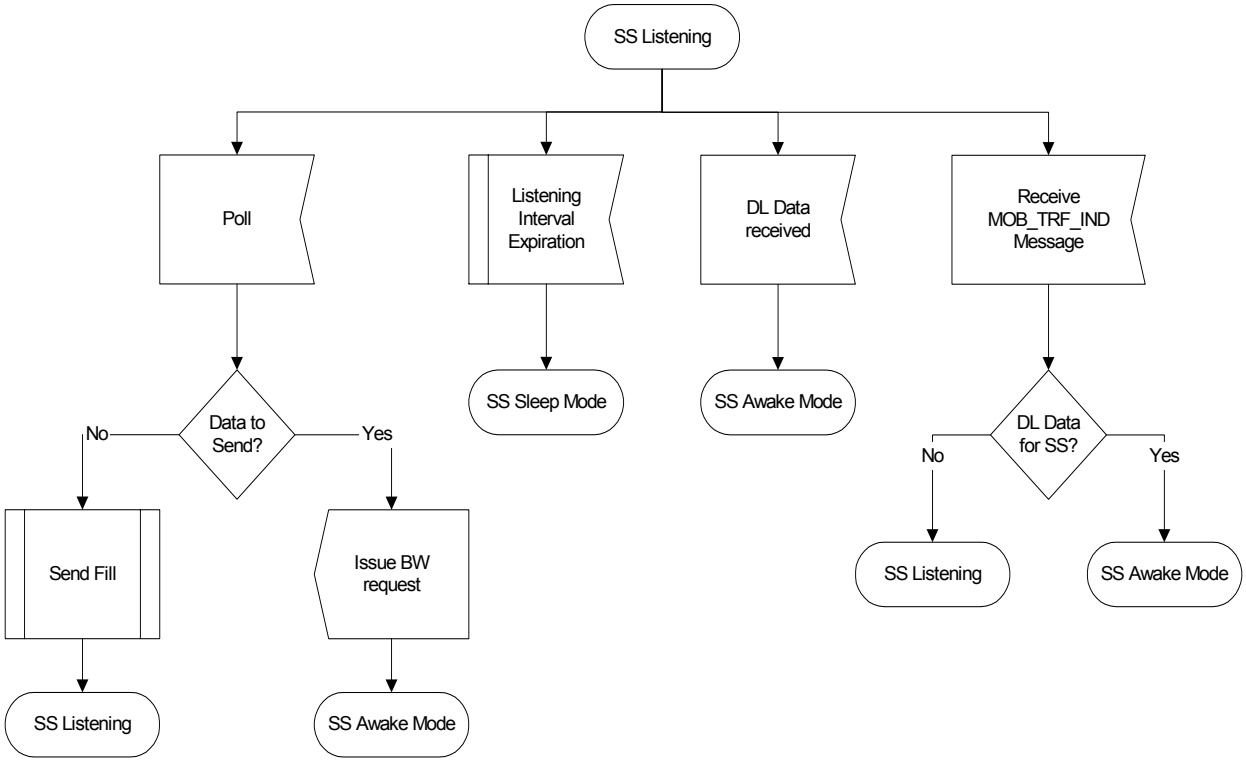

Figure 123d—SS Listening SDL Diagram

Figure 123e shows the SDL for when the SS has awakened prematurely.

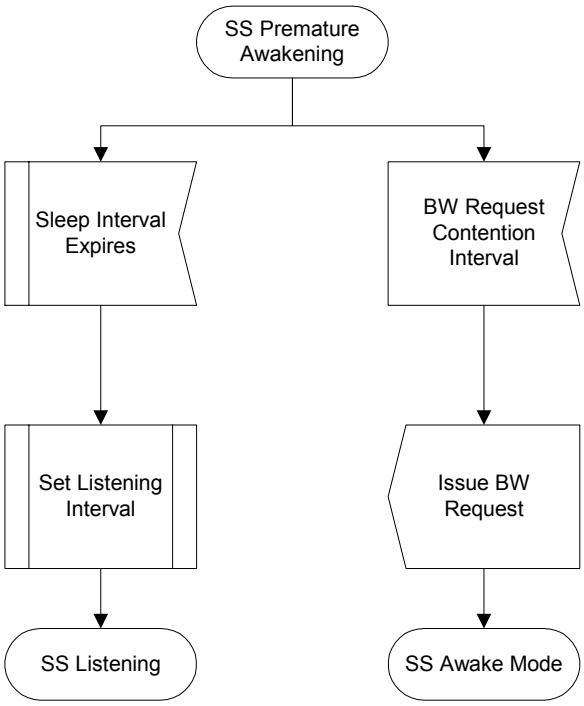

Figure 123e—SS Premature Awakening SDL Diagram

Figure 123f shows the SDL for the BS when an SS is in awake mode.

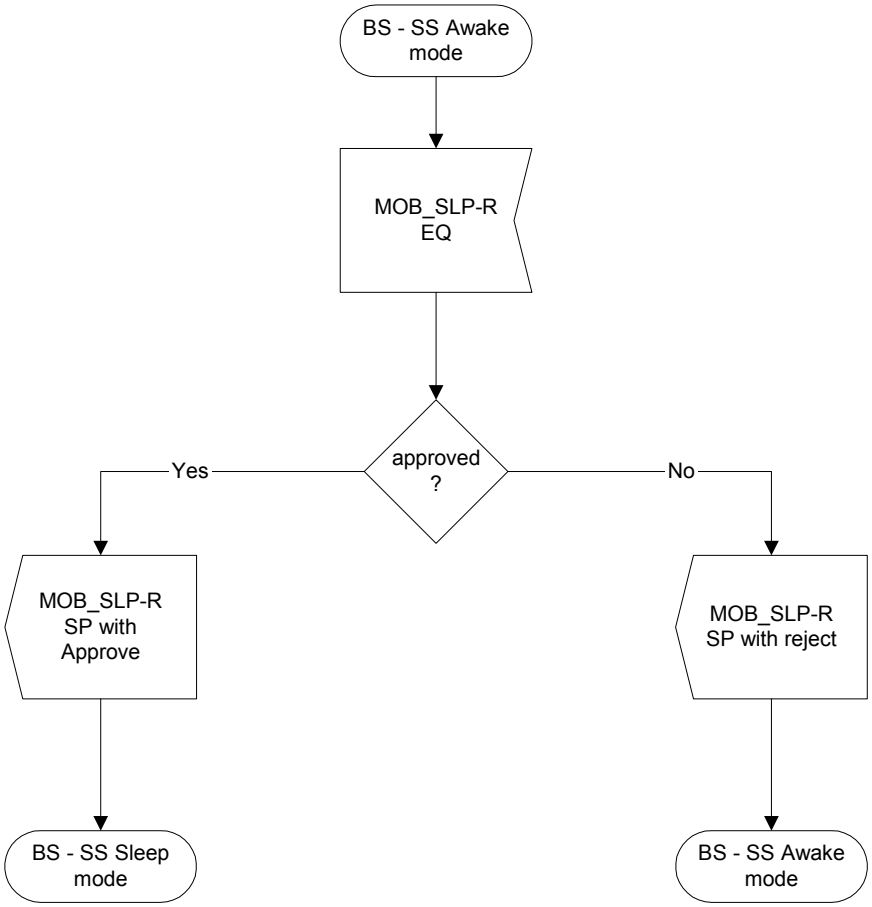

Figure 123f—BS – SS Awake Mode SDL Diagram

Figure 123g shows the SDL for the BS when the SS is in sleep mode.

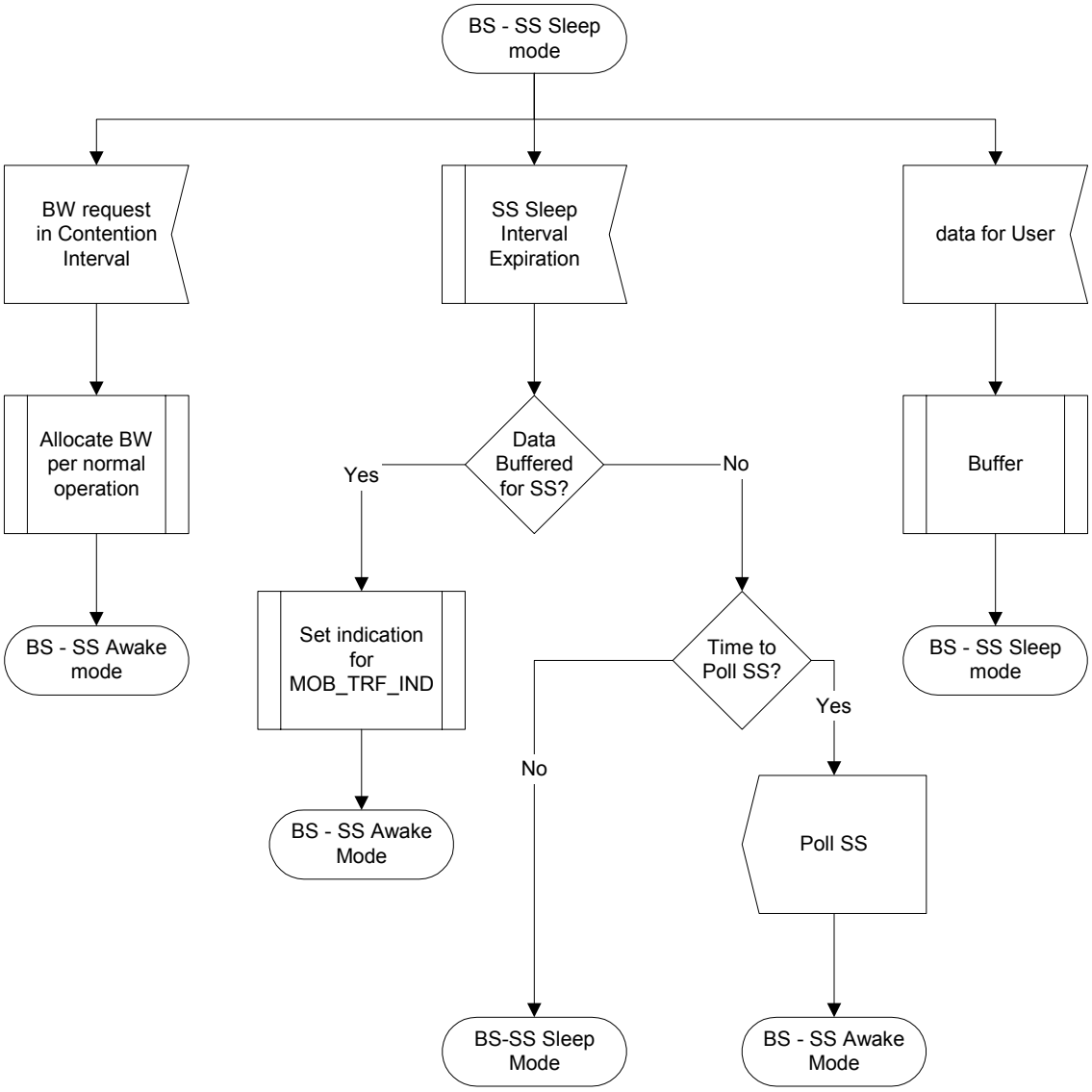

Figure 123g—BS – SS Sleep Mode SDL Diagram

Figure 123h shows the BS SDL for when the SS is awakening.

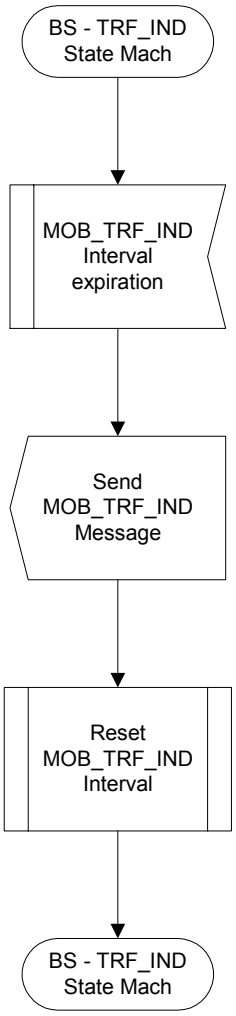

Figure 123h—BS – SS Awakening SDL Diagram

6.4.16.2 Sleep-interval update algorithm

An MSS shall enter sleep-mode after receiving an SLP-RSP message from the BS. In the first time it enters sleep-mode, it shall use the initial-sleep window value for the sleep interval. If during the following listening interval the BS has not signaled that traffic has been addressed for the MSS, the MSS shall re-enter sleep-mode an double the duration of the sleep-interval. This procedure shall be repeated as long as the resulting sleep-interval does not exceed the final-sleep window value. The following formula defines the claculation of the duration of k^{th} sleep-interval - I_k:

$$\begin{cases} I_0 = \text{initial-sleep window} \\ I_k = min\{2 \cdot I_{k-1}, \text{final-sleep window}\} \qquad k > 0 \end{cases} \tag{1}$$

When the MSS has reached the final-sleep window size, it shall continue in sleep mode without further increasing the sleep-interval.

6.4.16.3 Traffic indication signaling

A BS shall notify each SS in sleep-mode, during its listening-interval, if traffic has been addressed to it. The indication is sent on the TRF-IND broadcast message. The SS shall examine the frame number from the PHY Synchronization Field and shall verify its synchronization with the BS. If the expected frame number is different than found frame number, the SS shall return into awake mode.

~~If the SS did not find any positive indication with it's CID the TRF-IND~~ If the SS recives a TRF-IND message with 'num-positive' field = 0, or no CID in the TRF-IND message matches the SS's basic CID, it shall consider this as a negative indication and shall continue in sleep mode. For an example of sleep mode operation, see Annex D.

11. TLV Encodings

11.1 MAC management message encodings

11.1.4 REG-RSP TLVs for connection re-establishment

Change in table 127b:

Table 127b—REG-RSP Encodings

Name	Type (1 byte)	Length (1 byte)	Value (Variable-length)
~~CID_update~~New CID	~~?~~TBD	~~16 bits~~2	~~CID in the previous serving BS~~New CID after handover to new BS.
OLD CID	~~?~~TBD	~~16 bits~~2	~~Replacement CID in the current serving BS~~Old CID before handover from old BS.
Connection_Info	~~?~~TBD	Variable	The Connection_Info is a compound TLV value that encapsulates the Service Flow Parameters and the CS Parameter ~~Encodings TLVs allowed on the DSA-RSP message~~that have changed for the service. All the rules and settings that apply to the ~~TLVs~~parameters when used in the DS~~A~~C-RSP message apply to the contents encapsulated in this TLV.

11.4 Common encodings

Add to Table 278:

Table 278—Common encodings

Type	Parameter
44	Mobility support capabilities

11.4.2 SS Capabilities encoding

Add to Table 279

Table 279—SS Capability encodings

Type	Parameters
24	Mobility parameters support

Insert new sections 11.4.2.11, 11.4.2.11.1 and 11.4.2.11.2

11.4.2.11 MSS Mobility parameters support

This field defines the parameters associated with the mobility support capabilities of the MSS.

Type	Length	Value
5.24	n	-

11.4.2.11.1 Sleep-mode supported

This field indicates whether the MSS supports sleep-mode. A bit value of 0 indicates ìnot supportedî while 1 indicates ìsupported.

Type	Length	Value	Scope
5.24.1	1	Bit #0: Sleep-mode support Bits #1-7: *Reserved*, shall be set to zero	REG- REQ

11.4.2.11.2 Sleep-mode recovery time

This field indicates the time requires for an MSS which is in a sleep-mode to return to awake-mode. This parameter is optional and may be used by the BS to determine the sleep interval windows sizes when initiating sleep-mode with an MSS.

Type	Length	Value	Scope
5.24.2	1	Number of freames required for the MSS to switch from sleep-mode to awake-mide	REG- REQ

Insert new sections 11.4.14

11.4.14 Mobility support capabilities

This field defines common parameters for mobility support..

Type	Length	Value
44	n	-

11.4.14.1 Listening Interval

This field indicates the length in frames of listening interval for sleep-mode operation.

Type	Length	Value	Scope
44.1	1	Length in frames of listening interval	REG- RSP