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Title	<b>Sleep Mode in MR network</b>	
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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

### 1. Introduction

In MR networks, the RS may use two types of scheduling. Centralized Scheduling is where MR-BS controls all the radio resource scheduling and MAP allocation. Distributed Scheduling is where some functionality of radio resource scheduling and MAC allocation are distributed to RS. This contribution proposes text to clarify the handling of 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 this obtained information, the RS can allocate resources to MS on time for the event-based actions, also RS can avoid sending management messages to this MS, and can cancel the bandwidth allocated to MS during the sleep period.

In order to facilitate the centralized management of sleep mode in distributed MR networks, text is required to clarify how the RS and MR-BS shall process the MOB\_SLP-RSP messages such that RS could obtain the sleep-mode information. If a duplicated version of the MOB\_SLP-RSP message sent to the MS is also sent to the RS on the RS's basic CID, the RS can receive, and learn the sleep-mode information of each MS it serves.

However, as the MOB\_SLP-RSP message is sent on the RS basic CID, the message may not explicitly signal the MS CIDs for which the MR-BS is an indicating sleep mode response. To circumvent this problem simple modifications are required in the BS to duplicate and modify the message for the transmission to the RS to avoid setting Number\_of\_CIDs to zero and using a CID of zero to indicate all management CIDs.

Sending a SLP-RSP message to RS on its basic CID may cause inconsistency of sleep status among MR-BS, MS and RS. For example, MS receives the MOB\_SLP-RSP and enters sleep-mode, but RS does not get the corresponding sleep-mode information due to packet loss on relay link. In this case, RS could send PDUs/Messages to the MS while the MS is in sleep interval. To avoid any inconsistency of sleep status if RS doesn't successfully obtain the information about the sleep mode context of the CIDs, RS shall send a "sleep mode information obtained" acknowledgement message, SLP\_INF-ACK, to MR-BS after it correctly receives the duplicated MOB\_SLP-RSP message.

In conclusion, with some relatively simple modifications to the BS, it is possible to support the RS obtaining sleep mode information through MOB\_SLP-RSP messages in an MR network without the requirement for new messages. Hence the number of changes between an MR-BS and BS can be

minimized and the reuse of existing technology in the RS maximized. Furthermore, the duplicating of messages circumvents the problems associated with authenticating relayed messages of this type at the RS and also the inability of the RS to generate such messages in the absence of knowing the CMAC key or a security association between the RS and MS.

#### 4. Specific Text Change

##### 6.3.2.3 MAC management messages

*[Change Table 14 as indicated]*

Type	Message name	Message description	Connection
<del>67-255</del>		<del>Reserved</del>	
<u>67</u>	<u>SLP_INF-ACK</u>	<u>RS obtaining sleep-mode information acknowledge</u>	<u>Basic</u>
<u>68-255</u>	<u>=</u>	<u>Reserved</u>	<u>=</u>

##### 6.3.2.3.45 Sleep Response message (MOB\_SLP-RSP)

*[Insert the following text after the second paragraph of subclause 6.3.2.3.45:]*

In MR networks, the MOB\_SLP-RSP shall be sent from the MR-BS to an RS using the MS's basic CID in response to the relayed MOB\_SLP-REQ message, or may be sent unsolicited. The RS shall relay this message to MSs either directly or through another RS.

In the distributed scheduling case, the MR-BS shall send a MOB\_SLP-RSP message to the RS that is serving the MS on the RS basic CID. The RS can use this message to learn the MS's sleep-mode information.

*[Change the explanation text of the "Number\_of\_CIDs" field as indicated:]*

Number\_of\_CIDs

In case the message is sent on Basic Connection of certain MS, Number\_of\_CIDs = 0 means that all CIDs associated with the MS are included into the class.

In MR networks, the "Number of CIDs" field in the MOB\_SLP-RSP message sent from the MR-BS to the RS on the RS' basic CID shall not be set to zero, instead the corresponding MS's basic CIDs shall be included in the "CID" field and the "Number of CIDs" shall be set to indicate the number of CIDs included in the CID field.

*[Change the explanation text of the "CID" field as indicated:]*

CID

CIDs of all connections comprising the Power Saving Class. This list shall contain either unicast connections or multicast connections or management connections, but not combination of connections of different types. If Basic CID is encoded, it means that all MS connections are included in a single class. CID = 0 is reserved for management operations. In case the message is sent on Basic connection of certain MS, CID = 0 denotes set of all management connections associated with the MS.

In MR networks, the “CID” field in the MOB\_SLP-RSP message sent from the MR-BS to the RS on the RS’ basic CID shall not be set to zero instead it shall include a list of all management CIDs associated with the MS.

*[Add the “Transaction ID” field after the “HMAC/CMAC” field as indicated:]*

Transaction ID TLV (see 11.16.3)

In MR networks, the “Transaction ID” TLV will be added in the MOB\_SLP-RSP message sent from the MR-BS to the RS with distributed scheduling on the RS’ basic CID.

*[Insert a new subclause after 6.3.2.3.62]*

6.3.2.3.63 SLP\_INF-ACK message

After successfully receiving the a MOB-SLP-RSP message sent by MR-BS on RS’ basic CID, the RS shall transmit SLP\_INF-ACK message on its basic CID to MR-BS to acknowledge that it got the information about the sleep context of the CIDs indicated.

<u>Syntax</u>	<u>Size</u>	<u>Note</u>
<u>SLP_INF-ACK Message format(){</u>		
<u>Management message type = xx</u>	<u>8bits</u>	
<u>Transaction ID</u>	<u>16bits</u>	<u>Obtained = 1</u>
<u>TLV encoded information</u>	<u>Variable</u>	<u>TLV specific</u>
<u>}</u>		

The following parameters shall be included in the message:

Transaction ID

Transaction ID from corresponding MOB\_SLP-RSP message.

All other parameters are coded as tuples:

HMAC/CMAC Tuple (see 11.1.2)

The HMAC/CMAC Tuple attribute contains a keyed message digest (to authenticate the sender). The HMAC Tuple attribute shall be the final attribute in the DSx message’s attribute list.

*[Insert a new subclause after 6.3.21.7]*

6.3.21.7 Sleep mode for mobility-supporting MS in MR

In MR networks, the sleep mode shall be centrally controlled by the MR-BS in the presence of centralized or distributed scheduling. Therefore all MOB\_SLP-REQ messages generated by MSs shall be relayed by RSs to the MR-BS. The MR-BS shall be responsible for generating MOB\_SLP-RSP messages, which will be relayed by RSs, either in response to a MOB\_SLP-REQ or unsolicited.

In the distributed scheduling case, the MR-BS shall firstly send a MOB\_SLP-RSP message to the RS on the RS’s basic CID. After receive this MOB\_SLP-RSP message, the RS shall send SLP\_INF-ACK

message to MR-BS to acknowledge that it got the information about the sleep context of the CIDs indicated. The MR-BS shall retransmit the duplicated MOB\_SLP-RSP message to the RS on the RS's basic CID, if it does not receive the SLP\_INF-ACK message from the corresponding RS within the T48 timer. Once MR-BS receives the SLP\_INF-ACK message, it shall send a MOB\_SLP-RSP message, which will be relayed by RSs, either in response to a MOB\_SLP-REQ or unsolicited. Fig. XX illustrates the procedure of MR-BS approving of sleep-mode CIDs.

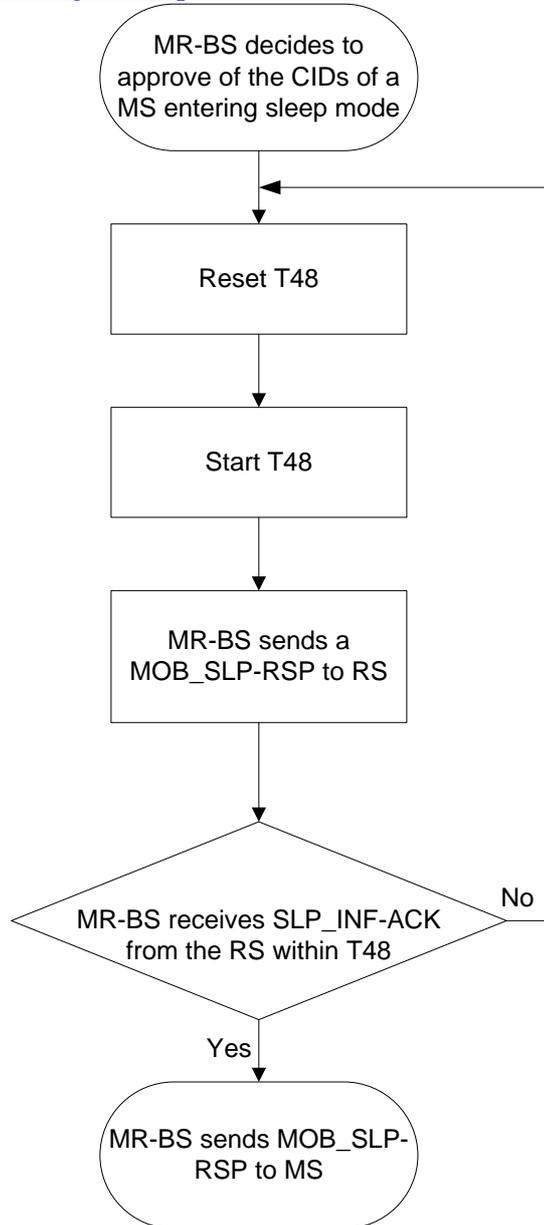


Figure XX – MR-BS approves of CIDs entering sleep mode

10.1 Global values

*[Add one row in table 342 as indicated]*

<u>System</u>	<u>Name</u>	<u>Time reference</u>	<u>Minimum value</u>	<u>Default value</u>	<u>Maximum value</u>
<u>MR-BS</u>	<u>T48</u>	<u>Time the MR-BS waits for SLP_INF-ACK from RS</u>	=	=	=

### 11.16 Sleep mode management TLV encodings

*[Insert new subclauses after 11.16.2:]*

#### 11.16.3 Transaction ID

<u>Type</u>	<u>Length</u>	<u>Value</u>	<u>Scope</u>
<u>TBA</u>	<u>2</u>	<u>Unique identifier for this transaction assigned by sender</u>	<u>MOB_SLP-RSP</u>