Project	**IEEE 802.16 Broadband Wireless Access Working Group <http://ieee802.org/16>**
Title	**BS's Proxy ARPing for Sleep or Idle Mode MSSs**
Date Submitted	**2004-06-25**

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Re:	Response to Recirculation Ballot #14b
Abstract	MSS's IP address delivery to BS and BS's proxy ARPing for MSSs.
Purpose	Adoption of proposed changes into P802.16e

BS's Proxy ARPing for Sleep & Idle Mode MSSs

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1. Problem Statement

The process of determining which link-layer address corresponds to a given IP address is called address resolution. The most common method for accomplishing this in the Internet is called *Address Resolution Protocol (**ARP**)*[RFC826]. ARP defines the target as the node whose link-layer address is sought and the sender as the node which seeks this information. Briefly, ARP works as follows.

1. The sender sends an ARP Request message on the secondary management connection. The Target IP Address field within this message contains the IP address of the node whose link-layer address is sought.
2. Each node receiving the ARP Request compares the Target IP Address field with its own IP addresses. If the Target IP Address equals one of the node's own IP addresses, then the node sends an ARP Reply message to the original sender, specifying the node's link-layer address.

Expected operation of ARP in IEEE802.16 is illustrated as following.

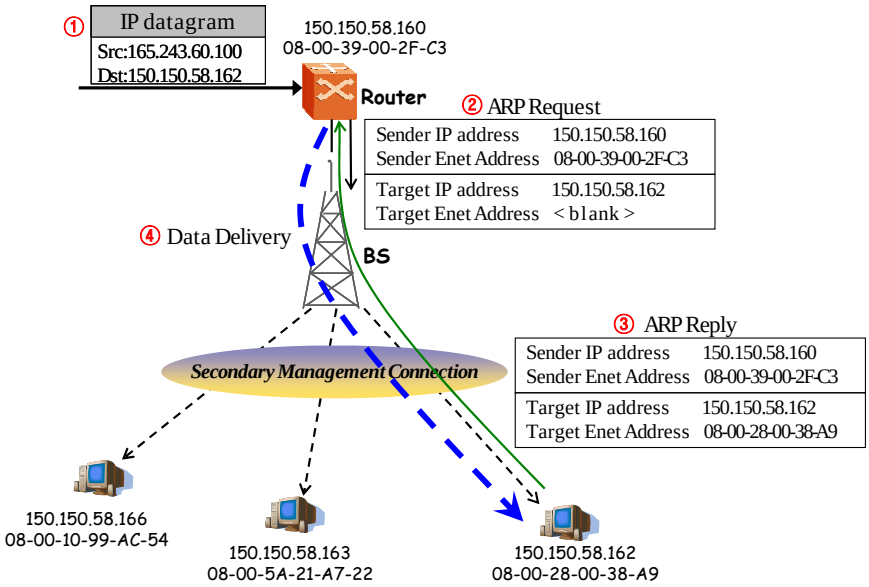

Figure 1. ARP & IP packet delivery

In case of sleep mode, the BS may buffer incoming PDUs addressed to the sleeping MSS and shall send notification to the MSS in its listening-window about whether data have been addressed for it during a preceding interval. If such PDUs exist, the MSS shall remain awake, terminating the sleep-interval and re-entering Normal operation. However, when IP packet delivered to the router and router sends ARP request to acquire link-layer address of IP packet's destination, ARP request can not be delivered to MSS

in sleep mode. Therefore, BS can not have incoming PDUs addressed to the sleeping MSS.

Similarly in idle mode, when IP packet delivered to the router and router sends ARP request to acquire link-layer address of IP packet's destination, ARP request can not be delivered to MSS in idle mode.

The following figure illustrates problems in sleep & idle mode.

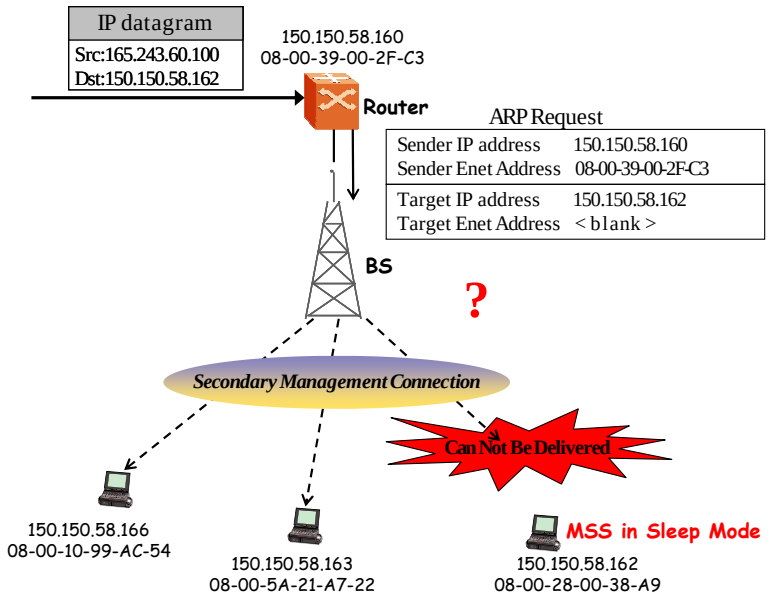

Figure 2. ARP Problem in Sleep Mode

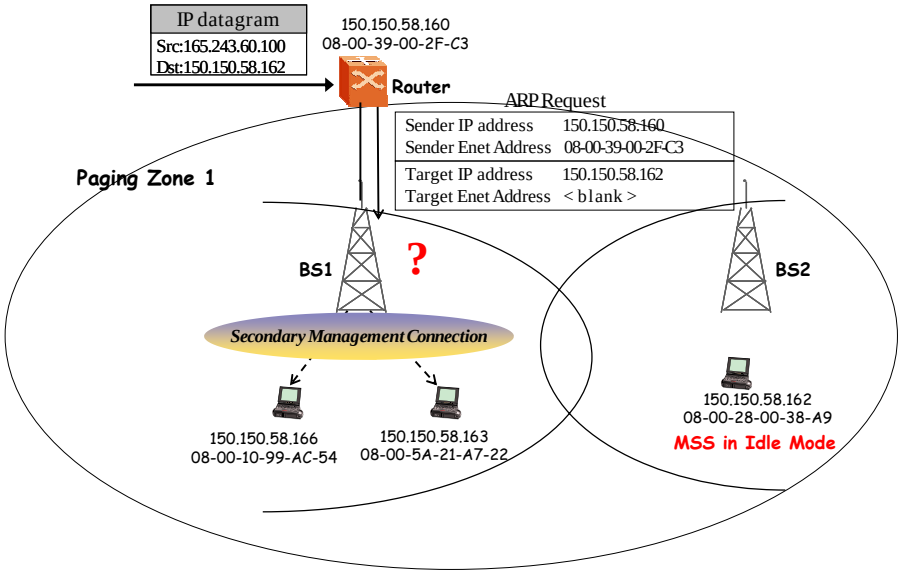

Figure 3. ARP Problem in Idle Mode

Therefore, in order for IP packet to be delivered to the BS, BS shall perform proxy ARP instead of MSSs in sleep and idle mode.

2. Overview of Proposed Solution

If an MSS wants to enter a Sleep Mode or Idle Mode, MSS should transmit its IP address to its BS. Because MSS can not reply for Router's ARP request, BS can reply for the ARP request on behalf of MSSs which are in Sleep Mode or Idle Mode.

Figure 4 shows how proxy ARP works in BS in case of Sleep Mode. After BS's proxy ARPing procedure, IP packet is delivered to the BS and BS buffers data and sends Traffic Indication (MOB-TRF-IND) with DL traffic indication to MSS during the MSS's listening-interval. Then the MSS turns into Normal Operation and receives PDUs.

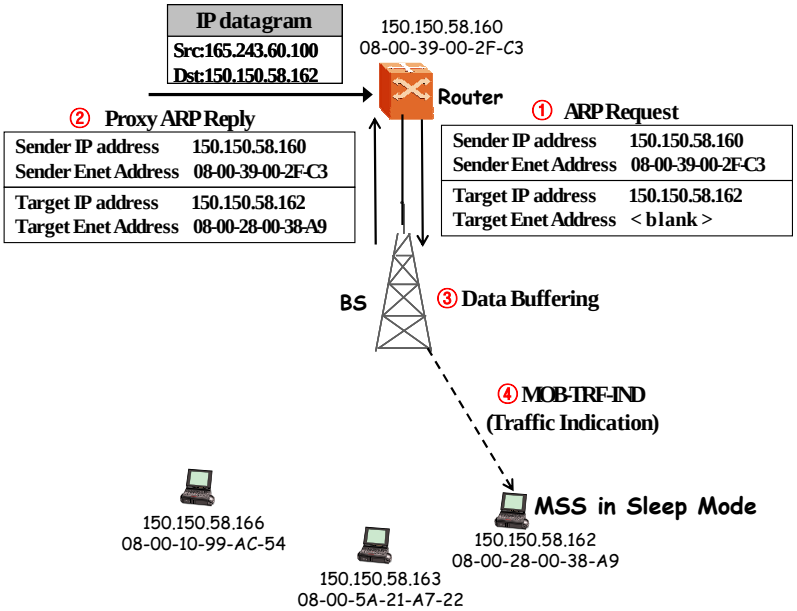

Figure 4. BS intercepts packets for MSSs in sleep mode by using Proxy ARP.

Figure 5 shows how proxy ARP works in BS in case of Idle Mode. After BS's proxy ARPing procedure, IP packet is delivered to the BS and BS buffers data and sends Paging message (MOB-PAG-ADV) indicating the presence of DL traffic pending. Then the MSS turns into Normal Operation and receives PDUs.

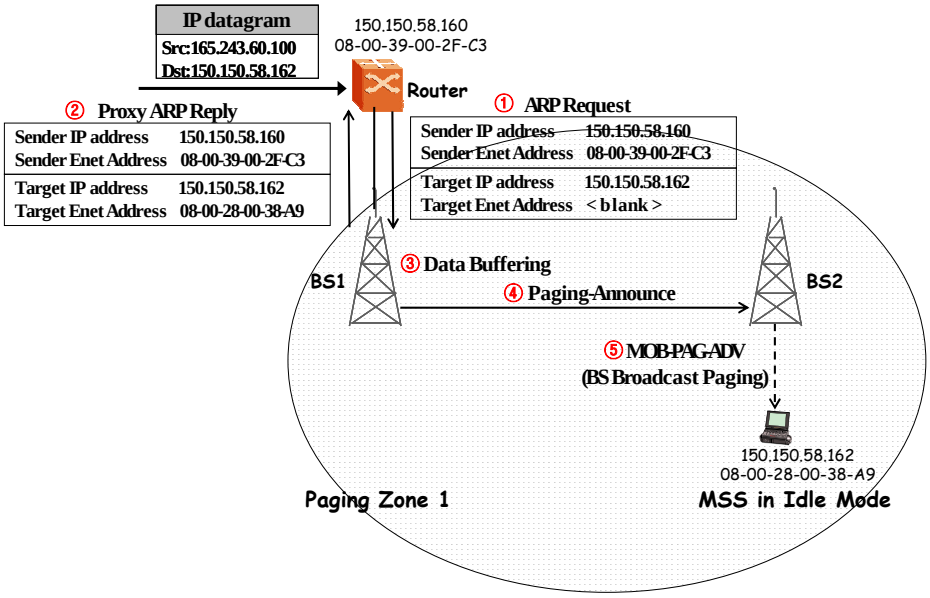

Figure 5. BS intercepts packets for MSSs in idle mode by using Proxy ARP.

3. Proposed Changes in Document

Remedy:

In order for IP packet directed to MSSs which are in Sleep or Idle mode to be delivered from a router to a BS, BS should reply with MSSs' Network Address (IP Address) and MAC address for router's ARP request on behalf of MSSs in Sleep or Idle Mode. For this, we add mechanism that MSS sends its Network Address to BS when it enters Sleep Mode or Idle Mode, and proper BS's action to react for router's link layer address resolution protocol. We also add one MAC management message to deliver MSS's Network Address for BS initiated Sleep Mode or Idle Mode.

Remedy1:

Add language for proxy ARPing of BS to Sleep-mode. An MSS shall include its Network Address when the MSS enters Sleep Mode. When an ARP request is received from the router, the BS sends ARP reply on behalf of the MSS.

[In 6.3.19 Sleep-mode for mobility-supporting MSS, page 38, lines 26-32, modify as]:

Before entering sleep-mode the MSS shall inform the BS using MOB-SLP-REQ and obtain its approval. The Serving BS shall respond with an MOB_SLP_RSP message. The MSS shall include its Network Address in MOB-SLP-REQ message. The Serving BS may send an unsolicited MOB-SLP-RSP to the MSS to initiate MSS sleep-mode. After receiving an MOB-SLP-RSP message from the BS, an MSS shall send Network Address in MOB-INFO message and enter sleep-mode by beginning sleep-interval at the

appropriate frame prescribed by start-frame.

When a BS receives link layer address resolution protocol messages, such as ARP (Address Resolution Protocol) [IETF RFC 826] from the router, the BS shall reply for the link layer address resolution protocol messages, which are destined to an MSS's Network Address in sleep mode with MSS's Network Address and MAC Address on behalf of the MSS.

Remedy2:

Add Network Address to Sleep-Request (MOB-SLP-REQ) message format.

[In 6.3.2.3.47 Sleep Request message, page 18, line 39, modify Table 92a –MOB-SLP-REQ Message Format]:

Syntax	Size	Notes
MOB_SLP_REQ_Message_Format() {		
Management Message Type=46	8 bits	
Initial-sleep window	6 bits	
Final-sleep window base	10 bits	
Listening interval	4 bits	
Final-sleep window exponent	3 bits	
Network Address	32 bits	MSS's current Network Address (IPv4 Address)
Reserved	1 bit	
}		

Parameters shall be as follows:

Initial-sleep window

Requested start value for the sleep interval (measured in frames).

Final-sleep window base

Requested final value for the sleep interval (measured in frames).

Listening interval

Requested listening interval (measured in frames) to the MOB-SLP-REQ.

Final-sleep window exponent

Defines the factor by which the final-sleep window base is multiplied in order to calculate the final-sleep window. The following formula is used:

final-sleep window = final-sleep window base*$2^{(\text{final-sleep window exponent})}$

Network Address

MSS's current Network Address (IPv4 Address)

Remedy3:

An MSS shall include its Network Address when the MSS enters Idle Mode for BS's proxy ARPing.

[In 6.3.21.1 MSS Idle Mode Initiation, page 57, line 26 - page 58, line3, modify as]:

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. The MSS shall include Network Address TLV in DREG-REQ message. 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. Upon reception of unsolicited DREG-CMD with an Action Code = 0x05, an MSS shall send Network Address in MOB-INFO message and enter Idle Mode.

Remedy4:

Add language for proxy ARPing of BS to MSS Idle Mode. When an ARP request is received from the router, the BS sends ARP reply on behalf of the MSS.

[New subsection 6.3.21.7 BS Link Layer Address Acquisition, page 57, after line 51, insert as]:

6.3.21.7 MSS's Link layer address resolution

When a BS receives link layer address resolution protocol messages, such as ARP (Address Resolution Protocol) [IETF RFC 826] from the router, the BS shall reply for the link layer address resolution protocol messages, which are destined to an MSS's Network Address in idle mode with MSS's Network Address and MAC Address on behalf of the MSS.

Remedy5:

Add Network Address TLV to DREG-REQ when De-Registration Request Code=0x01

[In 6.3.2.3.26 De/Re-register Command (DREG-CMD) message, page 16, line 24, add Network Address parameter as]:

The SS shall include the following parameters in the DREG-REQ only if De-Registration_Request_Code =0x01

Paging Cycle Request

PAGING_CYCLE requested by MSS

Network Address

Current Network Address of MSS

Remedy6:

Add Table of Network Address in DREG-CMD TLV.

[In 11.14 DREG-CMD message encodings, page 113, line 61, put subsection number and insert table as]:

11.14 DREG-CMD message encodings

11.14.1 Paging Cycle Request

Name	Type	Length	Value
Paging Cycle Request	?	2	Requested cycle in which the paging message is transmitted within the paging group.

11.14.2 Network Address

Name	Type	Length	Value
Network Address	?	4	MSS's current Network Address (IPv4 Address)

Remedy7:

Add MSS Information message language and Table.

[Insert 6.3.2.3.61 Mobile Information Message, page 31]:

An MSS shall transmit a MOB-INFO message to the BS when an MSS either enters sleep-mode upon reception of unsolicited sleep response message (MOB-SLP-RSP) or initiates Idle Mode upon reception of DREG-CMD with action code 0x05. The MOB-INFO message is sent from the MSS to the BS on the MSS's basic CID.

Table 92o – MOB-INFO Message Format

Syntax	Size	Notes
MOB-INFO message format() {		
Management Message Type=??	8 bits	
Network Address	32 bits	MSS's current Network Address (IPv4 Address)
}		