Project	**IEEE 802.16 Broadband Wireless Access Working Group <http://ieee802.org/16>**	
Title	**MS Sleep Mode in MR network**	
Date Submitted	**2007-03-05**	
Source(s)	Yousuf Saifullah, Shashikant Maheshwari, Haihong Zheng Nokia 6000 Connection Drive, Irving, TX	Voice: +1 (0) 972 894 5000 Email: Yosuf.saifullah@nokia.com Shashikant.maheshwari@nokia.com Haihong.1.zheng@nokia.com
	Kanchei (Ken) Loa, Hua-Chiang Yin, Yi-Hsueh Tsai, Shiann Tsong Sheu Institute for Information Industry 8F, No. 218, Sec. 2, Dunhua S. Rd., Taibei City 106, Taiwan, ROC	Voice: +886-2-27399616 FAX: +886-2-23782328 Email: Loa@nmi.iii.org.tw
	Aik Chindapol, Jimmy Chui, Hui Zeng Siemens Corporate Research 755 College Road East, Princeton, NJ, USA	Voice: +1 609 734 3364 Fax: +1 609 734 6565 Email: aik.chindapol@siemens.com
	David T Chen Motorola, Inc. 1441 W Shure Drive Arlington Heights, Illinois 60004, USA	Voice: 847-632-2664 Email: david.t.chen@motorola.com
	Kyu Ha Lee, Jae Hyung Eom, Young-jae Kim Samsung Thales San 14, Nongseo-Dong, Giheung-Gu,Yongin, Gyeonggi-Do, Korea 449-712	Voice: +82-31-280-9917 Fax: +82-31-280-1620 Email: kyuha.lee@samsung.com
	Young-il Kim, Byung-Jae Kwak, Sunggeun Jin ETRI 161, Gajeong-Dong, Yuseong-Gu, Daejeon, Korea 205-350	Voice: +82-42-860-5399 Fax: +82-42-861-1966 Email: yikim@etri.re.kr
Re:	IEEE 802.16j-07/07r2: “Call for Technical Proposals regarding IEEE Project P802.16j”	

Abstract	This proposal clarifies the sleep mode in MR.
Purpose	Discuss and adopt proposed text.
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MS Sleep Mode in MR network

Yousuf Saifullah, Shashikant Maheshwari, Haihong Zheng

Kanchei(Ken) Loa, Hua-Chiang Yin, Yi-Hsueh Tsai, Shiann Tsong Sheu

Aik Chindapol, Jimmy Chui, Hui Zeng

David T Chen

Kyu Ha Lee, Jae Hyung Eom, Young-jae Kim

Young-il Kim, Byung-Jae Kwak, Sunggeun Jin

1. Introduction

In WiMAX MR networks, the RS may use two types of scheduling. Centralized Scheduling, where MR-BS controls all the radio resource scheduling and MAP allocation. Distributed Scheduling, where some functionality of radio resource scheduling and MAP allocation are distributed to RS. This contribution proposes text to clarify the MS sleep mode for distributed scheduling.

2. Distributed Scheduling

The MS sleep mode in distributed scheduling case is still centrally controlled by MR-BS [2]. For example, the MS sleep-mode should be approved by the MR-BS, and MR-BS determines the duration of sleep, listening windows, and other properties of MS sleep mode. However, to give RS convenience for the distributed radio resource scheduling, RS has to know the MS sleep-mode information, such as the sleep, listening windows, and the event-based actions. Based on these obtained information, the RS can buffer and schedule traffic and management messages, including the event-based actions,. RS also needs to confirm to MR-BS that it can schedule MS sleep mode.

This contribution proposes two messages, SLP-INFO and SLP-ACK. In IEEE 802.16e std. [1], MOB_SLP_RSP message is exchanged between BS and MS on MS basic CID and provide the sleep mode information of one MS. If we use the same MOB_SLP-RSP message between MR-BS and RS to provide MS sleep information than we need to duplicate the whole message and transmit to RS individually for each MS. This will be bandwidth inefficient. A BS may get multiple MS sleep mode activation/deactivation simultaneously. It may also want to deactivate multiple MS at the same time.

If we combine the sleep mode information for multiple MS and use MOB_SLP-RSP message to transmit from MR-BS to RS than we have following issues:

It will be bandwidth inefficient because we can not use CID = 0 method that currently supported in MOB_SLP-RSP. It will require to include all the active MS CIDs in MOB_SLP-RSP message

We may not able to support more than 64 power_saving_class_id (refer MOB_SLP-RSP) at the MR-BS because reusing MOB_SLP-RSP message will impose this limitation. Current MOB_SLP-RSP can support 64 power_saving_class_id for each MS but if we combine sleep information of multiple MS and send using MOB_SLP-RSP than these power_saving_class_ids needs to be shared among MSs.

The proposed SLP-INFO message is bandwidth efficient and does not have this limitation of power_saving_class_ids. It supports all the functionality of MS as defined in IEEE 802.16e.

SLP-ACK message is introduced to acknowledge that RS receives the MS sleep information and also provide the indication whether RS can support MS sleep mode or not. In IEEE 802.16e-2005 Std [1] (Table 109d), BS has capability of approving/disapproving MS sleep mode. BS can disapprove MS's entering into sleep mode if BS has DL data to transmit to MS. In distributed scheduling, access RS will perform scheduling for MSs and MR-BS doesn't have sufficient information about DL traffic buffered at RS therefore to provide the same functionality to RS, we propose to have sleep_approve bit as defined in MOB_SLP-RSP message with same functionality. Note that the sleep_approve bit is independent of flow control between MR-BS and RS.

3. Specific Text Change

Change Table 14 as indicated:

Type	Message name	Message description	Connection
TBA	SLP-INFO	Sleep Information	Basic
TBA	SLP-ACK	Sleep Acknowledge	Basic

Insert the following sub-clause

6.3.21.7.2 MS sleep mode support for distributed scheduling

MR-BS informs the pre-negotiated periods of MS absence to the RS for sleep mode coordination. The MR-BS knows the MSs attached to an RS. If the MSs activate MS Sleep Mode, the MR-BS sends SLP-INFO message to the RS. The message contains the listening and sleep interval information of the MSs. The RS saves and uses this information in scheduling traffic for the MS. The RS sends a response in SLP-ACK (Approve) to the MR-BS. The MR-BS shall activate MS sleep mode, after confirmation from RS.

MR-BS starts timer T49, after sending SLP-INFO. If T49 expires before receiving SLP-ACK, the MR-BS retransmits SLP-INFO message. MR-BS may do retransmission for a maximum of SLP-INFO Retry Count.

Insert new subclause (6.3.2.3.65):

6.3.2.3.65 SLP-INFO message

An MR-BS sends the SLP-INFO message to RS for informing about its subordinate MS sleep mode. This message conveys sleep mode information for all the MS attached through the RS. If any of an MS's connection is removed from the sleep mode to idle mode, the MR-BS sends SLP-INFO with Definition=0 and Operation=0 for that particular CID. This removes only the corresponding sleep information from the RS.

Syntax	**Size**	**Notes**

SLP-INFO_Message_format() {	-	-
Management message type = xx	8 bits	-
Transaction ID	15 bits	
Reserved	1 bit	
Number of MS	8 bits	Number of MSs included in the message.
for (i=0; i<Number of MS; i++) {		
MS Basic CID	16 bits	Identification of an MS
Number of Classes	8 bits	Number of power saving classes
for (i=0; i<Number of Classes; i++) {	-	-
Definition	1 bit	-
Operation	1 bit	-
Power_Saving_Class_ID	6 bits	-
if (Operation = 1) {	-	-
Start_frame_number	6 bits	-
Reserved	2 bits	-
}	-	-
If (Definition = 1) {	-	-
Enabled-Action-Triggered	8 bits	Indicates action performed upon reaching trigger condition in sleep mode If bit#0 is set to 1, respond on trigger with MOB_SCN-REPORT If bit#1 is set to 1, respond on trigger with MOB_MSHO-REQ If bit#2 is set to 1, on trigger, MS starts neighboring

		BS scanning process by sending MOB_SCN-REQ bit#3–bit#7: Reserved. Shall be set to 0.
Power Saving Class Type	2 bits	
Direction	2 bits	
Traffic_triggered_wakening_flag	1 bit	
TRF_IND required	1 bit	
Reserved	2 bits	
Initial sleep window	8 bits	
Listening window	8 bits	
Final-sleep window base	10 bits	
Final-sleep window exponent	3 bits	
Number_of_Sleep_CIDs	3 bits	
for (i=0; i<Number_of_Sleep_CIDs; i++ {		
CID		
}	16 bits	
If (TRF-IND required) {		
SLPID	10 bits	
Reserved	6 bits	
}		
}		
TLV encoded information	variable	TLV specific.
}		

The following parameters shall be included in the message:

Transaction ID
Unique identifier set by the sender for identifying this transaction.
Number of MS
Total number of MS in the message.
Definition
0 = Definition of Power Saving Class absent; in this case the message shall request activation or deactivation of Power Saving Class identified by Power_Saving_Class_ID.
1 = Definition of Power Saving Class present.
Operation
0 = Deactivation of Power Saving Class (for types 1 and 2 only).
1 = Activation of Power Saving Class.
Power_Saving_Class_ID
Assigned Power Saving Class identifier. The ID shall be unique within the group of Power Saving Classes associated with the MS. This ID may be used in further MOB_SLP-REQ/RSP messages for activation / deactivation of Power Saving Class.
Start_frame_number
Start frame number for first sleep window.
Power Saving Class Type
Power Saving Class Type of a connection.
Direction
Defined the directions of the class's CIDs.
0b00 = Unspecified. Each CID has its own direction assign in its connection creation. Can be DL, UL, or both (in the case of management connections).
0b01 = Downlink direction only.
0b10 = Uplink direction only.
0b11 = Reserved.
Enabled-Action-Triggered
Indicates possible action upon reaching trigger condition
Traffic_triggered_wakening_flag (for Type I only)
0 = Power Saving Class shall not be deactivated if traffic appears at the connection as described in 6.3.19.2.
1 = Power Saving Class shall be deactivated if traffic appears at the connection as described in 6.3.19.2.
TRF-IND_Required
For Power Saving Class Type I only.
1 = BS shall transmit at least one TRF-IND message during each listening window of the Power Saving Class. This bit shall be set to 0 for other types.
Initial-sleep window
Assigned initial duration for the sleep window (measured in frames). For Power Saving Class type III, it is not relevant and shall be encoded as 0.
Listening window
Assigned Duration of MS listening window (measured in frames). For Power Saving Class type III, it is not relevant and shall be encoded as 0.
Final-sleep window base

Assigned final value for the sleep interval (measured in frames). For Power Saving Class type II, it is not relevant and must be encoded as 0. For Power Saving Class type III, it is the base for duration of single sleep window requested by the message.

Final-sleep window exponent

Assigned 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)

For Power Saving Class type III, it is the exponent for the duration of single sleep window requested by the message.

SLP_ID

This is a number assigned by the BS whenever an MS is instructed to enter sleep mode.

The SLP-INFO message shall include the following parameters encoded as TLV tuples:

HMAC/CMAC Tuple (See 11.1.2.)

The HMAC/CMAC Tuple shall be the last attribute in the message.

6.3.2.3.66 SLP-ACK message

An RS supporting MS sleep mode accepts SLP-INFO message by sending the following message with Approved=1.

Syntax	Size	Notes
SLP-ACK_Message_format() {	-	-
Management message type = xx	8 bits	-
Transaction ID	15 bits	
sleep_approve	1 bit	Approved =1 , Disapproved =0
TLV encoded information	variable	TLV specific.
}		

The following parameters shall be included in the message:

Transaction ID

Copied from SLP-INFO.

sleep_approve

1 = MS Sleep mode is approved

0 = MS Sleep mode is disapproved

The SLP-ACK message shall include the following parameters encoded as TLV tuples:

HMAC/CMAC Tuple (See 11.1.2.)

The HMAC/CMAC Tuple shall be the last attribute in the message.

Add new entry in Table 342 (Parameters and constants=

System	Name	Time Reference	Minimum Value	Maximum Value	Default Value
MR-BS	T49	Time the MR-BS waits for RS-SLP-ACK			
MR-BS	SLP-INFO Retry Count	Number of retries on SLP-INFO transmission.			3

4. Reference

[1] IEEE 802.16e-2005 Std - Part 16: Air Interface for Fixed and Mobile Broadband Wireless Access Systems Amendment 2: Physical and Medium A c c e s s Control Layers for Combined Fixed and Mobile Operation in Licensed Bands and Corrigendum 1
[2] C80216j-06/026r2 – 802.16j base line document