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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. This is a contribution which is harmonized with comment #308(contribution C80216e-04_207).
Purpose	Adoption as part of Handover Ad-hoc recommendation to IEEE802.16e
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Embodied traffic indication during sleep-mode

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1. Problem statements

There are two formats for the current MOB-TRF-IND message. These formats applied to the MOB-TRF-IND message are 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 during listening interval. When an 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 10-bit SLPID.

A SLPID is assigned by the serving BS whenever an MSS is directed to enter sleep-mode. The SLPID ranges from 0 to 1023 and it should be uniquely assigned to a single MSS which is instructed to enter sleep-mode.

When some MSSs in sleep mode with their SLPIDs (i.e. SLPID= 7, 39, 70, 900) enter listening interval, they shall decode SLPID-bitmap in MOB_TRF-IND, which includes many useless and dummy bits as well as the indication bits mapped to their own SLPIDs in order to determine whether they go to awake-mode or not. This redundant bits need to be reduced for the efficient bandwidth usage on downlink.

At first, two comments, referring to contribution 194 and 207, had been proposed to reduce that redundant bits and we got many replies that proposed schemes were very complex and should be harmonized between two contributions. This harmonized contribution reflects the replies and it propose the simple and efficient way to reduce the redundant bits in MOB-TRF-IND message.

2. Proposed remedy

We propose the modified MOB_TRF-IND message and also propose a related scenario.

The modified MOB_TRF-IND message has new several parameters as listed 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 if there is positive indication for SLPID Group to which the MSS belongs.
  - If there is a positive indication, that is, there is DL traffic or periodic ranging for one or more MSSs in the SLPID-Group, each MSS shall read its own 2 bit traffic indication from its own *64-bit traffic indicator stream* as a part of *Traffic indicator bit-map,* in order to detect whether there is a data traffic to receive or periodic ranging addressed to the MSS or not.
  - If there is no positive indication, that is, there is no DL traffic or periodic ranging for all the 32 MSSs in the SLPID-Group, all the MSS may ignore the remainder in the MOB_TRF-IND message and return to sleep mode.

According to the above procedure, the length of MOB_TRF-IND message depends not on the maximum SLPID assigned in the BS, but on the number of MSSs scheduled to wake up. Therefore, the MOB_TRF-IND message can be shortened even if there is an MSS with big SLPID.

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 for all the MSSs which belong to SLPID-Group#n. In this case, all the MSSs in sleep mode belonging to SLPID-Group#n may return to sleep mode without any more operation* *b_n = 1 means that there will be DL tfaffic or periodic ranging opportunity for one or more MSSs which belong to 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 64bits SLPID indication bit-map for 32 MSSs belonging to the SLPID-Group#n into MOB-TRF-IND message.*
2	Traffic indicator bit-map	Variable	This parameters is available in MSS whose SLPID-Group indication bit is set to '1'. Two bits in 64-bit Traffic Indicator stream are allocated to one MSS The traffic indicator bit-map for the SLPID-Group#n shall hold 2 x 32 bits for all 32 MSSs belonging to the SLPID-Group#n. 2 bits per an MSS has the value as follows *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)*

Each bit of SLPID-Group indication bit-map indicates the existence of Traffic Indicator bit-map, which is 64 bits long: two bits for each SLPID and 32 SLPIDs per a SLPID-Group. Each bit of the Group Indication bit-map means whether there is DL taffic or Peridodic ranging operation scheduled for at least one among the 32 MSSs in sleep mode. Therefore, if a bit of Group Indication is '1', 64-bit traffic indicator stream for 32 SLPIDs which belongs to it shall be included in MOB_TRF-IND message. Otherwise, not included.

Traffic Indicator bit-map includes the 2-bit traffic indication for each of 32 MSSs in sleep mode. If each bit of SLPID-Group indication bit-map is set to '1', 64-bit Traffic Indication stream for 32 MSSs in a SLPID Group shall be included in MOB_TRF-IND message so that MSS in sleep mode related to its SLPID-Group can decode whether to awaken or not.

For example, assume that a BS has to wake up MSSs with their SLPID '0', '1', '65 through 85' and '899'. 'Then the Group Indication bits corresponding to SLPID-Group #0 , #2 and #28 shall be set to '1', and three 64-bit Traffic Indicator streams are included in MOB_TRF-IND message. As a result, the Group Indication bit-map is set to 0x10000003 (=00010000 00000000 00000000 0000 0101b). The Traffic Indicator bit stream for SLPID #28 shall be set to 0x0000000000000040 and 0x000006D556955554 for SLPID-Group #2, and then 0x0000000000000004 for SLPID-Group #0. (refer to figure 1)

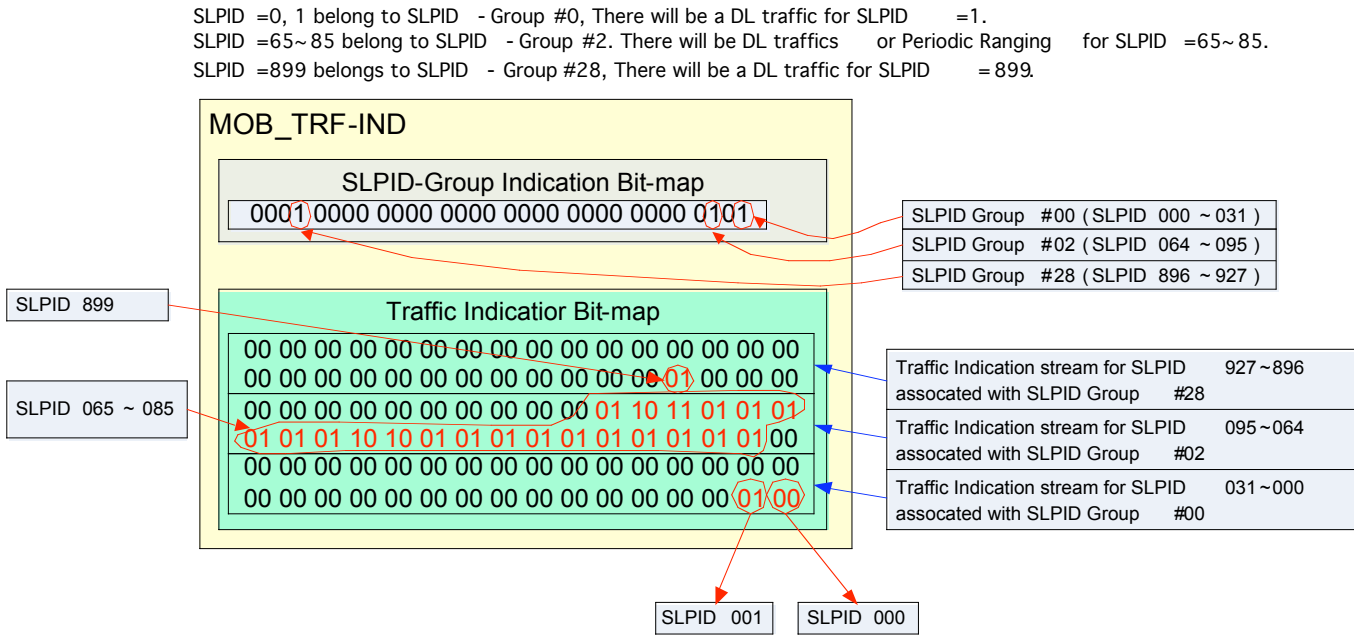

Figure 1 Example of Modified MOB_TRF-IND message

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	Each bit of SLPID-Group indication bit-map is allocated to 32 MSS units. 0 : There is no traffic or periodic ranging to be scheduled for all the MSSs which belong to its own SLPID-Group 1 : There is traffic or periodic ranging to be schedulded for an MSS at least which belong to its own SLPID-Group
Traffic indicator bit-map	Variable	Traffic Indicator bit-map for 32 SLPIDs is applied to only the SLPID Group which is set to '1' This field has the value as follows 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)
~~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, of SLPID-Group indication bit-map shall be interpreted in the following manner:

b_n = 0 means that there is 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.

b_n = 1 means that there is 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 its own Traffic Indicator bit-map with 64bit length in MOB-TRF-IND message.

Traffic indicator bit-map

The Traffic indicator bit-map comprises the mulitiple of 64bit Traffic Indicator stream of every SLPID-Group with SLPID-Group indication bit = 1 in descending order.

Two bits in 64-bit Traffic Indicator stream are allocated to one MSS.

the traffic indicator bit-map for the each SLPID-Group shall hold 32 multiples of 2bits to signal the individual MSSs traffic information in descending order of SLPID from MSB as follows.

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 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 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.