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Re:	This contribution is for call for contribution about IEEE P802.16e/D3-2004
Abstract	This contribution proposes the enhanced MOB_TRF-IND message and scenario for sleep mode.
Purpose	Adoption as part of Handover Ad-hoc recommendation to IEEE802.16e
Notice	
Release	
Patent Policy and Procedures	

Embodied traffic indication during sleep-mode

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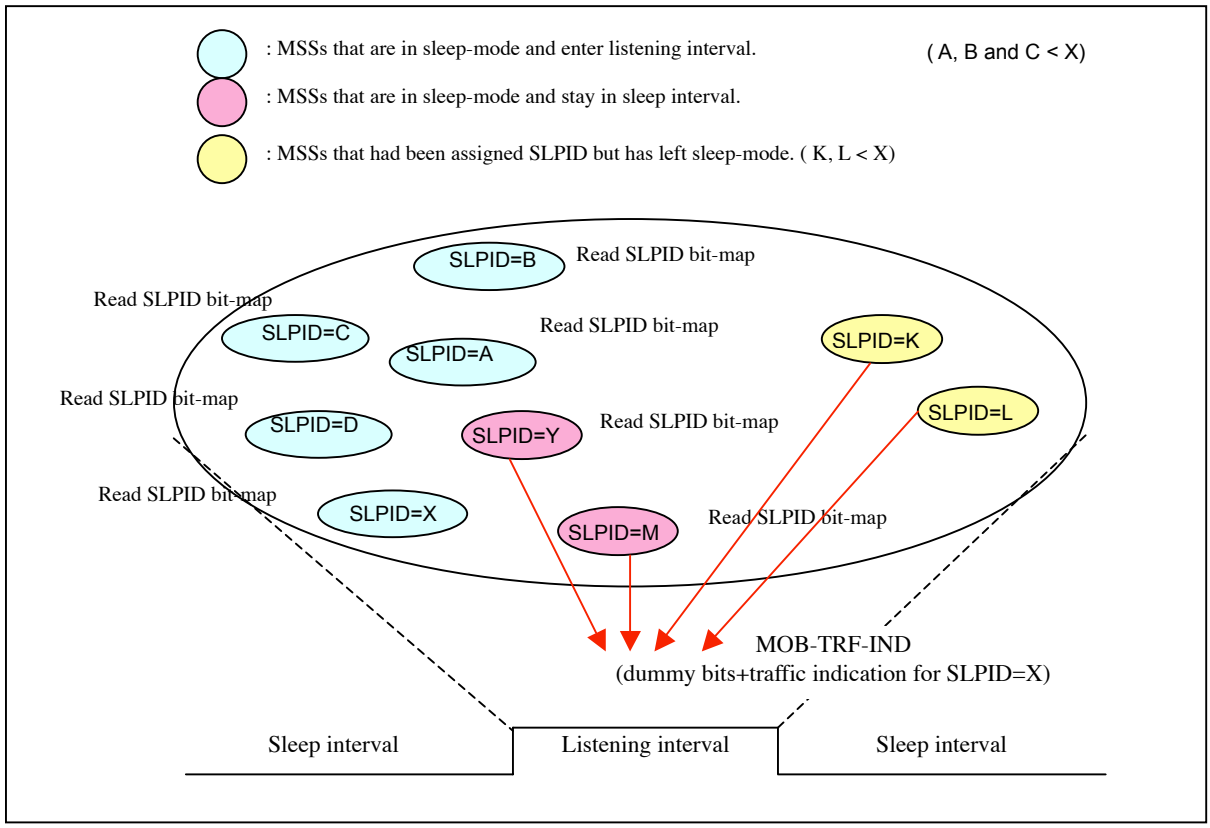
1. Problem statements

There are two formats for the MOB-TRF-IND message. The format applied to the present MOB-TRF-IND message is indicated by the FMT field. When FMT = 0, the MSS shall decide whether to stay awake or return to sleep according to the SLPID-based signal in a MOB-TRF-IND received from the serving BS. When a MSS requests a permission to enter sleep-mode using the MOB-SLP-REQ message, the serving BS shall respond with the MOB-SLP-RSP. In the case where sleep-mode request is approved, the MOB-SLP-RSP message shall contain the 10bits SLPID.

A SLPID is a number assigned by the serving BS whenever a MSS is directed to enter sleep-mode. The value of SLPID may range from 0 to 1023. 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 value as one of the first MSS while the first MSS is still in sleep-mode.

When some MSSs ,which are in sleep mode having their own SLPID, i.e. SLPID=X(7, 39, 70, 900), enter listening interval, They shall decode SLPID-bitmap in MOB_TRF-IND, which includes many useless and dummy bits except the indication bits mapped to their own SLPID, in order to determine whether they transit into awake-mode or not. This redundant bits need to be removed for the efficient bandwidth usage on downlink. Figure1 shows an example of the situations mentioned above.



2. Proposed remedy

We propose the modified MOB_TRF-IND message which does not includes unnecessary dummy bits except MSSs to awaken. We also propose the scenario related to it.

The modified MOB_TRF-IND message has new several parameters as described in table 1. If the modified MOB_TRF-IND message is used in sleep-mode operation, the MSSs in sleep-mode shall conform to the following procedure.

- The MSS in sleep-mode receives a MOB_TRF-IND message from the serving BS during its listening interval.
- The MSS shall decode the *SLPID-Group indication bit-map* in MOB_TRF-IND message to check whether there has been valid traffic information for the SLPID-Group where the SLPID assigned to the MSS belongs or not.
  - If there has been valid traffic information, the MSS shall read *Half traffic mask* to decide whether to use *Low_traffic_mode* or *High_traffic_mode* for searching traffic indicator related to itself.
  - If there has not been valid traffic information, the MSS shall ignore the remainder in the received MOB_TRF-IND message.

- When the *Low_traffic_mode* is used, the MSS shall decode its own 32 bits in the *SLPID indication bit-map list* in order to detect whether there is a non-zero 2bit traffic indication addressed to the MSS or not.
  - If there is a valid traffic information addressed to the MSS, it shall read its own 2bit traffic indicator in *Traffic indicator bit-map*. If there is the traffic indicator related to the MSS, it shall take an appropriate predefined action.
  - If there is no valid traffic information addressed to the MSS, the MSS shall ignore the remainder in the received MOB_TRF-IND message.

- When the *High_traffic_mode* is used, the MSS shall use directly its own *64bits traffic indicator stream* which is a part of *Traffic indicator bit-map* and also read its own 2 bit traffic indicator in the above *64 bits*, in order to detect whether there is a data traffic to receive or periodic ranging addressed to the MSS or not.
  - If there is the non-zero 2bit traffic indicator related to the MSS, it shall transit into awake mode.

According to the above procedure, the length of MOB_TRF-IND message depends on the number of MSS to awaken irrespective of maximum assigned SLPID by BS. Therefore, although there is an MSS with large number of SLPID, MOB_TRF-IND message can be shortened.

Table 1 – Newly defined parameters to properly signal MOB_TRF-IND

No	Parameters	Size	Notes
1	SLPID-Group indication bit-map	32bits	The SLPID assigned by serving BS belongs to one of 32 SLPID-Groups. Each SLPID-Group holds 32 SLPIDs. The least significant bit (=LSB) in this field relates to SLPID-Group#0, and subsequent bit relates to SLPID-Group#1, etc. *SLPID-Group#0 holds SLPID = 0 ... 31.* *SLPID-Group#1 holds SLPID = 32 ... 63.* *...* *SLPID-Group#31 holds SLPID = 992 ... 1023.* The n^{th} bit (b_n), n=0~31, from the LSB in this field shall be interpreted in the following manner: *b_n = 0 means that there will be no DL traffic and periodic ranging opportunity in SLPID-Group#n. In this case, the MSSs in sleep mode belonging to SLPID-Group#n may return to sleep mode without reading the remainder of the present MOB-TRF-IND message and serving BS shall not insert 32bits SLPID indication bit-map for the SLPID-Group#n into MOB-TRF-IND message.* *b_n = 1 means that there will be one or more MSSs which has to receive DL traffics or perform periodic ranging opportunities in SLPID-Group#n. In this case, the MSSs in sleep mode belonging to SLPID-Group#n shall read the remainder of the present MOB-TRF-IND message and serving BS shall insert 32bits SLPID indication bit-map for the SLPID-Group#n into MOB-TRF-IND message.*

2	Half traffic mask	32bits	This field is introduced to optimize the amount of information bits in MOB-TRF-IND message. A bit in this field indicates how many MSSs to awaken exists in the corresponding SLPID-Group because of thier the DL traffic or/and periodic ranging opportunity. The LSB in this field corresponds to the SLPID-Group#0, and subsequent bit corresponds to the SLPID-Group#1, etc. The n^{th} bit (b_n, n=0~31) in this field shall be interpreted in the following manner: *b_n = 0 means that there less than 16 MSSs with DL traffics or periodic ranging opportunities in SLPID-Group#n. The serving BS shall use the low_traffic_mode to signal the traffic information for the SLPID-Group#n.* *b_n = 1 means that there will be over 16 MSSs with DL traffics or periodic ranging opportunity in SLPID-Group#n. The serving BS shall use the high_traffic_mode to indicate the traffic information for the SLPID-Group#n.*
3	SLPID indication bit-map list	Variable	SLPID indication bit-map list comprises the multiple of 32bits map which indicates which MSS among 32 MSSs in Group#n enter awake mode for *DL traffics or periodic ranging opportunity* If the serving BS uses the low_traffic_mode to signal traffic information forthe SLPID-Group#n, 32bits SLPID indication bit-map for the SLPID-Group#n shall be included in this field. If the serving BS use the high_traffic_mode to signal traffic information for the SLPID-Group#n, 32bits SLPID indication bit-map for the SLPID-Group#n shall not be included in this field. Each bit of a 32bits SLPID indication bit-map included in this field corresponds to a SLPID managed in the SLPID-Group#n. If a MSS with SLPID=K is in sleep-mode and DL traffic or periodic ranging opportunity will be given to it after present listening interval and low_traffic_mode is applied for SLPID-Group#(K/32), the n^{th} bit (b_n), n=0~31 and n=K%32, in the 32bits SLPID indication bit-map for the SLPID-Group#(K/32) shall be set to 1. If a MSS with SLPID=K is in sleep-mode and no DL traffic and periodic ranging opportunity will be given to it after present listening interval and low_traffic_mode is used for SLPID-Group#(K/32), the related bit (b_n) shall be set to 0.
4	Traffic indicator bit-map	Variable	Two bits traffic are allocated to one MSS. If the low_traffic_mode is used for the specific SLPID-Group#n, the traffic indicator bit-map for the SLPID-Group#n shall hold 2 x *S* bits. *S* is the number of bits set to 1 in the 32bits SLPID indication bit-map for the SLPID-Group#n. If the high_traffic_mode is used for the specific SLPID-Group#n, the traffic indicator bit-map for the SLPID-Group#n shall hold 2 x 32 bits to signal the individual SLPID's traffic information that belongs to the SLPID-Group#n. *00: No periodic ranging opportunity and no PDUs such as DL Traffic. When the low_traffic_mode is used, traffic indicator 00 is meaningless and shall not be included in the traffic indicator bit-map for the SLPID-Group.* *01: No periodic ranging, but PDUs such as DL Traffic.* *10: Periodic Ranging opportunity and no PDUs such as MAC management messages (the MSS may return to sleep mode after periodic ranging operation)* *11: Periodic Ranging opportunity and PDUs such as MAC management messages (the MSS shall maintain awake mode after periodic ranging operation)*

Table 2 – definition of algorithm_0 and algorithm_1

No	Parameters	Notes
1	low_traffic_mode	This mode applies when the number of DL traffics or periodic ranging opportunities that will be generated within the corresponding SLPID-Group are less than 16. When this mode applies, the serving BS shall insert a SLPID-Group indication bit-map, Half traffic mask, the corresponding 32bits SLPID indication bit-map and Traffic indicator bit-map under 64bits into the MOB-TRF-IND message.
2	high_traffic_mode	This mode applies when the number of DL traffics or periodic ranging opportunities that will be generated within the corresponding SLPID-Group are over 16. When this mode applies, the serving BS shall insert a SLPID-Group indication bit-map, Half traffic mask and 64bits traffic indicator bit-map into the MOB-TRF-IND message.

[example1 : Traffic information based on newly introduced signaling]

: The serving BS has assigned SLPIDs with the range from 0 to 900. All MSS except SLPID=0, 1, 65~85 and 899 are in normal operation. The MSSs with SLPID=0, 1, 65~85 and 899 are still in sleep-mode. DL traffic or periodic ranging opportunities for SLPID = 1, 65~85 and 899 are scheduled in the first incoming sleep interval. The content of all traffic indicators are assumed to be‘01’ or ‘10’.

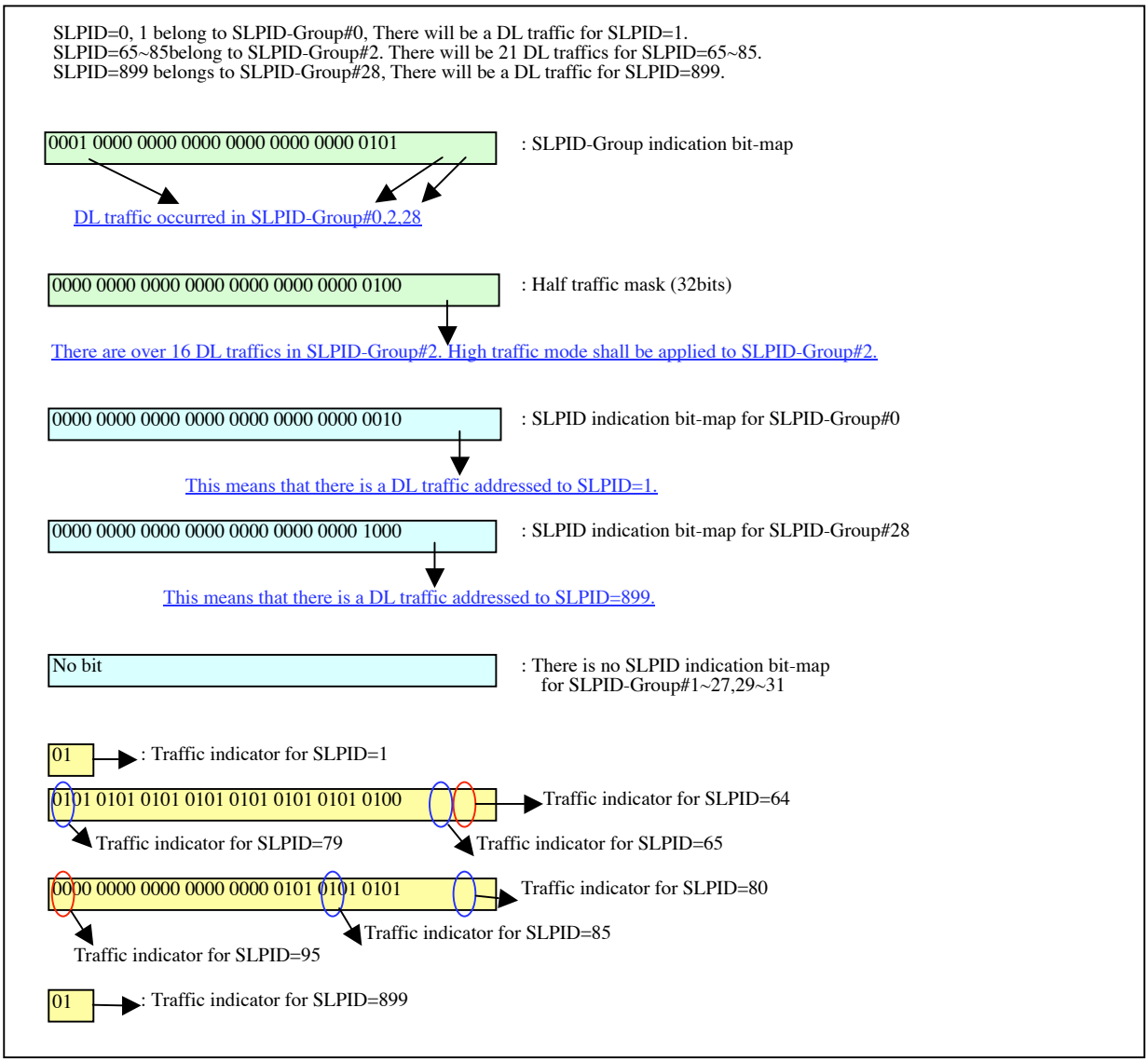


Figure 2—example, traffic information based on newly introduced signaling

[example2 : Low_traffic_mode & High_traffic_mode signaling]

: The serving BS has assigned SLPID with the range from 0 to 19. No MSS returned to normal mode. DLtraffic for SLPID=0~19 are scheduled in serving BS. The content of positive traffic indications are assumed to be ‘01’.

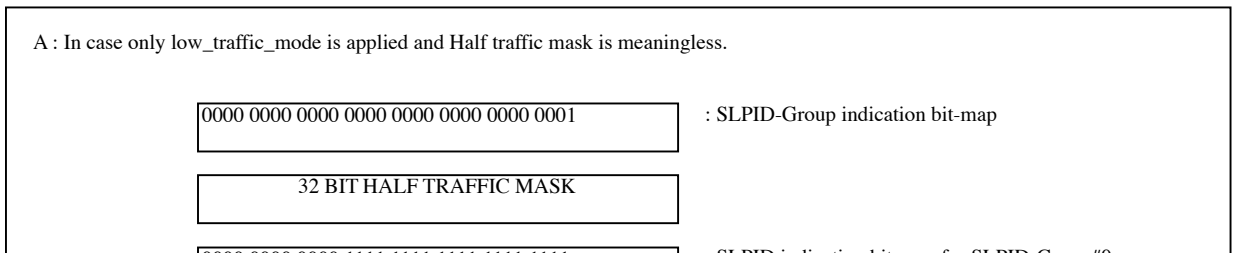


Figure 3—example2, case 'A'

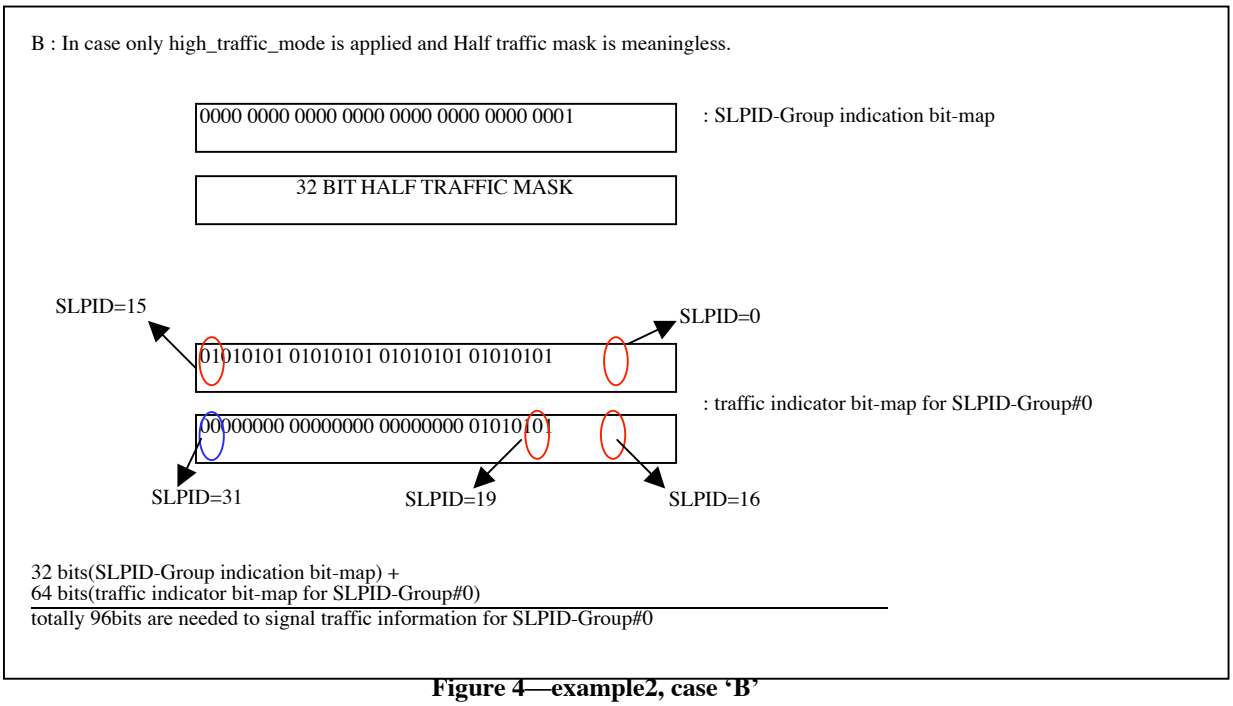


Figure 4—example2, case 'B'

So, Half-traffic mask is useful tool to reduce the transmitted information bits in the MOB_TRF-IND message.

3. Proposed text change

[Modify MOB_TRF-IND message in Page 20, Line 56]

Table 92c—Traffic-Indication (MOB-TRF-IND) message format

Syntax	Size	Notes
MOB-TRF-IND_Message_Format() {		
Management message type = 48	8bits	
FMT	1bit	0 = SLPID based format 1 = CID based format
if (FMT == 0) {		
SLPID-Group indication bit-map	32 bits	
Half traffic mask	32 bits	
SLPID indication bit-map list	Variable	
Traffic indicator bit-map	Variable	
~~Byte of SLPID bit-map~~	~~8bits~~	
~~SLPID bit-map~~	~~Variable~~	~~Two bits are allocated to one MSS 00: No periodic ranging opportunity and no PDUs such as DL Traffic. If algorithm_0 is used, traffic indicator 00 is meaningless. 01: No periodic ranging, but PDUs such as DL Traffic. 10: Periodic Ranging opportunity and no PDUs such as MAC management messages (the MSS may return to sleep mode after periodic ranging operation) 11: Periodic Ranging opportunity and PDUs such as MAC management messages (the MSS shall maintain awake mode after periodic ranging operation)~~
NUM_of_MSS_Periodic_Ranging	8bits	
(i=0;i<NUM_of_MSS_Periodic_Ranging;i++) {		
Ranging Frame Offset	10bits	Frame Offset for case where SLPID bit map indicator is set to '10' or '11'
}		
} else {		
Num-pos	7bits	Number of CIDs on the positive indication list
for (i=0;i<Num-pos;i++) {		
Short Basic CID	12bits	Basic CID
}		
while (!(byte_boundary)) {		
Padding bits	1	Padding for byte alignment
}		
}		
}		

Parameters shall be as follows:

~~SLPID bit-map~~

~~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 lease 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 (b_n) in the SLPID bit map in the following manner:~~

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

~~b_n = 1 means positive indication, MSS shall awake~~

SLPID-Group indication bit-map

The SLPID assigned by serving BS belongs to one of 32 SLPID-Groups. Each SLPID-Group holds 32 SLPIDs. The least significant bit (=LSB) in this field relates to SLPID-Group#0, and subsequent bit relates to SLPID-Group#1, etc.

SLPID-Group#0 holds SLPID = 0 ... 31.

SLPID-Group#1 holds SLPID = 32 ... 63.

...

SLPID-Group#31 holds SLPID = 992 ... 1023.

The n^{th} bit (b_n), n=0~31, from the LSB in this field shall be interpreted in the following manner:

b_n = 0 means that there will be no DL traffic and periodic ranging opportunity in SLPID-Group#n. In this case, the MSSs in sleep mode belonging to SLPID-Group#n may return to sleep mode without reading the remainder of the present MOB-TRF-IND message and serving BS shall not insert 32bits SLPID indication bit-map for the SLPID-Group#n into MOB-TRF-IND message.

b_n = 1 means that there will be one or more MSSs which has to receive DL traffics or perform periodic ranging opportunities in SLPID-Group#n. In this case, the MSSs in sleep mode belonging to SLPID-Group#n shall read the remainder of the present MOB-TRF-IND message and serving BS shall insert 32bits SLPID indication bit-map for the SLPID-Group#n into MOB-TRF-IND message.

Half traffic mask

A bit in this field indicates how many MSSs to awaken exists in the corresponding SLPID-Group because of thier the DL traffic or/and periodic ranging opportunity. The LSB in this field corresponds to the SLPID-Group#0, and subsequent bit corresponds to the SLPID-Group#1, etc.

The n^{th} bit (b_n, n=0~31) in this field shall be interpreted in the following manner:

b_n = 0 means that there less than 16 MSSs with DL traffics or periodic ranging opportunities in SLPID-Group#n. The serving BS shall use the low_traffic_mode to signal the traffic information for the SLPID-Group#n.

b_n = 1 means that there will be over 16 MSSs with DL traffics or periodic ranging opportunity in SLPID-Group#n. The serving BS shall use the high_traffic_mode to indicate the traffic information for the SLPID-Group#n.

SLPID indication bit-map list

SLPID indication bit-map list comprises the multiple of 32bits map which indicates which MSS among 32 MSSs in Group#n enter awake mode for *DL traffics or periodic ranging opportunity* If the serving BS uses the low_traffic_mode to signal traffic information forthe SLPID-Group#n, 32bits SLPID indication bit-map for the SLPID-Group#n shall be included in this field. If the serving BS use the high_traffic_mode to signal traffic information for the SLPID-Group#n, 32bits SLPID indication bit-map for the SLPID-Group#n shall not be included in this field. Each bit of a 32bits SLPID indication bit-map included in this field corresponds to a SLPID managed in the SLPID-Group#n.

If a MSS with SLPID=K is in sleep-mode and DL traffic or periodic ranging opportunity will be given to it after present listening interval and low_traffic_mode is applied for SLPID-Group#(K/32), the n^{th} bit (b_n), n=0~31 and n=K%32, in the 32bits SLPID indication bit-map for the SLPID-Group#(K/32) shall be set to 1.

If a MSS with SLPID=K is in sleep-mode and no DL traffic and periodic ranging opportunity will be given to it after present listening interval and low_traffic_mode is used for SLPID-Group#(K/32), the related bit (b_n) shall be set to 0.

Traffic indicator bit-map

Two bits traffic are allocated to one MSS.

If the low_traffic_mode is used for the specific SLPID-Group#n, the traffic indicator bit-map for the SLPID-Group#n shall hold 2 x *S* bits. *S* is the number of bits set to 1 in the 32bits SLPID indication bit-map for the SLPID-Group#n.

If the high_traffic_mode is used for the specific SLPID-Group#n, the traffic indicator bit-map for the SLPID-Group#n shall hold 2 x 32 bits to signal the individual SLPID's traffic information that belongs to the SLPID-Group#n.

00: No periodic ranging opportunity and no PDUs such as DL Traffic. When the low_traffic_mode is used, traffic indicator 00 is meaningless and shall not be included in the traffic indicator bit-map for the SLPID-Group.

01: No periodic ranging, but PDUs such as DL Traffic.

10: Periodic Ranging opportunity and no PDUs such as MAC management messages (the MSS may return to sleep mode after periodic ranging operation)

11: Periodic Ranging opportunity and PDUs such as MAC management messages (the MSS shall maintain awake mode after periodic ranging operation)

[Modify the paragraph as follows in Page 38, Line 13]

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, half traffic mask, SLPID indication bit-map and traffic indicator 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 or Basic CID to be addressed, the BS sends an empty indication message, that is, MOB_TRF-IND message without ~~SLPID bit-map~~ SLP-Group indication bit-map, half traffic mask, SLPID indication bit-map list and traffic indicator 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 an 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 traffic indicator in the ~~SLPID bit-map~~ traffic indicator bit-map.