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 duplicated message is sent on the RS basic CID, the duplicated MOB_SLP-RSP 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.

Duplicate messages of SLP-RSP 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]

<table>
<thead>
<tr>
<th>Type</th>
<th>Message name</th>
<th>Message description</th>
<th>Connection</th>
</tr>
</thead>
<tbody>
<tr>
<td>67-255</td>
<td>Reserved</td>
<td>Reserved</td>
<td></td>
</tr>
<tr>
<td>67</td>
<td>SLP_INF-ACK</td>
<td>RS obtaining sleep-mode information acknowledge</td>
<td>Basic</td>
</tr>
<tr>
<td>68-255</td>
<td>Reserved</td>
<td>Reserved</td>
<td></td>
</tr>
</tbody>
</table>

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 duplicate the MOB_SLP-RSP message and send the 
duplicate to the RS that is serving the MS on the basic CID of the serving RS. The RS can use this 
duplicated 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 duplicate MOB_SLP-RSP message sent from the 
MR-BS to the RS with distributed scheduling 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 duplicate MOB_SLP-RSP message sent from the MR-BS to the RS with distributed scheduling 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” filed as indicated:] Transaction ID TLV (see 11.16.3) In MR networks, the “Transaction ID” TLV will be added in the duplicate MOB_SLP-RSP message sent from the MR-BS to the RS with distributed scheduling.

[Insert a new subclause after 6.3.2.3.62] 6.3.2.3.63 SLP_INF-ACK message After successfully receiving the duplicated MOB_SLP-RSP message sent by MR-BS, 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.

<table>
<thead>
<tr>
<th>Syntax</th>
<th>Size</th>
<th>Note</th>
</tr>
</thead>
<tbody>
<tr>
<td>SLP_INF-ACK_Message_format()</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Management message type = xx</td>
<td>8bits</td>
<td></td>
</tr>
<tr>
<td>Transaction ID</td>
<td>16bits</td>
<td>Obtained = 1</td>
</tr>
<tr>
<td>TLV encoded information</td>
<td>Variable</td>
<td>TLV specific</td>
</tr>
<tr>
<td>}</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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 duplicated MOB_SLP-RSP message to the RS on the RS’s basic CID. After receive the duplicated 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 MB-RS 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.

MR-BS decides to approve of the CIDs of a MS entering sleep mode

- Reset T48
- Start T48
- MR-BS sends a duplicated MOB_SLP-RSP to RS

MR-BS receives SLP_INF-ACK from the RS within T48

- No
- Yes

MR-BS sends MOB_SLP-RSP to MS on R-DL

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

10.1 Global values

[Add one row in table 342 as indicated]
<table>
<thead>
<tr>
<th>System</th>
<th>Name</th>
<th>Time reference</th>
<th>Minimum value</th>
<th>Default value</th>
<th>Maximum value</th>
</tr>
</thead>
<tbody>
<tr>
<td>MR-BS</td>
<td>T48</td>
<td>Time the MR-BS waits for SLP INF-ACK from RS</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

11.16 Sleep mode management TLV encodings

[Insert new subclauses after 11.16.2:]

11.16.3 Transaction ID

<table>
<thead>
<tr>
<th>Type</th>
<th>Length</th>
<th>Value</th>
<th>Scope</th>
</tr>
</thead>
<tbody>
<tr>
<td>TBA</td>
<td>2</td>
<td>Unique identifier for this transaction assigned by sender</td>
<td>MOB_SLP-RSP</td>
</tr>
</tbody>
</table>