Project	**IEEE 802.16 Broadband Wireless Access Working Group <http://ieee802.org/16>**	
Title	**SS Paging**	
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Re:	Response to IEEE 802.16e-4/06 (Call for Contributions on IEEE 802.16e/D1)	
Abstract	SS Paging	
Purpose	Provide for a mechanism for SS to be detached from active Normal Operation service with a BS, but available to periodic broadcast messaging to prompt SS to return to Normal Operation service	
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SS Paging

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Problem:
The current mobility model for 16e, in common with contemporary IP networks, requires constant Normal Operation connectivity, persistent connection, of an MSS to Serving BS as the MSS traverses the RF geography. Even 'Sleep Mode', during portions of which the MSS has no DL listening/response requirements, is a 'Normal Operation' operational state requiring that the MSS be currently attached to a specific Serving BS with which the MSS has a negotiated 'Sleep Mode' operation. Given that the vast majority of devices in current mobile networks are typically inactive while attached to the mobile network, requiring these inactive MSS to conduct active HO transactions creates non-productive overhead. Eliminating non-productive HO traffic would likely result in a 90%+ reduction in all HO traffic, and a significant savings in total overhead.

Remedy:
Borrowing 'Area Paging' or 'Zone Paging' concepts and mechanisms from the cellular world provides a ready solution mechanism to enable MSS periodic 'availability' to DL traffic 'tickler' messages without requiring active UL connectivity to specific BS. The lack of transmission synchronization among BS creates some difficulty in crafting a solution. But options exist to overcome this obstacle.

It is possible to extend 'Sleep Mode' to accomplish our paging goals. It initially seems a ready choice given its already defined function as a negotiated MSS 'unavailable' mode of operation with a constructed method of MSS active recovery. However, due to the fact that 'Sleep Mode' has negotiated intervals of DL 'unavailability' interleaved with intervals of DL 'listening' and that these negotiated intervals are negotiated specific to a certain Serving BS, MSS and BS would have a difficult time negotiating and coordinating intervals between an MSS and several BS, especially given the lack of BS transmission synchronization.

Another, simpler mechanism presents itself. By creating a new 'Paging Availability Mode' that operates as a network pre-reentry state we can more easily provide a solution. And we can leave 'Sleep Mode' alone. 'Paging Availability Mode' would operate outside Normal Operations, pre-Initial Ranging in the registration process. 'Paging Availability Mode' would be passive only; any MSS UL traffic would discontinue the mode, though the MSS might immediately return to 'Paging Availability Mode'. 'Paging Availability Mode' would use fixed, not negotiated Paging Broadcast Message Listening Intervals. With these intervals being consistently located within the frame timing of individual BS, coordination between BS and synchronous Paging Broadcast Messages would be unnecessary. Overall, a properly constructed solution mechanism should reduce non-productive overhead while minimizing multimedia session initiation latency. And of course accomplish this with a minimum of new constructs and mechanisms.

Remedy 1:
*[Add new section for **1.4.1.2 MAC layer HO procedures**, page 7, line 57]:*
1.4.1.2.5 MSS Paging Availability Mode

Paging Availability Mode is intended as a mechanism to allow MSS to become periodically available for DL broadcast traffic messaging without requiring the MSS establish a UL traffic relationship with each BS as the MSS traverses an air link environment populated by multiple BS, typically over a distributed geography.

Paging Availability Mode benefits MSS by removing the active requirement for HO, and all Normal Operation requirements. By restricting MSS activity to scanning at discrete intervals, Paging Availability Mode allows the MSS to conserve power and operational resources.

Paging Availability Mode benefits the network and BS by providing a simple and timely method for alerting the MSS to pending DL traffic directed toward the MSS, and by eliminating air interface and network HO traffic from essentially inactive MSS.

Paging Availability Mode is an optional mode.

Paging Availability Mode is comprised of the following activities/stages:

1.4.1.2.5.1 MSS Paging Availability Mode Initiation

Paging Availability Mode Initiation may begin after MSS de-registration. During Normal Operation with its Serving BS, an MSS may signal intent to begin Paging Availability 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 Paging Availability Mode. Similarly, a Serving BS may signal for an MSS to begin Paging Availability Mode by sending a DREG-CMD with an Action Code = 0x05; require MSS de-registration from Serving BS and request initiation of MSS Paging Availability Mode.

1.4.1.2.5.1 Cell Selection

At MSS Paging Availability Mode Initiation, an MSS may engage in Cell Selection to obtain a new Preferred BS. A Preferred BS is a Neighbor BS that the MSS evaluates and selects as the BS with the best air interface DL properties. An MSS previous Serving BS may be the Preferred BS. In all other respects, Cell Selection is similar to **1.4.1.2.2.1 Cell Selection**.

1.4.1.2.5.2 MSS Broadcast Paging Message time synchronization

At evaluation and selection of the Preferred BS, the MSS shall synchronize and decode the DCD and DL-MAP for the Preferred BS, extracting the frame size and frame number. The MSS shall evaluate the frame size and frame number and use them to determine time until next regular BS Broadcast Paging message Transmission Interval for the Preferred BS. The calculated time until the next regular BS Broadcast Paging message Transmission Interval, less any MSS DL scanning, decoding, and synchronization time requirements, shall be the MSS Paging Unavailable Interval.

1.4.1.2.5.3 MSS Paging Unavailable Interval

During MSS Paging Unavailable Interval, the MSS may power down, scan Neighbor BSs, re-select a Preferred BS, conduct ranging, or perform other activities for which the MSS will not guarantee availability to any BS for DL traffic. Should the MSS re-select a Preferred BS during the MSS Paging Unavailable Interval, then the MSS shall return to the MSS Broadcast Paging Message time synchronization stage.

1.4.1.2.5.4 MSS Paging Listening Interval

The MSS shall scan, decode the DCD and DL-MAP, and synchronize on the DL for the Preferred BS in time for the MSS to begin decoding any BS Broadcast Paging message during the entire BS Broadcast Paging

message Transmission Interval. At the end of MSS Paging Listening Interval, providing that the MSS does not elect to terminate the MSS Paging Availability Mode, the MSS may return to MSS Paging Unavailable Interval.

1.4.1.2.5.5 BS Broadcast Paging message Transmission Interval

A BS Broadcast Paging message Transmission Interval shall occur on each 0x005 through 0x010 numbered frames on each BS. Only the last three digits of frame number shall be evaluated for purposes of determining a Transmission Interval. A BS may broadcast one or more BS Broadcast Paging messages during the six frame duration of a BS Broadcast Paging message Transmission Interval. Different BS may, but need not synchronize their Transmission Intervals.

1.4.1.2.5.6 BS Broadcast Paging message

A BS Broadcast Paging message is an MSS notification message indicating the presence of DL traffic pending, through the BS or some network entity, for the specified MSS. The BS Broadcast Paging message shall be sent on the Broadcast CID during the BS Broadcast Paging message Transmission Interval. If a BS has no Paging messages pending for any MSS, then the BS need not make any BS Broadcast Paging message during the Transmission Interval.

MSS are identified in the BS Broadcast Paging message by their MAC Address. A single BS Broadcast Paging message may include multiple MAC Addresses.

The BS Broadcast Paging message shall also include a RAN Segment ID (Radio Access Network Logical Segment ID). The RAN Segment ID is a logical affiliation ID, common amongst one or more BS typically that provide radio link service in a common geography. RAN Segment ID shall be programmable into the BS. RAN Segment ID may be used by an MSS to validate continued presence in a RAN Segment common to the RAN Segment of the MSS's last Serving BS, when the MSS last had UL traffic to a BS and the network, thus establishing a last attachment presence that the Serving BS and network were aware of.

1.4.1.2.5.7 Paging Availability Mode Termination

An MSS may terminate MSS Paging Availability Mode at any time. An MSS shall terminate Paging Availability Mode if it decodes a BS Broadcast Paging message that either contains the MSS MAC Address or contains a RAN Segment ID different than the RAN Segment ID decoded from its last Serving BS. An MSS terminates MSS Paging Availability Mode by completing a network re-entry and beginning Normal Operation with a new Serving BS.

Remedy 2:
*[Modify **6.4.2.3.?? SS De-registration Request (DREG-REQ) message**, contribution item to **6.4.2.3 MAC Management Message**, page 60, line 33]:*

Table *nn*—De-registration Request (DREG-REQ) message format

Syntax	Size	Notes
DREG-REQ_Message_Format() {		
Management Message Type=??	8 bits	
De-registration_Request_Code	8 bits	0x00 = SS de-registration request from BS and network 0x01 = request for MSS de-

		registration from Serving BS and initiation of MSS Paging Availability Mode ~~0x01~~0x02-0xFF = reserved
TLV encoded parameters	Variable	
}		

An SS shall generate SS DREG-REQs including the following parameters:

De-registration_Request_Code

Request code identifying the type of de-registration request:

0x00 = SS de-registration request for de-registration from BS

0x01 = request for MSS de-registration from Serving BS and initiation of MSS Paging Availability Mode

~~0x01~~ 0x02 – 0xFF = reserved

The DREG-REQ shall include the following parameters encoded as TLV tuples:

HMAC Tuple (see 11.1.2)

The HMAC Tuple shall be the last attribute in the message.

Remedy 3:
*[Modify **6.4.2.3.26 De/Re-register Command (DREG-CMD) message**, **Table 55—Action Codes and actions**, page 93, lines 12-28]:*

Table 55—Action Codes and actions

Action Code	Action
0x00	SS shall leave the current channel and attempt to access another channel
0x01	SS shall listen to the current channel but shall not transmit until an RES-CMD message or DREG_CMD with Action Code 0x00 is received.
0x02	SS shall listen to the current channel but only transmit on the Basic, Primary Management, and Secondary Management Connections.
0x03	SS shall return to normal operation and may transmit on any of its active connections.
0x04	SS shall terminate current Normal Operations with the BS; the BS shall transmit this action code only in response to any SS DREG-REQ
0x05	require MSS de-registration from Serving BS and request initiation of MSS Paging Availability Mode
~~0x05~~ 0x06 – 0xFF	Reserved

Remedy 4:

*[Add MAC Management message to **6.4.2.3 MAC Management messages**, page 18, line 1; editor will make appropriate allocation of numbering for subsection and Management Message Type, set appropriate Table number nn, and adjust referenced Table 14a to include new Management Message Type reference]:*

6.4.2.3.?? BS Broadcast Paging (MOB_PAG-ADV) message

The MOB_PAG-ADV message shall be sent on the Broadcast CID during the BS Broadcast Paging message Transmission Interval. If a BS has no Paging messages pending for any MSS, then the BS need not make any MOB_PAG-ADV message during the Transmission Interval.

The MAC Management Message Type for this message is given in Table 14a. The format of the message is shown in Table *nn*.

Table *nn*—BS Broadcast Paging (MOB_PAG-ADV) message format

Syntax	Size	Notes
MOB_PAG-ADV_Message_Format() {		
Management Message Type=??	8 bits	
RAN Segment ID	8 bits	
For (i=0 ; i<Num_MACs; i++) {		Number of MSS MAC Addresses in message can be determined from the length of the message (found in the generic MAC header).
MAC Address	48 bits	
}		
}		

A BS shall generate MOB_PAG-ADV including the following parameters:

RAN Segment ID

The RAN Segment ID is a logical affiliation ID, common amongst one or more BS typically that provide radio link service in a common geography

MAC Address

MAC Address for MSS to be notified through Paging Availability notification mechanism