Project	**IEEE 802.16 Broadband Wireless Access Working Group** <http://ieee802.org/16>	
Title	**RS sleep and wakeup in the MR cell**	
Date Submitted	**2007-07-05**	
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Re:	IEEE 802.16j-07/019, "Call for Technical Comments Regarding IEEE Project 802.16j."	
Abstract	This document is to propose a RS sleep and wakeup procedure in IEEE 802.16j-06/026r4 document.	
Purpose	Adopt the text proposal in the document	
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RS Sleep and Wakeup in the MR cell

1 Introduction

This document is to describe RS sleep and wakeup mechanism in MR cell as an input for call for contribution of 802.16j task group. RS sleeping and wakeup is an optional technical requirement, as requirement O13 defined in IEEE802.16j-06/016r1 [1]. RS sleep mode is essential for power saving in the MR networks [2].

In the MR cell, for the purpose of power saving, MR-BS and RS require a mechanism to control RS sleep and wakeup between RS and MR-BS in such access network. The main concern is that RS sleep does not influence MS operations defined in IEEE 802.16e-2005. As a trade-off, RS sleep may result in a lower level of service because the MS may have to wait for the RS to wake up before it can access the system. In the case of handover, if MS is not served quickly enough, calls would drop down. In the case of RS sleep, RS may turn off the receiver, and thus ranging signal for MS network entry or HO requests can not be received.

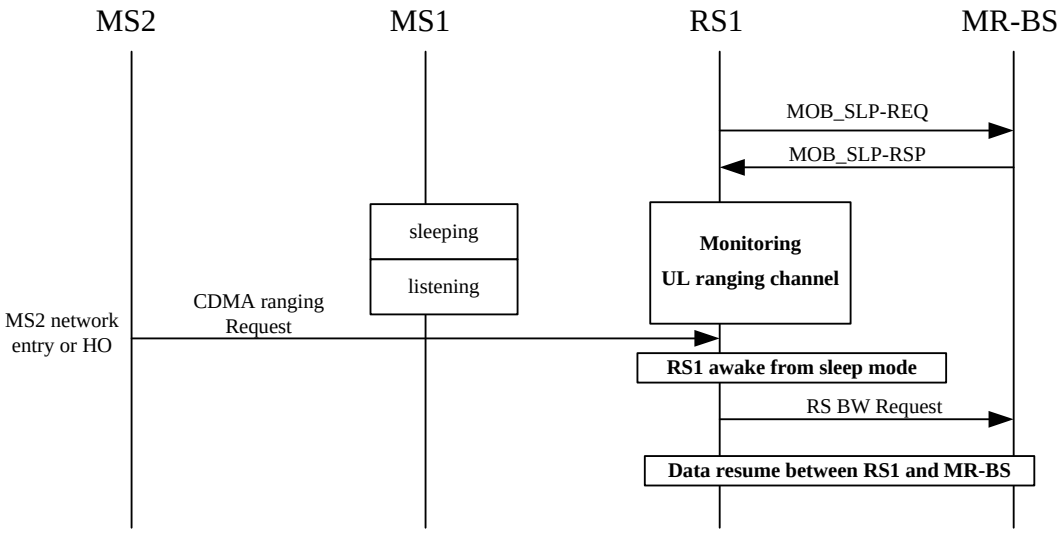
In this document, we propose a series of procedure to support RS sleep and wakeup mechanism. Using the mechanism, RS can enter or leave sleep mode with maximal power saving capability.

2 RS sleeping and RS wakeup mechanism

In the cell planning stage, RS can be placed within the cell coverage of MR-BS for the purpose of throughput enhancement or coverage extension. In the former case, the MSs served by the RS are also covered by MR-BS, and can be served by MR-BS if necessary. An MS may also select to attach MR-BS or the RS according to the signal qualities with the coordination from MR-BS, such as handover messages. When the RS enters the sleep mode, the subordinated new-entry MS can initiate network entry procedure with MR-BS. After the RS leaves sleep mode, MR-BS can perform a path selection procedure to provide a optimized access station to the new-entry MS, and then may launch intra-MR-BS handover for the specified MS. In the latter case, only a portion of MSs served by RS can directly access MR-BS. RS cannot fully turn off the radio transceiver in the sleep window. Even in the sleep window, RS has to keep one eye on the new-entry MSs to detect the initial ranging signal sent from them. Upon receiving message from MR-BS, or transmitting message towards MR-BS, the RS has to be waken up and return to Normal operation.

2.1 Partial RS sleep mode and RS wakeup

RS has to provide the basic access capability to the new-entry MS which cannot directly access MR-BS.
In partial RS sleep mode, RS can sleep with limited power consumption, only receiving and handling UL ranging signal from MSs attached to it or new-entry MS. Only if the condition is met, for example, when RS can detect the initial ranging signal correctly, RS is woken up to serve these MSs.
The basic partial RS sleep procedure is illustrated as follows:



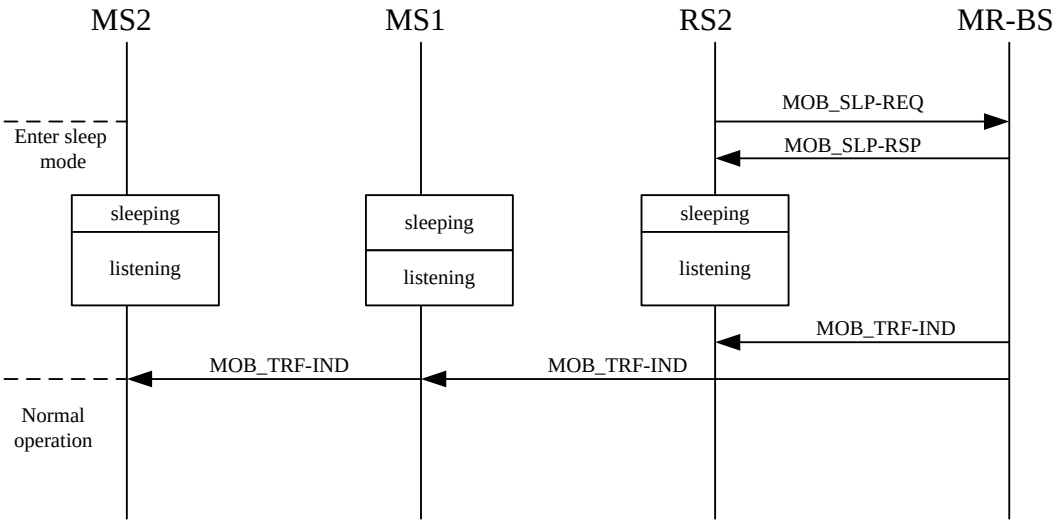
For example, RS1 knows that all subordinated MS entered the sleep mode, it may also request to enter sleep mode. In its sleep window, RS do not perform message relaying except keeping detecting UL ranging channel. For transparent relaying, RS also monitors the MAP information on the downlink channel. For non-transparent relaying, RS transmits its preamble and MAP broadcasting information. If the MS2 performs network entry or handover operation, the CDMA initial/handover ranging request is received by RS1, to forward the control management information, RS1 wakes up and forwards messages to MR-BS.

2.2 Full RS sleep mode

In the full RS sleep mode, RS turns off its radio transceiver in the frames of the sleep window and wake up in the listen window.

Full RS sleep mode can be active only when all subordinated MSs enter sleep mode. To meet this condition, all subordinated MSs need to have the alignment of sleep window. Otherwise, even only one MS is being in listen window, RS has to be in listen window ready for transferring data or control messages between MR-BS and MS. Thus, MR-BS needs to coordinate the start position and size of sleep window for each subordinated MS attached to the RS, to enable RS sleep.

The basic full RS sleep procedure is illustrated as follows:



MR-BS has the knowledge of the sleep windows of RS's subordinated MSs, and then informs RS2 to sleep in the common sleeping window of MS1 and MS2. MOB_SLP-REQ, MOB_SLP-RSP and MOB_TRF-IND message is sent using the basic CID of RS.

If MR-BS decides to wake up the RS2, it will send MOB_TRF-IND message to RS2.

3 Text to be inserted into standard

[Insert a new subclause 6.3.21.8]

6.3.21.8 RS sleep mode

RS sleep mode is intended to minimize RS power consumption and reduce the resource usage of serving MR-BS air interface.

When all of the subordinated MSs turn to sleep mode, attached RS may enter sleep mode. RS sleep mode shall be activated by an MOB-SLP_RSP message in response of MOB-SLP_REQ message or an unsolicited MOB-SLP_RSP message. RS's sleep window shall be within the overlapped period of sleep windows of all subordinated MSs.

RS sleep mode is categorized into partial RS sleep mode and full RS sleep mode according to power saving level and coverage overlapping of MR-BS and RS. MR-BS informs RS the sleep mode type by the MOB_SLP-RSP message.

In partial RS sleep mode, RS provides the basic access capability to the new-entry MS which does not directly access MR-BS when new-entry MS does not receive synchronization or broadcasting signals from MR-BS or its uplink signal does not reach MR-BS.

In full sleep mode, RS shall turn off its radio transceiver completely without monitoring UL signal from MS or DL signal from MR-BS or upstream RS.

The messages between the RS and MR-BS are sent using the basic CID of RS.

6.3.21.8.1 Partial RS sleep mode and wakeup

RS does not fully turn off the radio transceiver in the common sleep window. For transparent relaying, RS also monitors the MAP information on the downlink channel. For non-transparent relaying, RS transmits its preamble and MAP broadcasting information. RS in partial sleep mode only receives UL ranging signal from MSs, and R-MAP from MR-BS.

RS shall exit sleep mode upon receiving a valid initial/handover ranging request from MS in the allocated UL ranging channel, or a MOB_TRF-IND message from MR-BS.

6.3.21.8.2 Full RS sleep mode and wakeup

All subordinated MSs need to have the alignment of sleep window to make the overlapped period of sleep windows maximum. In the common sleep window, RS may turn off its radio transceiver completely.

In full sleep mode, RS shall be woken up upon receiving the MOB_TRF-IND message generated from MR-BS in the listening window.

[Insert a new subclause 11.16.3]

11.16.3 RS sleep mode

This value indicates the type of RS sleep mode. The TLV information is sent by MR-BS in response of MOB_SLP-REQ or unsolicited MOB_SLP-RSP. If RS receives MOB_SLP-RSP message with 'RS sleep mode' =0, it shall activate partial sleep procedure. Otherwise, if RS receives MOB_SLP-RSP message with 'RS sleep mode' =1, it shall activate full sleep procedure.

Type	Length	Value	Scope
3	1	0: Partial sleep mode 1: Full sleep mode	MOB_SLP-RSP

[Reference]

[1] IEEE802.16j-06/016r1, Technical Requirements Guideline for IEEE 802.16 Relay TG

[2] IEEE802.16j-07/066r4, RS Sleep Mode