Project	**IEEE 802.16 Broadband Wireless Access Working Group <http://ieee802.org/16>**
Title	**Sleep mode operation during handoff**
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Re:	The contribution corresponding to commentary 109 sub-item4 (Sleep mode operation)
Abstract	This document is to explain sleep mode operation during HO in IEEE 802.16e.
Purpose	In this contribution, we propose sleep mode operation and its related message to make firm the sleep mode operation.
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Patent Policy and Procedures	

Sleep mode operation during Handoff

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Problem Statements

The purpose of IEEE802.16e project is to improve the 802.16a system in the mobility aspect. And it includes power saving option to support efficient MSS operation. Power saving algorithm mainly handles the operation of MSS according to the amount of traffic data to save consumed power of terminal and Handoff algorithm is to support continuing service despite the movement of MSS to another cell. Since the main focus in IEEE802.16e project is to improve the mobility of terminal, for the efficient operation of handoff, power saving algorithm should consider the various cases of terminals at the environment of handoff.

When an MSS cannot keep the connection with BS, it drops and retry to get the connection as it power on newly. Because there needs many resources and message turns between MSS and BS to recover its service as the same level of QoS granted before drop, MSS should prevent dropping and handover to new BS

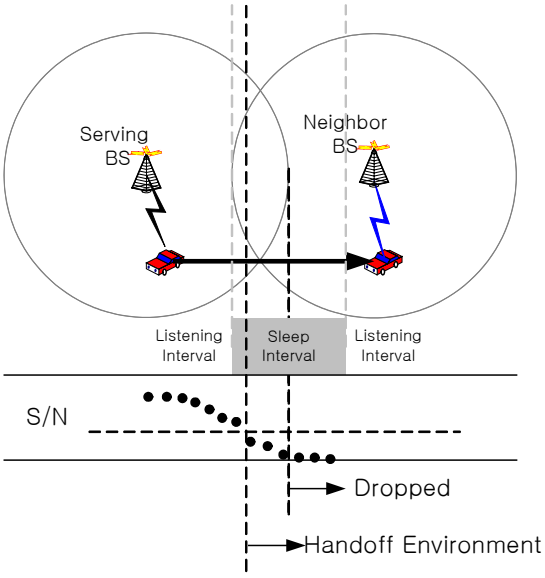

Figure 1 : Terminal Drop at Sleep mode

Figure 1 shows the case of terminal dropping when it is at sleep mode. As shown in figure 1, if the MSS operate based on only comparing SNR with handoff threshold and it turn off during the sleep interval, it cannot detect the abnormal variation of SNR to go down below handoff threshold and drops. When the MSS keep receiving from BS during the sleep interval, it can detect when to handoff but the efficiency of power saving is bad.

To solve such an problem, even though SNR is above the handoff threshold, the MSS should detect the abnormal variation of SNR. And the MSS should return to awake mode to measure SNR from BS when detecting the abnormal variation of SNR. And when it detect the handoff environment, it can handoff to new BS or when it detect it is safe, it can move to sleep mode with the normal operation between BS and MSS.

BS may save the traffic data to MSS at sleep mode and it send traffic indicator at the listening interval of MSS. Since sleep interval increase exponentially, it may take much time to send traffic indicator after occurring the traffic to MSS. Therefore, it does help efficient operation to report of returning to awake mode to BS.

But currently the messages from the MSS to BS are only the request or response messages for each operation, therefore it needs the message for reporting of status update.

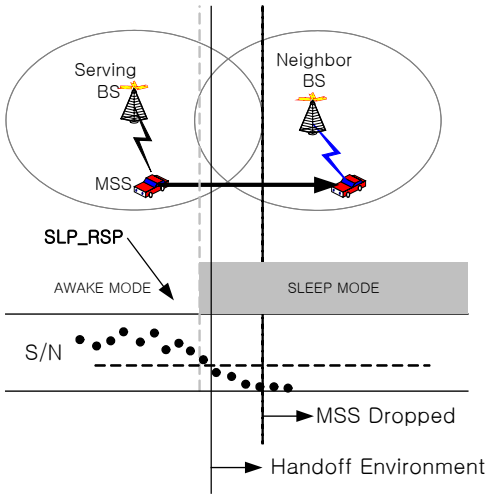

Figure 2 : Terminal drop when changing to Sleep mode

Figure 2 shows the case of dropping immediately after the MSS enter sleep mode after receiving SLP_RSP at the handover environment. To prevent such an case of dropping, the MSS should remain awake mode after detecting such an abnormal case of SNR variation that it is above the threshold occurring handoff but is suspected to decrease to such an level.

At this case, MSS should report to BS that it remains at awake mode a while despite receiving SLP_RSP. And based on this status update from MSS, BS can efficiently handle the traffics to the MSS after.

Proposed Remedy

As shown in problem statements, there are many cases an MSS should change its terminal state between sleep mode and awake mode and deny entering sleep mode in order to prevent dropping of the MSS. And for the efficient communication between MS and BSS, the terminal state of each MSS should be reported to BS immediately whenever the terminal state is changed.

We propose the following remedies in 802.16e-03/07r3 to solve the mentioned problems.

- Add the Following Message :

6.2.2.3.5x State Lock Indication (MOB_SLOCK-IND) message

The MSS supporting sleep mode uses the MOB_SLOCK-IND message to indicate to BS that its current mode is AWAKE Mode and will keep the current AWAKE Mode a while. This message shall be transmitted on the basic CID.

Table 56xx – MOB_SLOCK-IND Message Format

Syntex	**Size**	**Notes**
MOB_SLOCK_IND_Message_Format() {		
Management Message Type = xx	8 bits	
Lock Flag	8 bits	1 : Mobile is currently AWAKE Mode and will not change to SLEEP Mode a while (AWAKE Mode lock) 0 : AWAKE Mode lock is cleared

A MSS shall generate MOB_SLOCK-IND message in the format shown in table 56xx.

The following parameter shall be included in the MOB_SLOCK-IND message,

Lock Flag – This value indicates current state of MSS. The following encoding apply :

0 = MSS can change between AWAKE Mode and SLEEP Mode according to normal power saving process.

1 = MSS is at AWAKE Mode and will not change to SLEEP Mode a while.

- Add in line 27 of page 27 the following paragraph :

"When MSS return to AWAKE Mode or want to keep AWAKE Mode, and there is no message to send to the BS, MSS should report its current state using MOB_SLOCK_IND message to the BS.".

- Change the first paragraph in line 48 of page 27 to the following :

~~An SS shall enter sleep-mode after receiving an SLP_RSP message from the BS~~

An SS may enter sleep-mode after receiving an SLP-RSP message from the BS or deny entering sleep-mode. The denying SS should report its current status using MOB_SLOCK_IND message to BS.