Project	**IEEE 802.16 Broadband Wireless Access Working Group <http://ieee802.org/16>**
Title	Sleep mode supporting the periodic ranging with compressed format of SLP ID fields in MOB_TRF-IND message – Harmonization Ad-Hoc Consensus Contribution
Date Submitted	**2004-08-17**

Source(s)	Yeongmoon Son, Kanggyu Lee Samsung Electronics	Voice: +82 31 279 5845 ym1004.son@samsung.com
	Vladimir Yanover Alvarion Ltd.	Voice : +972 364 57834 vladimir.yanover@alvarion.com
	Yigal Eliaspur, Assaf Mor, Sharon Intel	Voice : +972 547 884877 yigal.eliaspur@intel.com
	Yongjoo Tcha, Seong-Choon Lee KT	Voice : +82 2 526 6155 yjtcha@kt.co.kr
	San-Yun Han, Jae-Hak(Steve) Lee SOLiD Tech., Inc	Voice : +82 2 2142 3881 syhan@st.co.kr
	Phillip Barber Broadband Mobile Technologies, Inc.	Voice: +1 (972) 365-6314 pbarber@BroadbandMobileTech.com
	Kiseon Ryu, Yongho (Ronny) Kim, Kihyoung Cho, Beomjoon Kim, Changjae Lee, LGE	Voice : +82 31 450 4387 beom@lge.com
	Dong-Cheol Lee, Chi-Man Lee, Ki-Jun Lee Dacom	Voice : +82 505 889 4248 dhlees@dacom.net

Re:	This contribution is response to call for contribution about IEEE 802.16e-D4/2004

Abstract	This document proposes the scheme for sleep mode supporting the periodic ranging and reduction of dummy bits in MOB_TRF-IND message. It is the harmonized Ad-hoc consensus contribution among multiple companies.

Purpose	Discuss and adapt proposed text and message format.

Patent Policy and Procedures	The contributor is familiar with the IEEE 802.16 Patent Policy and Procedures <http://ieee802.org/16/ipr/patents/policy.html>, including the statement "IEEE standards may include the known use of patent(s), including patent applications, provided the IEEE receives assurance from the patent holder or applicant with respect to patents essential for compliance with both mandatory and optional portions of the standard." Early disclosure to the Working Group of patent information that might be relevant to the standard is essential to reduce the possibility for delays in the development process and increase the likelihood that the draft publication will be approved for publication. Please notify the Chair <mailto:chair@wirelessman.org> as early as possible, in written or electronic form, if patented technology (or technology under patent application) might be incorporated into a draft standard being developed within the IEEE 802.16 Working Group. The Chair will disclose this notification via the IEEE 802.16 web site <http://ieee802.org/16/ipr/patents/notices>.

Sleep mode supporting the periodic ranging with compressed format of SLP ID fields in MOB_TRF-IND message (Harmonization Ad-Hoc Consensus)

Yeongmoon Son, Kanggyu Lee,
Vladimir Yanover[*],
Yigal Eliaspur[**], Assaf Mor[**], Sharon[**]
Yongjoo Tcha[***], Seong-Choon Lee[***]
San-Yun Han[****], Jae-Hak(Steve) Lee[****]
Phillip Barber[#]
Kiseon Ryu[##], Yongho (Ronny) Kim[##], Kihyoung Cho[##],
Beomjoon Kim[##], Changjae Lee[##]
Dong-Cheol Lee[###], Chi-Man Lee[###], Ki-Jun Lee[###]

Samsung Electronics, Alvarion Ltd.[*], Intel[**], KT[***], SOLiD Tech. Inc[****], Broadband Mobile Technologies Inc.[#], LGE[##], Dacom[###]

1. Problem Statement

In IEEE P802.16-REVd/D5-2004, SS joined to BS shall perform the periodic ranging procedure in order to adjust transmission parameters so that it can maintain its uplink communications with the BS. Since MSS may suffer from channel characteristics variation much more than fixed SSs, it shall perform the periodic ranging procedure even during sleep mode.

For each MSS, its BS shall maintain a T27 timer for the periodic ranging opportunity. Whenever the timer expires, the BS shall issue a ranging opportunity for an uplink transmission (or uplink burst) to the MSS through a UL-MAP message. However, the MSS in sleep-mode faces a problem in performing the periodic ranging: Since MSS can increase the sleep window upto 130944 frames (=(1024-1)*(2^7)), several periodic ranging operations may be scheduled within a sleep interval. The current sleep mode assumes that there occurs only one periodic ranging operation during a sleep interval, if any. Consequently, this requires some modifications to the current periodic ranging operation in sleep mode.

Another problem is that whenever an MSS in sleep mode goes into listening intervals, it shall decode SLPID-bitmap in MOB_TRF-IND including many meaningless dummy bits as well as the indication bits mapped to its own SLPIDs. This redundant bits need to be reduced for the efficient use of the downlink bandwidth.

2. Proposed Remedy

We propose that both MOB_SLP-RSP and RNG-RSP messages are modified to support multiple periodic ranging operations in a sleep interval. And at the same time, we simplify the current MOB_TRF-IND message by removing periodic ranging related information, which greatly reduces the unnecessary bits for SLPIDs decoded in the listening interval.

2.1 New scheme supporting periodic ranging in sleep mode

In the proposed scheme, both MOB_SLP-RSP and RNG-RSP message includes a new parameter in itself as follows.

- ***Next Periodic Ranging***

This parameter indicates the frame in which MSS has to be ready to receive the periodic ranging opportunity allocated by BS identified by 16 bits offset with respect to the frame where RNG-RSP is transmitted.

It is also used to indicate a positive traffic indication for an MSS by setting 'Next Periodic Ranging' = 0, The MSS receiving the RNG-RSP message with 'Next Periodic Ranging' = 0 shall maintain Awake mode.

This parameter may be added as TLV encoding to RNG-RSP message or MOB_SLP-RSP message.

When MSS sends MOB_SLP-REQ message to BS in order to enter sleep mode, BS shall send MOB_SLP_RSP including 'Next Periodic Ranging' so that MSS can know when to awaken during sleep interval for performing periodic ranging. Thus, if MSS is still sleeping in that frame whose frame number is the 'Next Periodic Ranging', it shall listen downlink frame and decode the DL-MAP and UL-MAP for periodic ranging

When the periodic ranging operation between MSS and BS comes to an end, BS shall inform MSS of the frame number in which next periodic ranging operation is expected to start. For this situation, BS shall append 'Next Periodic Ranging' as TLV encoding to RNG-RSP message whose ranging status parameter is set to 'success'. In other words, if an MSS receives the last RNG-RSP message that indicates the successful termination of the periodic ranging operation, it shall read the frame number in which next periodic ranging will start. Thus, if MSS is still in sleep interval just after completion of periodic ranging, it may return to sleep mode till the frame as 'Frame Number for Next Periodic Ranging'.

The proposed scheme does not require the current MOB_TRF-IND message to support the periodic ranging. That is, it can get rid MOB_TRF-IND message of information about periodic ranging. Therefore, MOB_TRF-IND message plays a role of only the traffic indication in this scheme.

Figure 1 depicts the proposed operation of periodic ranging during sleep mode.

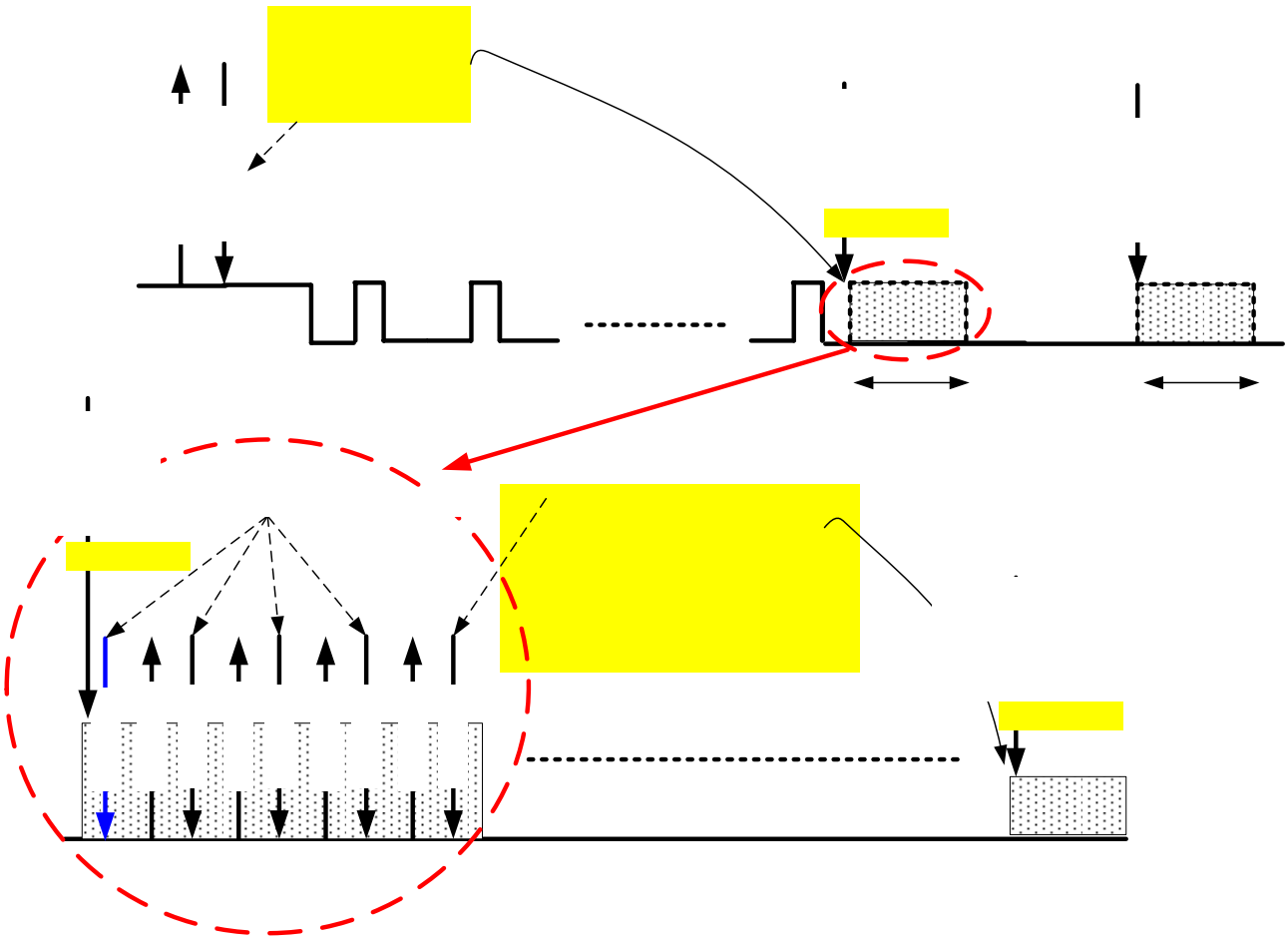

Figure 1. The proposed operation of periodic ranging during sleep mode

2.2 A scheme for compressed format of SLP ID fields in MOB_TRF-IND message

In the proposed scheme, both MOB_TRF-IND message includes the new parameters in itself as follows.

- ***SLPID-Group Indication bit-map***

  SLPIDs from 0 to 1023 are divided into 32 SLPID-Groups. Therefore, the respective SLPID-Group has the range as follows

  SLPID-Group#0 represents SLPID = 0 ... 31.
  SLPID-Group#1 represents SLPID = 32 ... 63.
  ...
  SLPID-Group#31 represents SLPID = 992 ... 1023.

  'SLPID-Group Indication bit-map' is a 32 bit-long whose each bit is assigned to the respective SLPID-Group. In other words, the most significant bit (=MSB) in it is assigned to SLPID-Group#0, and subsequent bit relates to SLPID-Group#1, etc.

  A bit in 'SLPID-Group Indication bit-map' indicates whether a traffic indication for all the MSSs in a SLPID-Group is negative indication or not. For example, if a bit about SLPID-Group#0 is set to '0', it means that all the MSSs with SLPID from #0 to #31 have a negative indication or a dummy indication. Therefore, all the 32 negative indications can be removed from MOB_TRF-IND message because SLPID-Group Indication takes the place of all the 32 negative indications

- ***Traffic Indication bit-map***

  This parameter is almost the same as the current 'SLPID bitmap' in MOB_TRF-IND message with the only difference that groups of 32 zeroes are omitted

In the proposed scheme, MOB_TRF-IND message does not need information about the periodic ranging operation because periodic ranging operation is performed using the MOB_SLP-RSP and RNG-RSP messages. Thus, it focuses on the only traffic indication for MSSs except periodic ranging indication.

3. Proposed Text Changes

[Add the following text below line 11 in Page 19 of D4 document]

Next Periodic Ranging

Indicates Frame Offset for the next periodic ranging opportunity. This value shall be set to zero to indicate that there has been DL traffic addressed to the MSS.

[Append the following parameter after Resource Retain Flag in Table 320a on Page 106, Line 44]

Table 320a --- RNG-RSP message Encodings

Name	Type (1 byte)	Length	Value (Variable-length)
Next Periodic Ranging	21	2	This value indicates offset of the frame in which the periodic ranging will be performed with respect to the

			frame where RNG-RSP is .transmitted. This TLV encoding is included in RNG-RSP message only when its ranging status is 'success' If MSS receives RNG-RSP message with 'Next Periodic Ranging' = 0, it shall remain awake mode.

[Modify the MOB_SLP-RSP message in Table 92b on Page 18, Line 51 as follows]

Table 92b --- Sleep-Response (MOB_SLP-RSP) message format

Syntax	Size	Notes
MOB-SLP-RSP_Message_Format() {		
Management message type = 47	8 bit	
Sleep-Approved	1 bit	0 : Sleep-mode request denied 1 : Sleep-mode request approved
IF(Sleep-Approved == 0) {		
After-REQ-action	1 bit	0: The MSS may retransmit the MOB-SLP-REQ message after the time duration (REQ-duration) given by the BS in this message 1: The MSS shall not retransmit the MOB-SLP-REQ message and shall await the MOB-SLP-RSP message from the BS
REQ-duration	4 bit	Time duration for case where After-REQ-action value is 0.
Reserved	2 bit	
}		
else {		
Start frame	6 bit	
initial-sleep window	6 bit	
final-sleep window base	10 bit	
listening interval	4 bit	
final-sleep window exponent	3 bit	
SLPID	10 bit	
}		
}		
TLV encoded information		

Parameters shall be as follows:

Sleep approved

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

After-REQ-action

On MSS request to enter sleep mode rejected by the BS, indicate recourse action.

REQ-duration

Waiting value for the MOB-SLP-REQ message re-transmission (measured in MAC frames)

Start-frame

Lower 6 bits of the frame number in which the MSS shall enter into sleep mode.

Initial-sleep window

Start value for the sleep interval (measured in frames).

Final-sleep window base

Base for ~~Final~~ final value for the sleep interval (measured in frames).

Listening interval

Requested listening interval (measured in frames) to the MOB-SLP-REQ.

Final-sleep window exponent

Defines the factor by which the final-sleep window base is multiplied in order to calculate the final-sleep window. The following formula is used:

final-sleep window = final-sleep window base * 2^(final-sleep window exponent)

SLPID

This is a number assigned by the BS whenever an MSS is instructed to enter sleep-mode. This number shall be unique in the sense that it is assigned to a single MSS that is instructed to enter sleep-mode. No other MSS shall be assigned the same number while the first MSS is still in sleep-mode.

The MOB_SLP-RSP may contain the following TLVs :

Next Periodic Ranging

This value indicates the offset of frame in which MSS shall be ready to perform a periodic ranging with respect to the frame where MOB_SLP-RSP is transmitted. Unit is Frame. From the point of view of both BS and MSS periodic ranging does not interrupt Sleep Mode for the MSS.

[Modify the paragraph 6.3.2.3.49 Traffic Indication message (MOB_TRF-IND) on Page 20, Line 1 as follows]

6.3.2.3.49 Traffic Indication message (MOB-TRF-IND)

This message is sent from BS to MSS on the broadcast CID. The message is intended for MSS's that are in sleep-mode, and is sent during those MSS's listening-intervals. The message indicates whether there has been traffic addressed to each MSS that is in sleep-mode ~~and whether Periodic Ranging opportunity for each MSS exists or not within its own sleep interval~~. An MSS that is in sleep-mode during its listening-interval shall decode this message to seek an indication addressed to itself.

When an MSS awakens, it will check the frame number to ensure that it did not lose frame synchronization with the BS and read the SLPID-Group-Indication or Traffic Indication ~~two bit SLPID indicator~~ assigned to it so that it decides whether it returns to sleep mode or not.~~, then take one of the following actions:~~

~~**SLPID indicator 00**~~

~~The MSS will have neither a periodic ranging opportunity nor PDU such as DL traffic. The MSS may return to sleep mode.~~

~~**SLPID indicator 01**~~

~~The MSS will not have a periodic ranging opportunity but it will have PDUs such as DL traffic so that the MSS shall transit to normal operation.~~

~~**SLPID indicator 10**~~

~~The MSS will have a periodic ranging opportunity, but it will not have PDUs such as additional MAC Management messages after successful periodic raging operation. The MSS shall read its 'Ranging Frame Offset' in the order of its SLPID among all the MSSs with their indicator set to '10' or '11'. MSS may return to and remain in sleep mode until the start of periodic ranging operation apart from the end of its listening interval as 'Ranging Frame Offset'. And then, it shall awaken to decode the UL-MAP for periodic ranging opportunity. Upon completion of the periodic ranging operation, it may return to sleep mode if not passed the sleep interval.~~

~~**SLPID indicator 11**~~

~~MSS will have a periodic ranging opportunity and PDUs such as additional MAC Management messages after successful periodic raging operation. Thus, it shall do the same operation as the case where the SLPID indicator is 10 except for remaining in normal operation to receive the additional MAC Management message even after the completion of the periodic ranging operation.~~

~~If the MSS meets another listening interval during the periodic ranging operation, it shall monitor and decode MOB_TRF-IND message.~~

There are two formats for the MOB_TRF-IND message, indicated by the FMT field. When FMT=0, if the MSS does not find its own SLPID-Group Indication or Traffic Indication to its SLPID in the MOB_TRF-IND message, it will consider this as a negative indication and may return to sleep mode. When FMT=1, if the MSS does not find its own basic CID in the MOB_TRF-IND message, it will consider this as a negative indication and may return to sleep mode.

BS may forcibly include a positive indication for an MSS in MOB_TRF-IND message during listening interval if MSS's periodic ranging operation is scheduled to start sooner or later within next sleep interval, although there is no DL Traffic to be sent to MSS.

Table 92c --- Traffic-Indication (MOB_TRF-IND) message format

Syntax	Size	Notes
MOB_TRF-IND_Message_Format() {		
Management message type = 48	8 bits	
FMT	1 bit	
IF(FMT == 0) {		
Reserved	7 bits	
~~Byte of SLPID bit-map~~	~~8 bits~~	
SLPID-Group Indication bit-map	32 bits	Nth bit of SLPID-Group indication bit-map [MSB corresponds to N = 0] is allocated to SLPID Group that includes MSSs with SLPID values from N*32 to N*32+31 Meaning of this bit 0 : There is no traffic for all the 32 MSSs which belong to the SLPID-Group 1 : There is traffic for at least one MSS in SLPID-Group
~~SLPID bit-map~~ Traffic Indication bit-map	Variable	~~Two bits are allocated to one MSS~~ ~~00 : No Periodic Ranging opportunity and No PDUs such as DL Traffic~~ ~~01 : No Periodic Ranging opportunity but PDUs such as DL Traffic~~ ~~10 : Periodic Ranging opportunity and No PDUs such as MAC Management message (the MSS may return to sleep mode after periodic ranging operation)~~ ~~11 : Periodic Ranging opportunity and PDUs such as MAC Management message (the MSS shall maintain Awake mode after Periodic Ranging operation)~~ Traffic Indication bit map comprises the multiples of 32-bit long Traffic Indication unit. A Traffic Indication unit for 32 SLPIDs is added to MOB_TRF-IND message whenever its SLPID Group is set to '1' 32 bits of Traffic Indication Unit (starting from MSB) are allocated to MSSs in the ascending order of their SLPID values

		0 : Negative indication 1 : Positive indication
~~NUM_of_MSS_Periodic_Ranging~~	~~8 bit~~	
~~For(i=0; i<NUM_of_MSS_Periodic_Ranging; i++) {~~		
~~Ranging Frame Offset~~	~~10 bit~~	~~Frame Offset for case where SLPID bit map indicator is set to '10' or '11'~~
~~}~~		
} else {		
Num-pos	7 bits	Number of CIDs on the positive indication list
Fir(i=0;i<Num-pos;i++) {		
Short Basic CID	12 bits	Basic CID
}		
while(!(byte_boundary)) {		
Padding bits	~~1~~ <= 7bits	Padding for byte alignment
}		
}		
}		

Parameters shall be as follows:

FMT

This field indicates one of the SLPID bitmap-based format and the Basic CID-based format.

SLPID-Group indication bit-map

SLPIDs from 0 to 1023 are divided into 32 SLPID-Groups. Therefore, the respective SLPID-Group has the range as follows

SLPID-Group#0 (MSB) corresponds to SLPID = 0 ... 31.
SLPID-Group #1 corresponds to SLPID = 32 ... 63.
...
SLPID-Group#31 corresponds to SLPID = 992 ... 1023.

'SLPID-Group Indication bit-map' is a 32 bit-long field whose each bit is assigned to the respective SLPID-Group. In other words, the most significant bit (=MSB) in it is assigned to SLPID-Group#0, and subsequent bit relates to SLPID-Group #1, etc. [VY: in 802.16 bit transmission order is from MSB, so it's more natural to start from MSB]

The n^{th} bit (b_n), n=0~31, of SLPID-Group Indication bit-map shall be interpreted in the following manner:

b_n = 0 means that there is no traffic for all the 32 MSSs belonging to SLPID-Group #n. In this case, the MSSs in sleep mode belonging to SLPID-Group #n may return to sleep mode.

b_n = 1 means that there exists traffic for one or more MSSs belonging to SLPID-Group #n. In this case, the MSSs in sleep mode belonging to SLPID-Group #n shall read its own Traffic Indication bit-map in MOB-TRF-IND message.

Traffic Indication bit-map

Traffic Indication bit map comprises the multiples of 32-bit long Traffic Indication Unit for every SLPID-Group with SLPID-Group indication bit = 1. Bits in 32-bit Traffic Indication unit (starting from MSB) are allocated to MSSs to in ascending order of SLPIDs. Each bit signals traffic information for the corresponding MSS as follows.:

0: Negative Indication

1: Positive Indication

~~**SLPID bit-map**~~

~~The SLPID bit-map field is a variable length field (that is its length is determined by the number of SLPID currently assigned by the BS). The least significant bit of the first byte in this field relates to SLPID=0, and subsequent bits relate to SLPID=1, etc.~~

~~The MSS that has been assigned SLPID=n by the SLP-RSP message shall interpret bit n (bn) in the SLPID bit-map in the following manner:~~

~~bn = 0 means negative indication, MSS may return to sleep mode~~

~~bn = 1 means positive indication, MSS shall awake.~~

Num-pos

The number of Positive indication.

Short Basic CID

The Basic CID for MSS to be transited into an awake mode.

[Modify the paragraph 6.3.19.1 Introduction on Page 38, Line 3 as follows]

6.3.19.1 Introduction

Sleep-mode is a mode in which MSSs supporting mobility may power down, scan neighbor BSs, range neighbor BSs, conduct hand-over/network re-entry, or perform other activities for which the MSS will be unavailable to the Serving BS for DL or UL traffic. Sleep-mode is intended to enable mobility-supporting MSSs to minimize their power usage and to facilitate hand-over decision and operation while staying connected to the network. Implementation of sleep-mode is optional for the MSS and mandatory for the BS.

An MSS in sleep-mode shall engage in a sleep-interval, defined as a time duration, measured in whole frames, where the MSS is in sleep-mode. The sleep-interval is constructed of one or more variable-length, consecutive sleep-windows, with interleaved listening-windows. During a sleep-window, an MSS does not send or receive PDUs, and may power down one or more physical operation components, or may awaken for periodic ranging. During a listening-interval, an MSS shall synchronize with the Serving BS downlink and listen for an appropriate MOB-TRF-IND traffic indication message. The MSS shall decide whether to stay awake or go back to sleep based on the either value of its own ~~2 bit indicator in the SLPID bitmap~~SLPID-Group-Indication bit-map/Traffic Indication bit-map or the basic CID of the MSS in a MOB-TRF-IND from the Serving BS. During consecutive sleep-windows and listening-windows, comprising a single sleep-interval, sleep-window shall be updated using the algorithm as defined in 6.3.19.2 Sleep-window update algorithm.

Before entering sleep-mode the MSS shall inform the BS using MOB-SLP-REQ and obtain its approval. The Serving BS shall respond with an MOB-SLP-RSP message. The Serving BS may send an unsolicited MOB-SLP-RSP to the MSS to initiate MSS sleep-mode. After receiving an MOB-SLP-RSP message from the BS, an MSS shall enter sleep-mode by beginning sleep-interval at the appropriate frame prescribed by start-frame.

An MSS shall awaken, enter into an interleaved listening-window according to the sleep-interval, and check whether there were PDUs addressed for it ~~and Periodic Ranging opportunity within the next sleep interval~~. The listening-window parameter defines the maximum number of whole frames the MSS shall remain awake waiting for an MOB-TRF-IND message. Traffic indication message (MOB-TRF-IND) shall be sent by the BS on the broadcast CID during each appropriate MSS listening window. If there is no ~~SLPID~~SLPID-Group-Indication or Basic CID to be addressed, the BS sends an empty indication message, that is, MOB_TRF-IND message without ~~SLPID~~SLPID-Group-Indication bit-map or Basic CID. The BS may buffer (or it may drop) incoming PDUs addressed to the sleeping MSS and shall send notification to the MSS in its listening-window about whether data has been addressed for it during a preceding interval. If such PDUs exist, or if the listening interval has passed but the MSS didn't receive any TRF-IND message, the MSS shall remain awake, terminating the sleep-interval and re-entering Normal Operation.

~~If MSS finds that there will be a periodic ranging opportunity within next sleep window, then, it may return to sleep mode until the start of periodic ranging operation apart from the end of the negotiated listening interval as its own Ranging Frame Offset, and it shall awaken to decode the UL MAP for periodic ranging opportunity. Upon completion of Periodic ranging operation, it may return to sleep mode if not passed the sleep interval or remain in awake mode based on its two bit indicator in the SLPID bit-map.~~

An MSS may terminate sleep-mode and return to Normal Operation anytime (i.e. there is no need to wait until the sleep-interval is over). If a Serving BS receives a PDU from an MSS that is supposed to be in sleep mode, the BS shall assume that the MSS is no longer in sleep-mode, except for RNG-REQ or DBPC-REQ. An MSS which sends the RNG-REQ or DBPC-REQ message to the BS remains in awake mode during the operation of downlink burst profile management and then returns to sleep mode after the operation. Any UL message from the MSS to the Serving BS shall interrupt the sleep-interval, shall signal the Serving BS that the MSS is still active and connected and has not dropped connection during its sleep-interval. Upon completion of sleep-interval, the MSS shall awaken and return to Normal Operation.

[Add the section 6.3.19.4 Periodic Ranging in sleep mode after Page 45, Line 15 as follows]

6.3.19.4 Periodic Ranging in sleep mode

For each MSS at sleep mode, during its listening interval, BS may allocate an UL transmission opportunity for periodic ranging. Alternatively, BS may wake up the MSS using TRF-IND to keep it in active state until assignment of UL transmission opportunity for periodic ranging or let the MSS know when the periodic ranging opportunity occur with ‘Next Periodic Ranging’ of last successful RNG-RSP.

While BS operates for periodic ranging or negotiation of sleep mode, after RNG-REQ (or MOB_SLP-REQ) reception, BS may send RNG-RSP (or MOB_SLP_RSP) including ‘Next Periodic Ranging’ so that MSS can know when to perform periodic ranging. Then in the frame specified by ‘Next Periodic Ranging’, it shall decode all consequent UL-MAP messages waiting for UL unicast transmission opportunity for periodic ranging. When such an opportunity occurs, MSS has to transmit RNG-REQ message to BS and then perform regular procedure of periodic ranging: wait for RNG-RSP etc. Successful periodic ranging procedure does not interrupt Sleep state. In the case periodic ranging procedure fails, MSS has to perform Initial Ranging procedure or handover to another BS.

When the periodic ranging operation between MSS and BS successfully processed, BS may inform MSS of the frame number in which next periodic ranging operation is expected to start. For that, BS shall append ‘Next Periodic Ranging’ as TLV encoding to RNG-RSP message. BS also may inform MSS of the existence of DL Traffic addressed to MSS. For that, BS shall set the 'Next Periodic Ranging' to zero. If an MSS receives the RNG-RSP message with this indication from BS, then it shall immediately exit the Sleep Mode and resume Normal Operation with the BS.