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Re:	IEEE 802.16j-06/027: "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

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## 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 both type of scheduling.

## 2. Centralized Scheduling

The sleep mode is centrally controlled by MR-BS. 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. The RS simply relays the sleep mode messages, such as MOB\_SLP-REQ/RSP, and traffic indication, and it does not maintain any state information of sleep-mode MSs, which means the MS sleep mode does not need any extra functionalities from RS.

## 3. Distributed Scheduling

The MS sleep mode in distributed scheduling case is still centrally controlled by MR-BS. 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.

## 3. Specific Text Change

Change Table 14 as indicated:

Type	Message name	Message description	Connection
TBA	RS_SLP-CMD	RS Sleep Command	Basic
TBA	RS_SLP-ACK	RS Sleep Acknowledge	Basic

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6.3.21.7 Relay support for MS sleep mode

6.3.21.7.1 MS sleep mode support for centralized scheduling

MS sleep mode, for the MS attached through an RS, works as in the section 6.3.21. RS only relays the signaling and doesn't need any additional functionality for supporting sleep mode procedure. The RS doesn't keep any state information related to the MS sleep mode. The MR-BS needs to take the additional relay delay into account while it forwards the packets.

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 RS\_SLP-CMD 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 RS\_SLP-ACK (Approve) to the MR-BS. The MR-BS shall activate MS sleep mode, after confirmation from RS.

MR-BS starts timer T48, after sending RS\_SLP-CMD. If T48 expires before receiving RS\_SLP-ACK, the MR-BS retransmits RS\_SLP-CMD message. MR-BS may do retransmission for a maximum of RS\_SLP-CMD Retry Count.

The RS may send RS\_SLP-ACK (Disapprove) to the MR-BS, if it can't support the MS sleep mode. For instance, in distributed scheduling each RS on the relay path schedules frames independently. The access RS may receive traffic outside of the listening interval of an MS, and it may need to buffer the packets until the listening interval. If an RS may not be able to support buffering for additional MS in sleep state, it sends RS\_SLP-ACK (Disapprove) to the MR-BS.

*Insert new subclause (6.3.2.3.62):*

6.3.2.3.62 RS\_SLP-CMD message

An MR-BS sends the RS\_SLP-CMD 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 RS\_SLP-CMD with Definition=0 and Operation=0 for that particular CID. This removes only the corresponding sleep information from the RS.

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 For the power saving class type-1, MR\_BS also assigns a SLPID to RS. The MOB\_TRF-IND message is also used for indicating traffic to RS without any change. When there is any traffic indication for a sleeping MS under a RS, it also includes SLPID of the RS in the MOB\_TRF-IND message. The RS reads it and stays up for its UL allocation. In this way there is no change in the MOB\_TRF-IND message. When an RS receives MOB\_TRF-IND, it relays the message to the next level of RS and MS. ¶

Syntax	Size	Notes
RS_SLP-CMD_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

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		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	
}		
}		
<u>TLV encoded information</u>	<u>variable</u>	<u>TLV specific.</u>
}		

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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.

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**Deleted:** RS SLPID¶  
 SLPID assigned to RS. When there is any traffic indication for an MS under a sleeping RS, the BS includes RS SLPID in the MOB\_TRF-IND message. The RS reads it and stays up for its UL allocation. RS SLPID = 0 implies that there is no SLPID assigned.

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  $\times$  2<sup>(final-sleep window exponent)</sup>

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 RS\_SLP-CMD 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.

**Deleted:** If Activate/Deactivate RS sleep mode is 1, the RS\_SLP-CMD message shall include the following parameter encoded as TLV tuple: Broadcast message intervals (see 11.20.1)

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**6.3.2.3.63 RS\_SLP-ACK message**

An RS supporting MS sleep mode accepts RS\_SLP-CMD message by sending the following message with Approved=1.

Syntax	Size	Notes
RS_SLP-ACK_Message_format() {	-	-
Management message type = xx	8 bits	-
Transaction ID	15 bits	
MS Sleep Mode Approved/Disapproved	1 bit	Approved =1 , Disapproved =0
<u>TLV encoded information</u>	<u>variable</u>	<u>TLV specific</u>
}		

The following parameters shall be included in the message:

**Transaction ID**

Copied from RS\_SLP-CMD.

**MS Sleep Mode Approved/Disapproved**

0 = MS Sleep mode is approved

1 = MS Sleep mode is disapproved

The RS\_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.

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Add new entry in Table 342 (Parameters and constants=

System	Name	Time Reference	Minimum Value	Maximum Value	Default Value
MR-BS	T48	Time the MR-BS waits			



		for RS-SLP-ACK			
MR-BS	RS_SLP-CMD Retry Count	Number of retries on RS_SLP-CMD transmission.			3

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67-255		Reserved	-
67TBA	<u>RS_SLP-CMD</u>	<u>RS Sleep Command</u>	<u>Basic</u>

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69-255		Reserved	-
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RS SLPID	10 bits	Sleep ID for the RS; assigned only when an attached MS needs SLPID; this is used in Traffic Indication  SLPID= 0 – No Sleep ID assigned. This is the case when there is no attached MS with SLPID.
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