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| Source(s) | Yeongmoon Son Changhoi Koo Jungje Son Samsung Electronic, Suwon P.O.Box 105, 416, Maetan-3dong, Paldal-gu, Suwon-si, Gyeonggi-do, Korea 442-742 | Voice : +82-31-279-5091 Fax : +82-31-279-5130 ym1004.son@samsung.com chkoo@samsung.com junje.son@samsung.com |
| Re: | This contribution is for call for contribution about IEEE802.16e-D1 | |
| Abstract | This contribution is to propose the modification of MOB_TRF IND message in order to perform the periodic ranging within sleep interval appropriately. | |
| Purpose | Handoff Ad Hoc draft proposal for the IEEE802.16e group. | |
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Periodic Ranging in Sleep mode

Yeongmoon Son, Changhoi Koo, Jungje Son

SAMSUNG Electronic

1. Problem Statement

In IEEE P802.16-REVd/D3-2004, SS joined to BS shall perform the periodic ranging procedure in order to adjust transmission parameters so that it can maintain its uplink communications with the BS. Therefore, An MSS supporting sleep-mode shall also support the periodic ranging procedure defined in IEEE P802.16e/D1-2004.

For each MSS, a BS shall maintain a T27 timer for the periodic ranging opportunity . Whenever the timer expires, the BS shall issue a ranging opportunity for an uplink transmission (or uplink burst) to the MSS through a UL-MAP message.

However, for the MSS supporting sleep-mode, there is a big problem in performing the periodic ranging. Since MSS does not know whether it is given any uplink burst during the sleep interval, it cannot execute the periodic ranging properly even though a BS allocates an uplink burst for periodic ranging opportunity to MSS that is in sleep window, at the expiration of the T27 timer.. As a result, from this undesirable and imbalance operation MSS may have difficulty to adjust the uplink communication with the BS.

2. Proposed Remedy

For the purpose to resolve the above problems, we propose a modified MOB_TRF-IND message considering both sleep mode and periodic ranging. Currently, the MOB_TRF-IND message contains some parameters including a SLPID bitmap. Each bit of the SLPID bitmap indicates a traffic indication for an MSS in sleep mode represented by a sleep id. The MSS shall decode the MOB_TRF-IND message during its listening intervals in order to check whether it receives a positive indication.

As a way to support both the periodic ranging and the power saving in sleep mode, we modify the MOB_TRF-IND message as followings;

- The length of SLPID indicator which has been allocated and designated to a single MSS is expanded to 2bits from 1bit in order to represent both the periodic ranging and the traffic indication
- 10bits for ranging frame offset is added in order to indicate the opportunity of the periodic ranging for the MSS

Table 1. Proposed Bit Allocation and MSS action

| Bit Allocation (SLPID indicator) | Meaning | MSS Action |
|-------------------------------------|---|---|
| 00 | No Periodic Ranging opportunity and negative Traffic Indication | May return to Sleep mode. |
| 01 | No Periodic Ranging opportunity and positive Traffic Indication | Shall transit to Awake mode |
| 10 | Periodic Ranging opportunity during the next sleep window and negative traffic indication (No Additional MAC Management | May return to sleep mode and remain in sleep mode until the start of periodic ranging operation. (The Ranging Frame Offset measured in |

| | | |
|----|--|---|
| | Message) after completion of the Periodic Ranging | frames indicates when to awake in the sleep window from the end of listening interval.) After the completion of periodic ranging operation, if MSS does not pass the sleep interval, MSS may return to sleep mode. |
| 11 | Periodic Ranging opportunity during the next sleep window and positive traffic indication (Additional MAC Management Message) after completion of the Periodic Ranging | May return to sleep mode and remain in sleep mode until the start of periodic ranging operation. (The Ranging Frame Offset measured in frames indicates when to awake in the sleep window from the end of the listening interval.) After the Completion of Periodic ranging Operation, MSS will remain in awake mode. |

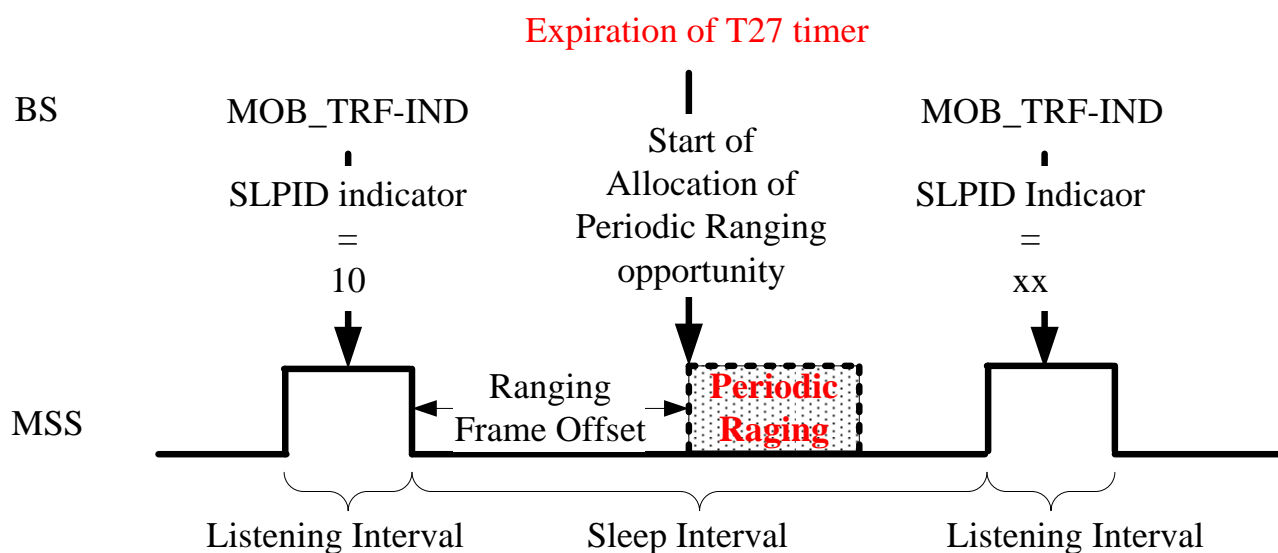


Figure 1. The proposed operation of sleep mode and periodic ranging

3. Proposed Text Changes

[Modify the paragraph of 6.4.2.3.4.44 in Page 23, Line 52 as follows]

6.4.2.3.44 Traffic Indication message (MOB_TRF-IND)

This message is sent from BS to MSS on the broadcast CID. The message is intended for MSS's that are in sleep-mode, and is sent during those MSS's listening-intervals. The message indicates whether there has been traffic addressed to each MSS in sleep-mode and whether Periodic Ranging opportunity for each MSS exists or not within its own sleep interval. An MSS that is in sleep-mode during its listening interval shall decode this message to seek a 2bit-wise indication addressed to it.

When an MSS awakens, it will check the frame number to ensure that it did not lose frame synchronization with the BS and read two bit SLPID indicator assigned to it, and take one of the following actions accordingly.

- SLPID indicator "00"

The MSS will have neither a periodic ranging opportunity nor PDU such as DL traffic. The MSS may return to sleep mode.

- SLPID indicator "01"

-The MSS will not have a periodic ranging opportunity but it will have PDUs such as DL traffic so that the MSS shall transit to awake mode.

- SLPID indicator "10"

The MSS will have a periodic ranging opportunity, but it will not have PDUs such as additional MAC Management messages after successful periodic ranging operation. The MSS shall read its 'Ranging Frame Offset' in the order of its SLPID among all the MSSs with their indicator set to '10' or '11'. MSS may return to and remain in sleep mode until the start of periodic ranging operation apart from the end of its listening interval as 'Ranging Frame Offset'. And then, it shall awaken to decode the UL-MAP for periodic ranging opportunity. Upon completion of the periodic ranging operation, it may return to sleep mode if not passed the sleep interval.

- SLPID indicator "11"

MSS will have a periodic ranging opportunity and PDUs such as additional MAC Management messages after successful periodic ranging operation. Thus, it shall do the same operation as the case where the SLPID indicator is "10" except for remaining in an awake mode to receive the additional MAC Management message even after the completion of the periodic ranging operation.

If the MSS meets another listening interval during the periodic ranging operation, it shall monitor and decode MOB_TRF-IND message.

[Modify Table 85c in Page 24, Line 1 – Traffic-Indication(MOB_TRF-IND) message format as follows]

Table 85c --- Traffic-Indication(MOB_TRF-IND) Message format

| Syntax | Size | Notes |
|---|-----------------|--|
| <u>MOB_TRF-IND_Message_Format() {</u> | | |
| Management message type = <u>487</u> | | |
| <u>Byte of SLPID bit-map</u> | <u>8 bit</u> | |
| SLPID bit-map | <u>Variable</u> | <u>Two bits are allocated to one MSS</u> |

| | | |
|--|---------------|--|
| | | <p>00 : No Periodic Ranging opportunity and No PDUs such as DL Traffic</p> <p>01 : No Periodic Ranging opportunity but PDUs such as DL Traffic</p> <p>10 : Periodic Ranging opportunity and No PDUs such as MAC Management message (the MSS may return to sleep mode after periodic ranging operation)</p> <p>11 : Periodic Ranging opportunity and PDUs such as MAC Management message (the MSS shall maintain Awake mode after Periodic Ranging operation)</p> |
| <u>NUM of MSS Periodic Ranging</u> | <u>8 bit</u> | |
| <u>For(i=0; i<NUM of MSS Periodic Ranging; i++) {</u> | | |
| <u>Ranging Frame Offset</u> | <u>10 bit</u> | <u>Frame Offset for case where SLPID bit map indicator is set to '10' or '11'</u> |
| <u>↓</u> | | |
| <u>↓</u> | | |

Parameters shall be as follows:

Byte of SLPID bit-map

The size of SLPID bit-map field in bytes

SLPID bit-map

The SLPID bit-map field is a variable length field ~~with (that is its length is~~ determined by the number of SLPID currently assigned by the BS). ~~It requires padding for byte alignment, if needed.~~ The ~~most~~least-significant 2 bits of the first byte in ~~this the bit-map bit-map is~~ field ~~an indicator for the MSS with relates to~~ SLPID=0, and ~~the~~ subsequent 2 bits ~~are for the MSS with relate to~~ SLPID=1, etc.

The MSS ~~with that has been assigned~~ SLPID=n by the SLP-RSP message shall interpret ~~the 2 bit indicator n (b_{2n}b_{2n+1}b_n)~~ in the SLPID ~~bit-map bit-map~~ in the following manner:

~~b_n = 0 means negative indication, MSS may return to sleep mode~~

~~b_n = 1 means positive indication, MSS shall awake~~

b_{2n} means whether a periodic ranging opportunity exists within the next sleep interval.

b_{2n} = 0 means that a periodic ranging opportunity is not scheduled within the next sleep interval.

b_{2n} = 1 means that a periodic ranging opportunity is scheduled within the next sleep interval.

b_{2n+1} has different meanings depending on the b_{2n}

In case of b_{2n} = 0

b_{2n+1} = 0 means a negative traffic indication

b_{2n+1} = 1 means a positive traffic indication

In case of b_{2n} = 1

b_{2n+1} = 0 means that MSS may return to sleep mode after the periodic ranging operation succeeds.

b_{2n+1} = 1 means that MSS shall remain in awake mode after the periodic ranging operation succeeds.

Num of MSS Periodic Ranging

The number of MSSs with their b_{2n} set to 1.

Ranging Frame Offset

This field is valid only for a group of MSSs with the first bit of their two bit indicator set to 1. An MSS in the group shall count the number of MSSs with SLPID lower than its SLPID. The count indicates the position of a 'Ranging Frame Offset' that the MSS should read. After the ranging frame offset apart from the end of its listening interval as this field, the MSS shall awaken to receive UL-MAP containing a grant of bandwidth to it, and execute a periodic ranging operation.

[Modify the paragraph of 6.4.17.1 in Page 35, Line 22 as follows]

6.4.17.1 Introduction

Sleep-mode is a mode in which MSSs supporting mobility may power down, scan neighbor BSs, range neighbor BSs, conduct hand-over/network re-entry, or perform other activities for which the MSS will be unavailable to the Serving BS for DL or UL traffic. Sleep-mode is intended to enable mobility-supporting MSSs to minimize their power usage and to facilitate hand-over decision and operation while staying connected to the network. Implementation of sleep-mode is optional.

An MSS in sleep-mode shall engage in a sleep-interval, defined as a time duration, measured in whole frames, where the MSS is in sleep-mode. The sleep-interval is constructed of one or more variable-length, consecutive sleep-windows, with interleaved listening-windows, through one or more sleep-window-iterations. During a sleep-window, an MSS does not send or receive PDUs; ~~has no obligation to listen to DL traffic and~~ may powerdown one or more physical operation components, or may awaken for periodic ranging. During a listening-interval, an MSS shall synchronize with the Serving BS downlink and listen for appropriate MOB_TRF-IND traffic indication message. The MSS shall decide whether to stay awake or go back to sleep based on the value of its own 2-bit indicator in the SLPID bit-map in a positive MOB_TRF-IND from the Serving BS. During consecutive sleep-windows and listening-windows, comprising a single sleep-interval, sleep-window shall be updated using the algorithm as defined in 6.4.17.2 Sleep-window update algorithm.

An MSS shall awaken, enter into an interleaved listening-window according to the sleep-interval, and check whether there were PDUs addressed for it and Periodic Ranging opportunity within the next sleep interval. The listening-window parameter defines the maximum number of whole frames the MSS shall remain awake waiting for an MOB_TRF-IND message. Traffic indication message (MOB_TRF-IND) shall be sent by the BS on the broadcast CID during each appropriate MSS listening window. ~~If the number of positive indications is zero there is no MSS to be scheduled for receiving its PDUs such as DL traffic or executing periodic ranging during the next sleep window,~~ the BS sends an empty indication message, that is, MOB_TRF-IND message with 'Byte of SLPID bit-map' num-positive=0. The BS may buffer (or it may drop) incoming PDUs addressed to the sleeping MSS and shall send notification to the MSS in its listening-window about whether ~~data has been addressed, there are PDUs or periodic ranging opportunity~~ addressed for it during an preceding interval. If PDUs exist ~~If such PDUs exist~~, or if the listening interval has passed but the MSS didn't receive any TRF-IND message, the MSS shall remain awake, terminating the sleep-interval and re-entering Normal Operation.

If MSS finds that there will be a periodic ranging opportunity within next sleep window, then, it may return to sleep mode until the start of periodic ranging operation apart from the end of the negotiated listening interval as its own Ranging Frame Offset, and

it shall awaken to decode the UL-MAP for periodic ranging opportunity. Upon completion of Periodic ranging operation, it may return to sleep mode if not passed the sleep interval or remain in awake mode based on its two-bit indicator in the SLPID bit-map.

An MSS may terminate sleep-mode and return to Normal Operation anytime (i.e. there is no need to wait until the sleep-interval is over). If a Serving BS receives a PDU from an MSS that is supposed to be in sleep mode, the BS shall assume that the MSS is no longer in sleep-mode. Any UL message from the MSS to the Serving BS shall interrupt the sleep-interval, shall signal the Serving BS that the MSS is still active and connected and has not dropped connection during its sleep-interval.