Project	IEEE 802.16 Broadband Wireless Access Working Group <http://ieee802.org/16>
Title	MOB_TRF-IND message length reduction and MSS power savings in sleep mode
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Re:	IEEE 802.16e Sleep mode operation
Abstract	This contributions is to propose the message length reduction scheme and its application for the MSS power saving in sleep mode
Purpose	Present how the IEEE802.16a can be enhanced in order to support mobility.
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Patent Policy and Procedures	

MOB_TRF-IND message length reduction and MSS power savings in Sleep mode

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1 Problem Statement

Currently, the MOB_TRF-IND message is transmitted to the MSS in listening interval that indicates whether there has been traffic addressed to each MSS in sleep mode and it can be sent every allocated frame if the listening interval is set to more than two frames. A MSS in listening interval shall decode the MOB_TRF-IND message to seek an indication addressed to it. At this time if there is a positive indication to the MSS, the MSS shall remain awake. Otherwise, the MSS shall monitor the MOB_TRF-IND message until the expiration of listening interval and return to the sleep mode again if not detect the positive indication that is expressed as Basic CID with 16 bits long. Therefore, the message length will be increased in proportion to the number of MSS increasing in listening interval. And also, the MSS in listening interval, which there were no PDU addressed to it, shall monitor the MOB_TRF-IND message until expiration of its listening interval.

As results, the undesirable operation (e.g., signaling transmission error, message transmission over one frame) can be happened due to longer message length. Furthermore, the MSS should consume undesirable power because the MSS shall continue to monitor the MOB_TRF-IND message until the expiration of listening interval even in the unnecessary case that the MSS will not be addressed by the positive indication (its Basic CID) during this listening interval.

2 Proposed Remedy

For the purpose to resolve the above problems, we propose the modified MOB_TRF-IND message format with message length reduction scheme and power saving facility.

2.1 Message length reduction

The MOB_TRF-IND message consists of some parameters including Basic CID (16bits) that is most dominant among the parameters in it in terms of message length as described above. Therefore, we propose the bit-wise CID indexing scheme to diminish the MOB_TRF-IND message length. The table 1 shows the CID allocation policy in IEEE802.16 specification. As shown in the table 1, the CID will be allocated from 0x0000 to 0xFFFF. Among them, the Basic CID will be allocated to the each MSS from 0x0001 to m (m is variable). And the upper limit for the Basic CID will be decided based on the value “m” that BS can support. However, the value “m”, the total number of Basic CID to be allocated, can be expressed using dramatically less than 16bits because other CIDs except for Basic CID shall be allocated to the MSS. And also, according to the current parameters depicted in table 84c (MOB_TRF-IND message), the value

for Num-positive is 8bit that the maximum 255 MSSs can transit from sleep-mode to the awake-mode simultaneously.

Table 1. CID allocation policy in IEEE802.16 family

CID	Value	Description
Initial ranging	0x0000	Used by an SS during initial ranging as part of initial ranging process.
Basic CID	0x0001—*m*	
Primary management	*m*+1—2*m*	
Transport CIDs and secondary Mgt CIDs	2*m*+1—0xFEF~~F~~E	
AAS initial ranging CID	0xFEFF	A BS supporting AAS shall use this CID when allocating a Initial Ranging period for AAS devices
Multicast polling CIDs	0xFF00—0xFFFD	An SS may be included in one or more multicast polling groups for the purposes of obtaining bandwidth via polling. These connections have no associated service flow.
Padding CID	0xFFFE	Used for transmission of padding information.
Broadcast CID	0xFFFF	Used for broadcast information that is transmitted on a downlink to all SS.

Therefore, we propose the re-configuration of the Basic CID mapping in sleep mode. Table 2 shows the reconfiguration between the Basic CID and bit-wise CID indexing.

Table 2. Re-configuration between Basic CID and Sleep CID

Basic CID	Basic CID indexing (Bit position index in MOB_TRF-IND)
0x0001	1st bit position (MSB)
0x0002	2nd bit position
[…]	[…]
m	mth bit position

From the table 2, the bit-wise CID indexing (bit position) that the MSS shall monitor will be resolved and allocated to the MSS implicitly. That is, if MSS has the value ‘n’ of Basic CID, ‘n-th’ bit away from MSB of CID Indexing is allocated to it. Therefore, it can be allowed that the MSS monitor the CID indexing (bit map position) during receiving the MOB_TRF-IND message during the listening interval. As results, the MSS can detect its own bit position in the CID indexing as a positive Basic CID from the specific bit-wise position extracted from the table 2. Using this scheme, the maximum room size (255*16bit=510byte) for the positive CID will be 32byte.

2.2 MSS power saving

According to the current sleep-mode operation, the MSS shall decode the MOB_TRF-IND message in listening interval in order to check whether the Positive indication for itself exists or not. Thus, the MSS shall decode the MOB_TRF-IND message even though there will be no Positive indication during listening interval, so that the MSS shall consume the undesirable power. However, if the MSS early knows there will be no its own Positive indication prior to the end of listening interval, it can stop the monitor and save the unnecessary power consumption due to monitoring and decoding the MOB_TRF-IND message during whole listening interval.
For the purpose, we propose the additional information bits (2bit) with the CID indexing scheme proposed in 2.1. As results, two bits per one MSS will be allocated. Table 3 shows the bit allocation policy and commands for the MSS action

Table 3. Bit allocation and MSS action

Bit Allocation	Meaning	MSS action
00	Negative Basic CID	Monitor the next frame (As it is in current operation)
01	Transit to sleep mode	No monitor the MOB_TRF-IND for remaining listening interval to save power
10	N/A	Reserve
11	Positive Basic CID	Transit to Awake mode

Figure 1 shows the proposed MOB_TRF-IND message structure using the bit-wise CID indexing and additional bit for the power saving. As shown in table 3 and figure 1, when the MSS #1 having Basic CID indexing "1st bit position" (Basic CID: 0x0001) receives the "01", it shall transit to the sleep mode without monitoring MOB_TRF-IND message during remaining listening interval in order to save the power consumption. In addition, if the MSS receives "00" or "11" on its respective Basic CID indexing (MSS#2: Basic CID indexing of "2nd bit position" with Basic CID "0x0002", MSS#8: Basic CID indexing of "8th bit position" with Basic "CID 0x0008"), it shall do the same operation as it is in the current sleep mode operation. The message field, N_Group as shown in figure 1, is used for the message length fixing. If the N_Group, which consists of 4 MSSs per one group, is set to "3", up to12 MSSs will be present in the message and total 24bits are added for the Basic CID indexing and power saving.

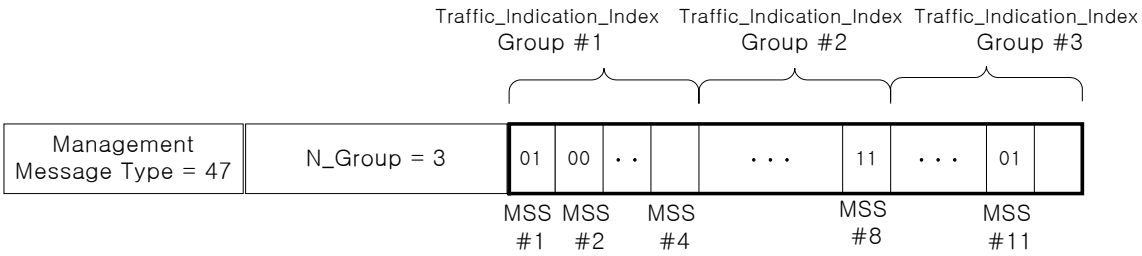

Figure 1. The proposed MOB_TRF-IND message structure

Table 4 shows the message length comparison. As shown in table 4, the proposed scheme provides the message length reduction dramatically.

Table 4. Message length comparison

Num of MSS in listening interval	Original MOB_TRF-IND	Proposed MOB_TRF-IND (with power saving)	Proposed MOB_TRF-IND (without power saving)
1	2 byte	2 byte	1 byte
2	4 byte	2 byte	1 byte
4	8 byte	2 byte	1 byte
8	16 byte	2 byte	1 byte
16	32 byte	4 byte	2 byte
32	64 byte	8 byte	4 byte
64	128 byte	16 byte	8 byte
128	256 byte	32 byte	16 byte
255	510 byte	64 byte	32 byte

3 Proposed Text Changes

[Replace the paragraph of 6.4.2.3.4.43 Page 19 line 46 with the followings]

6.4.2.3.43 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 interval. The message indicates whether there has been traffic addressed to each MSS that is in sleep-mode. An MSS that is in sleep-mode during its listening-interval shall decode this message to seek an indication on the allocated its own bit position of the Traffic_Indication_Index

When an MSS awaken in listening interval, it shall check the frame number to ensure that it did not lose frame synchronization with the BS and decode the MOB_TRF-IND message. If the MSS finds Traffic_Indication_Index set to "01" on the allocated bit position, it may return to the sleep-mode even though the listening interval is not over. And if the MSS does not find any its own positive indication (Traffic_Indication_Index=11) in the MOB_TRF-IND message until expiration of listening interval, it will check consider this as a negative indication, and then shall return to sleep-mode. Otherwise (Traffic_Indication_Index=00), the MSS shall continually monitor the MOB_TRF-IND message to check the Traffic_Indication_Index until expiration of the listening interval.

[Correct Table 84c Page 19 line 57—Traffic-Indication(MOB_TRF-IND) message format as follows]

Table 84c---Traffic-Indication (MOB_TRF-IND) message format

Syntax	Size	Notes
MOB_TRF-IND_Message_Format() {		
Management message type = 47	8bit	
~~Num-positive~~	~~8bit~~	
~~For (i=0; i<Num-positive; i++) {~~		
~~CID~~	~~16bit~~	~~Basic CID of the SS~~
~~}~~		
}		
N_Group	6bit	
For (i=0; i<N_Group; i++) {		
Traffic_Indication_Index	8bit	Two bits are allocated to one MSS (instead of Basic CID) 00=Negative Basic CID 01=Transit to Sleep-mode 10=Reserved 11=Positive Basic CID
}		
}		

A BS shall generate MOB_TRF-IND message in the format shown in Table 84c. The following parameters shall be included in the MOB_TRF-IND message.

N_Group
Number of MSS group

Traffic_Indication_Index -
The activation indication of the MSS when the MSS receives this message from the BS. Two bits in this parameter are allocated to one MSS and 4 MSSs are grouped into one Traffic_Indication_Index.
The following encodings apply :
00 = Negative Basic CID
01 = Transit to Sleep-mode
10 = Reserved
11 = Positive Basic CID

Table 84d. The mapping of Basic CID and Traffic_Indication_Index

Basic CID	Traffic_Indication_Index (2bits) (Bit position index in MOB_TRF-IND)
0x0001	1st bit position (MSB)
0x0002	2nd bit position
[…]	[…]
M	mth bit position

Replace Page 27 line 31 – 33 with;

Traffic indication message (MOB_TRF-IND) shall be sent by the BS on the broadcast CID and may not be sent when there is no MSS in listening interval of sleep-mode. If the number of positive indications is zero, the BS sends an empty indication message, that is, MOB_TRF-IND message with N_Group=0.

Replace page 35 line 9 – 12 with followings;

If the MSS receives the MOB_TRF-IND message with Traffic_Indication_Index=01 on the allocated its own bit position, it shall return to the sleep-mode even in the listening interval is not over. And if the MSS receives the MOB_TRF-IND message with Traffic_Indication_Index=00 on the allocated its own bit position, it shall consider this as a negative indication and shall continually monitor the MOB_TRF-IND message to check the Traffic_Indication_Index until expiration of the listening interval. Otherwise(Traffic_Indication_Index=11), the MSS shall remain awake.