Project	**IEEE 802.16 Broadband Wireless Access Working Group <http://ieee802.org/16>**
Title	**Complementing Idle Mode Handover Operations**
Date Submitted	**2004-06-07**
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Complementing Idle Mode Handover Operations

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1. Problem Statement

Idle Mode specified in IEEE 802.16e/D2 may have problems that arise from the following two facts:

(1) The action that BS Broadcast Paging (MOB_PAG-ADV) message indicates does not agree with the action that Paging-announce backbone message.

The message used for paging, MOB_PAG-ADV, includes four paging action instructions to MSS such as “perform ranging to establish location and acknowledge message” and “enter network”. However, Paging-announce, a backbone message used for exchanging information of MSSs in Idle Mode, has a list of only MSSs that need paging. Therefore, a BS receiving a paging-announce message from another BS cannot decide whether the MSSs in the paging-announce message should re-enter, perform ranging, or staying in Idle Mode. For example, when an MSS exits Idle Mode, it is necessary for every BS in the current paging group to delete the MSS’s MAC address from its paging list, which is impossible with the current Paging-announce message.

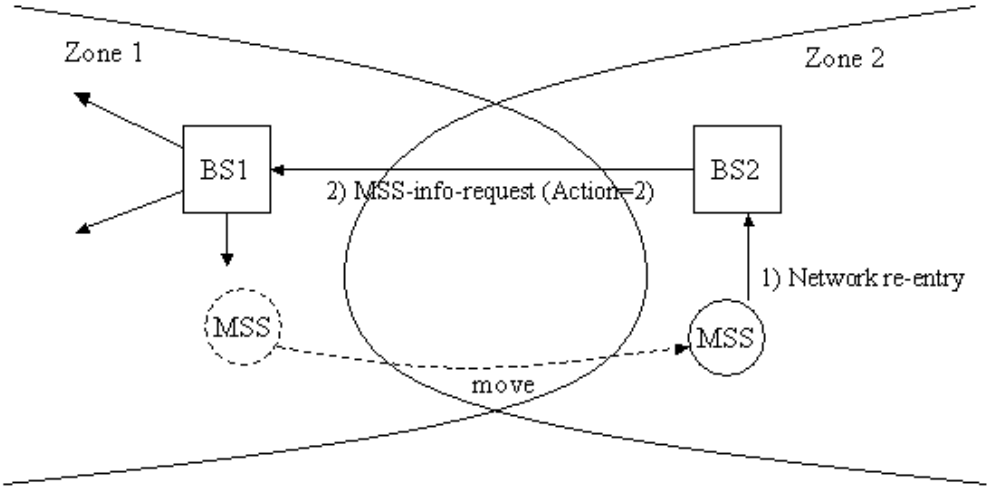

Fig. 1. Procedures for network re-entry when an MSS moves outside the current paging zone

(2) When an MSS tries to re-enter a network after passing over the coverage region of the initial paging group, the BS through which the MSS performs network re-entry cannot be informed of the initial BS that allows the MSS to enter Idle Mode. (See fig. 1.)

In this situation, the BS at which the MSS enters the network (BS2) cannot transmit MSS-info-request message to the BS that initiates the paging (BS1) because BS2 is not able to decide which zone the MSS comes from. It means that the BSs of the previous paging group, even if the MSS is not in their coverage region, should page the MSS’s MAC address every paging cycle in vain.

(When an MSS attempts to re-enter network due to lost of synchronization with the periodic paging within the same paging group, the current BS can be informed the fact because it has MAC address of the MSS in its paging list.)

In this contribution, we suggest to complement the operations of Idle Mode by simple modifications to existing messages such as Paging-announce (see Proposed Remedy 1-1), MOB_PAG-ADV (see Proposed Remedy 1-2), and TLV encoding of RNG_REQ (see Proposed Remedy 1-3).

2. Proposed Remedy

Remedy 1:

1-1. Paging-announce message

The BSs in a paging group should share the information of MSSs in Idle Mode. If a new MSS enters Idle Mode from a paging group, every BS in the paging group should be able to know the fact. It is applied to the cases similarly, if it is needed to page an MSS or make it perform ranging. Therefore, the Paging-announce message can be modified as follows.

All BSs belonging to the same paging group have already been informed of PAGING_CYCLE and PAGING_GROUP when the paging group is defined by Paging-group-action backbone message. Because every BS in the same paging group shall use the same value of PAGING_CYCLE and PAGING_OFFSET, these values may not be included in Paging-announce message.

We have considered the cases when either Sender-BS or Target-BS has multiple Paging Group IDs and both BSs have multiple Paging Group IDs. If the Target-BS has a single Paging Group ID, the Target-BS need not care the Paging Group ID because it can be sure that the MSS whose MAC address in included in Paging-announce message should be added to its own paging list. If the Sender-BS has only a Paging Group ID, even if the Target-BS has multiple Paging Group IDs, the MSS is in the paging group of the Sender-BS. If both BSs have multiple BSs, the Target-BS can arbitrate the Paging Group IDs it has. (It cannot be sure the direction of the MSS, e.g. toward a Target BS of paging group 1 or a Target BS of paging group 2, and so on.) However, for the case of using ASA, we have added 8-bit field of Paging Group ID to paging announce message shown in the next page.

Proposed text change:

6.3.21.1 MSS Idle Mode Initiation

Idle Mode Initiation may begin after MSS de-registration. During Normal Operation with its Serving BS, an MSS may signal intent to begin Idle Mode by sending a DREG-REQ with a De-registration_Request_Code =0x01; request for MSS de-registration from Serving BS and initiation of MSS Idle Mode. Similarly, a Serving BS may signal for an MSS to begin Idle Mode by sending a DREG-CMD with an Action Code = 0x05; require MSS de-registration from Serving BS and request initiation of MSS Idle Mode. At the same time as the initiation of MSS Idle Mode, the Serving BS shall transmit Paging-announce backbone message to all BSs belonging to the same paging group in order to inform that the MAC address of the MSS should be included in paging list.

D.2.9 Paging-announce message

This message is sent from BS to BS (or the ASA server) to announce that the recipient BS should page the provided list of MSS, according to their PAGING CYCLE and PAGING OFFSET. This message should be exchanged between BSs belonging to the same paging group, and be used to instruct a target BS to add/remove an MSS to/from its paging list or to page an MSS in accordance with the Action Code this message includes, e.g., perform paging or enter network.

The message contains the following information:

Proposed message change:

Field	Size	Notes
Message Type=?	8-bit	
Sender BS-ID	48-bit	Base station unique identifier (Same number as that broadcasted on the DL-MAP message)
Target BS-ID	48-bit	Set to 0xffffff to indicate broadcast
Time Stamp	32-bit	Number of milliseconds since midnight GMT (set to 0xffffff to ignore)
Num MSS	8-bit	Number of MSSs to page according to their Action Code
For (j=0; j<Num NSS; j++){		
MSS MAC address	48-bit	
Paging Group ID	8-bit	The identifier of the paging group to which the MSS belong
~~PAGING_CYCLE~~	~~16-bit~~	~~MSS PAGING CYCLE parameter~~
~~PAGING_OFFSET~~	~~8-bit~~	~~MSS PAGING OFFSET parameter~~
Action Code	3-bit	0=Add the MSS MAC address to paging list 1=Remove MSS MAC address from paging list 2=MSS should be paged to perform ranging to establish location and acknowledgement message 3=MSS should be paged to enter network 4-7= Reserved
Reserved	5-bit	
}		
Security field	TBD	
CRC field	32-bit	

1-2. MOB_PAG-ADV message

During Idle Mode, an MSS can be sure that it may stay in Idle Mode only if it can receive MOB_PAG-ADV message including the same Paging Group ID every PAGING CYCLE. Therefore, the MOB_PAG-ADV message may not need the MAC Address Hash of an MSS that needs not enter network or perform ranging. This modification can decrease the number of bytes of the message to be broadcasted over wireless channels. The MOB_PAG-ADV message can be modified as follows.

Proposed message change:

Table 92k – BS Broadcast Paging (MOB_PAG-ADV) message format

Syntax	Size	Notes
MOB_PAG-ADV_Message_Format( ) {		
Management Message Type=??	8 bits	
Num_Paging Group IDs	8 bits	Number of Paging Group IDs in this message
For (i=0; I<Num_Paging_Group_Ids; i++){		
Paging Group ID	8 bits	
}		
For (j=0; j<Num_MACs; j++) {		Number of MSS MAC Addresses in message can be determined from the length of the message (found in the generic MAC header).
MSS MAC Address hash	24 bits	The hash is obtained by computing a CRC24 on the MSS 48-bit MAC address. The polynomial for the calculation is 0x864CFB
Action Code	2 bits	Paging action instruction to MSS ~~00=No Action Required~~ 00=Enter Network 01=Perform Ranging to establish location and acknowledge message ~~10=Enter Network~~ 10-11=reserved
Reserved	6 bits	
}		
}		

Proposed text change:

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Action Code

Paging action instruction to MSS to perform the following action:
~~00=No Action Required~~
00=Enter Network
01=Perform Ranging to establish location and acknowledge message
~~10=Enter Network~~
10-11=reserved

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6.3.21.7 BS Broadcast Paging message

The BS Broadcast Paging message shall also include an Action Code directing each MSS notified via the inclusions of its MSS MAC Address hash to either:

~~00=No Action Required~~

00=Enter Network

01=Perform Ranging to establish location and acknowledge message

~~10=Enter Network~~

10-11=reserved

1-3. TLV Encoding of RNG_REQ message

When an MSS moves outside the region of the paging group, the BS at which the MSS re-enter the network should be informed the identifier of the BS that initiated the paging in order to deliver MSS-info-request backbone message. Without it, the BS at which the MSS re-enter the network cannot decide where MSS-info-request message should be transmitted. For this purpose, TLV encoding of RNG_REQ may be modified as follows. (In last Session, there was a comment that Serving BS ID shall be used for this purpose, which was rejected because of Serving BS ID AGINGTIMER.)

Proposed message change:

Table 318a – RNG-REQ Message Encodings

Name	Type (1byte)	Length	Value (Variable-length)
Serving BS ID	4	6	The unique identifier of the former Serving BS
Basic CID	6	2	Basic CID allocated from the former Serving BS
Initiating BS ID	?	6	The unique identifier of the BS initiating the paging

Proposed text change:

6.3.2.3.5 Ranging Request (RNG_REQ) message

Serving BS ID

The BS ID of the BS to which the MSS is currently connected (has completed the registration cycle and is in The BS ID of the BS to which the MSS is currently connected (has completed the registration cycle and is in AGINGTIMER, see Table 264a). Inclusion of Serving BS ID in the RNG-REQ message signals to the Target BS that the MSS is currently connected to the network through the serving BS and is performing association or is in the process of either hand-over or network re-entry.

The following parameter shall be included in the RNG-REQ message when the MSS is attempting to perform re-entry after terminating Idle Mode.

(Idle Mode) Initiating BS ID

The BS ID of the BS that allowed the MSS to enter Idle Mode. Inclusion of Initiating BS ID in the RNG-REQ message signals to the current BS where the MSS performs re-entry that MSS-info-request message shall be sent to the Initiating BS ID.