Project	**IEEE 802.16 Broadband Wireless Access Working Group <http://ieee802.org/16>**
Title	Fast MSS-BS Data Flow Coordination for FBSS Support
Date Submitted	**2004-11-04**

Source(s)	Hang Zhang, Bill Gage, Shalini Periyalwar, Mo-Han Fong	mhfong@nortelnetworks.com
	Nortel Networks	Tel: +1 613 765-8983
		Fax: +1 613 765-6717

Re:	IEEE P802.16e/D5-2004
Abstract	A fast signalling mechanism is introduced to identify the next information unit to be transmitted by a new anchor BS while the MSS is in FBSS handoff
Purpose	Review and Adopt the suggested changes into P802.16e/D5
Notice	This document has been prepared to assist IEEE 802.16. It is offered as a basis for discussion and is not binding on the contributing individual(s) or organization(s). The material in this document is subject to change in form and content after further study. The contributor(s) reserve(s) the right to add, amend or withdraw material contained herein.
Release	The contributor grants a free, irrevocable license to the IEEE to incorporate material contained in this contribution, and any modifications thereof, in the creation of an IEEE Standards publication; to copyright in the IEEE's name any IEEE Standards publication even though it may include portions of this contribution; and at the IEEE's sole discretion to permit others to reproduce in whole or in part the resulting IEEE Standards publication. The contributor also acknowledges and accepts that this contribution may be made public by IEEE 802.16.
Patent Policy and Procedures	The contributor is familiar with the IEEE 802.16 Patent Policy and Procedures <http://ieee802.org/16/ipr/patents/policy.html>, including the statement "IEEE standards may include the known use of patent(s), including patent applications, provided the IEEE receives assurance from the patent holder or applicant with respect to patents essential for compliance with both mandatory and optional portions of the standard." Early disclosure to the Working Group of patent information that might be relevant to the standard is essential to reduce the possibility for delays in the development process and increase the likelihood that the draft publication will be approved for publication. Please notify the Chair <mailto:chair@wirelessman.org> as early as possible, in written or electronic form, if patented technology (or technology under patent application) might be incorporated into a draft standard being developed within the IEEE 802.16 Working Group. The Chair will disclose this notification via the IEEE 802.16 web site <http://ieee802.org/16/ipr/patents/notices>.

1 Problem Statement

When an MSS is in FBSS HO, the MSS triggers a switch to a new anchor BS by sending a codeword on its CQICH indicating the TEMP_BS_ID corresponding to the new anchor BS. After the switch, a mechanism is required for the new anchor BS to identify the next information unit to continue transmissions to the MSS. In the current p802.16e/D5 text, in order for the new anchor BS to identify the next information unit to transmit, the old anchor BS needs to communicate with the new anchor BS to relay such information. This backhaul communication will incur unnecessary latency in data transmission during FBSS.

2 Proposed Solution

This contribution proposes a MSS-assisted procedure to facilitate continuity of the data transmission when an MSS in FBSS HO moves to a new anchor BS. The proposed procedure removes the need and the associated latency of transferring data flow continuity information between the old and the new anchor BSs.

The proposed solution is summarized below:

- Depending on whether the connection is ARQ based or non-ARQ, the identity of the next information unit can be identified by the ARQ block sequence number currently defined in p802.16e/D5 or by a virtual MAC SDU sequence number respectively.
- During FBSS operation, the MSS provides the new Anchor BS with either the ARQ block sequence number or the MAC SDU sequence number for the selected connections.
- In the case of ARQ connections, the last ARQ block sequence number is already available at the MSS. For non-ARQ connections, the anchor BS maintains a virtual MAC SDU sequence number. The BS provides the MAC SDU sequence number to the MS only when the Anchor BS switch indication is received on the CQICH since this information is redundant otherwise. The virtual MAC SDU sequence numbers of the selected non-ARQ connections are included in the Anchor_BS_Switch_IE sent to the MSS prior to the expiration of the Anchor switch timer.
- The support of sequence number feedback is optional and is communicated using the new capability TLV defined for REG-REQ/RSP messages. If the sequence number feedback capability is supported, the feedback can be optionally enabled for certain connections using the new TLV for DSA-REQ/RSP.
- At the expiration of the Anchor switch timer, the new anchor BS should assign UL resource for the MSS to transmit the sequence number(s) of ARQ block or MAC SDU. The MSS subsequently sends a new FBSS SN Request MAC header that includes the next ARQ Block (or MAC SDU) sequence number that it is expecting for each of its selected CIDs.
- The new anchor BS begins its communication with the MS with the requested ARQ block (or MAC SDU)
- In the process of transferring to the new anchor BS, the prior ARQ blocks (or MAC SDUs) pending retransmission are dealt with in the conventional manner, once the new anchor BS connection is established.
- To reduce feedback overhead, only the sequence numbers (not the CIDs) of the selected connections is included in the FBSS SN Feedback header. Thus a MAC header can feedback the sequence number of up to three connections (those numbers are listed based on index or value of CIDs). The MSS can send up to two FBSS SN Feedback headers to provide up to 6

sequence numbers. The order of sending the sequence number shall be in ascending order of the CID values of those selected connection with sequence number feedback enabled.

- For uplink FBSS, the MSS transition between the old anchor BS and the new anchor BS will occur at the MAC SDU level if FBSS SN coordination is supported by the BSs.

3 Proposed Text Changes

[Add a new section 6.3.2.1.4]

6.3.2.1.4 FBSS SN Request Header

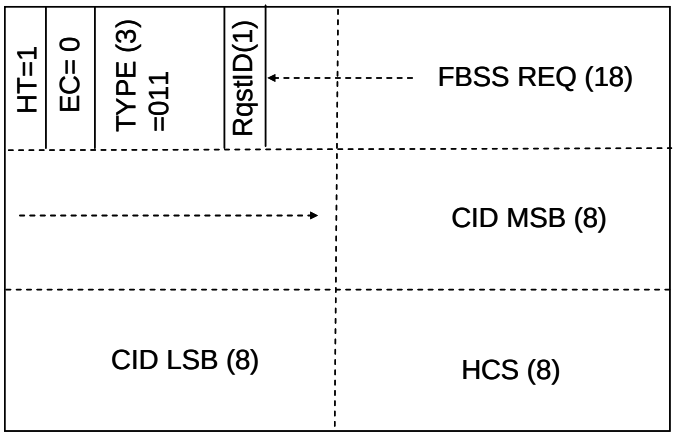

Figure 1: FBSS SN Request Header Format

The FBSS SN Request Header shall be of the form illustrated in Figure 1. The FBSS SN subheader shall have the following properties:
a) The length of the header shall always be 6 bytes
b) The EC field shall be set to 0, indicating no encryption
c) The CID shall indicate the basic connection for which the FBSS SN request is being made.
d) The FBSS REQ field shall indicate the LSB of the next ARQ BSN or the virtual MAC SDU Sequence number for the active connections. The LSB of the ARQ BSN or virtual MAC SDU sequence number for each connection is provided. At most 3 SNs can be provided in each FBSS SN Request Header in numerical ascending order of the CID values of the connections with sequence number feedback enabled.
e) The RqstID field may be used to indicate whether the FBSS SN header is the first or second of two consecutive FBSS SN headers, to accommodate up to 6 active connections. The fields of the FBSS SN Request header are defined in Table 1. Every header is encoded, starting with the HT and EC fields. The coding of these fields is such that the first byte of a MAC header shall never have the value of 0xFX. This prevents false detection of the stuff byte.

Table 1 – FBSS SN Request Header Fields

Name	Length (bits)	Description
FBSS REQ_1	6	FBSS SN Request. The ARQ BSN (LSB) or MAC SDU SN (LSB) for the first CID in this header. The order of reporting the SNs for the connections is predetermined as indicated in Section xxx
FBSS_REQ_2	6	The ARQ BSN (LSB) or MAC SDU SN (LSB) for the second CID in this header.
FBSS_REQ_3	6	The ARQ BSN (LSB) or MAC SDU SN (LSB) for the third CID in this header.
CID	16	Basic Connection Identifier
EC	1	Encryption Control. Always set to 0
HCS	8	Header Check Sequence
HT	1	Header Type = 1
Type	3	Set to 0b011. Indicates that it is a FBSS SN request header
RqstID	1	Set to 0 to indicate that this is the first FBSS SN request header. Set to 1 to indicate that this is a second FBSS SN request header with up to 3 additional connections reported

_[…]

[Modify section 6.3.20.2.6.2.1]

6.3.20.2.6.2.1 Fast Anchor BS Selection Feedback Mechanism

[…]

The current anchor BS may send the Anchor_Switch_IE prior to the expiry of the switching timer to do one of the following: 1) acknowledge the MSS' switch indication and/or assign a CQICH at the new Anchor BS (BS B), and/or specify a new action time when the switch shall occur, and/or specify a new anchor BS to switch to, and/or specify the virtual MAC SDU sequence number of the connections with MSS sequence number feedback enabled; 2) cancel the MSS switching event. If MSS sequence number feedback is enabled for one or more of the non-ARQ connections of the MSS, the BS shall send the Anchor_BS_Switch_IE prior to the expiration of the switching timer, to specify the virtual MAC SDU sequence number of the corresponding connections. If the MSS does not receive an Anchor_BS_switch_IE prior to the expiry of the switching timer, the MSS shall switch to the new Anchor BS after the expiry of the switching timer. If the MSS receives an Anchor_BS_Switch_IE prior to the expiry of the switching timer with no cancellation and no new action time specified, the MSS shall switch to the new Anchor BS after the expiry of the switching timer. If the MSS receives an Anchor_BS_Switch_IE prior to the expiry of the switching timer with new action time specified, the MSS shall switch to the new Anchor BS at the action time specified. If the MSS receives an Anchor_BS_Switch_IE with cancellation prior to the expiry of the switching timer, the MSS shall cancel the switching operation. If the MSS successfully decodes an Anchor_BS_Switch_IE, the MSS shall acknowledge the reception of the IE using the allocated codeword over the CQICH.

[…]

[Add a new section 6.3.20.2.6.2.2]

6.3.20.2.6.2.2 MSS-Assisted Coordination of transmission at New Anchor BS

Once the MSS has successfully switched to the new anchor BSS, to maintain continuity of transmission to the MSS between the old and new anchor BSs, the last successfully received information unit needs to be identified to the new anchor BS. Depending on whether the connection is ARQ based or non-ARQ, the identity of the next information unit can be given by the ARQ block sequence number or the MAC SDU sequence number respectively.

MSS can optionally support the feedback of ARQ block sequence number or the virtual MAC SDU sequence number after the MSS has successfully switched to the new anchor BS. The capability and the support for each connection are defined in the REQ-REQ/RSP and DSA-REQ/RSP TLVs respectively.

In the case of ARQ connections, the last ARQ block sequence number is already available at the MSS. For non-ARQ connections, the anchor BS maintains a virtual MAC SDU sequence number which is internal to the BS and not communicated over the air. The BS transmits the list of virtual MAC SDU sequence numbers to the MSS in the Anchor BS Switch_IE (Section 8.4.5.4.2.1) in numerical ascending order ot the CID values of the connections with sequence number feedback enabled.
At the expiration of the Anchor switch timer, the new anchor BS should assign UL resource for the MSS to transmit the LSB of the sequence number(s) of ARQ block or virtual MAC SDU on the FBSS SN Request MAC header (Section 6.3.2.1.4). The MSS subsequently sends up to two FBSS SN Request MAC headers that include the next ARQ Block (or virtual MAC SDU) sequence number that it is expecting for each of its connections that have sequence number feedback enabled. The MSS shall send the sequence number in numerical ascending order of the values of the CIDs values.
Once the handover to the new anchor BS has been completed, acknowledgement and/or retransmission of any outstanding ARQ blocks is handled in the conventional manner.

For the uplink FBSS procedure, the continuation of transmission of information units between the old anchor and the new anchor will be determined by the information shared during registration in the REG-RSP TLV encodings of the BS capability to process FBSS_SN Feedback. Based on the BS capability to support FBSS_SN feedback, the MSS switches to the new anchor BS only after the full MAC SDU has been transmitted. For those ARQ BSNs which are not ACKed by the old anchor BS, the MSS retransmits the respective MAC SDUs to the new anchor. The ARQ BSN in the FBSS SN Request Header refers to the BSN associated with (the start of) the next SDU to be sent by the MSS.

[…]

[Modify section 8.4.5.4.21]

8.4.5.4.21 Anchor_BS_Switch_IE

The Anchor_BS_switch_IE is sent by a BS to indicate to one or more MSS(s) to switch to a new specified Anchor BS at specific action time, or to cancel the switch. The Anchor_BS_switch_IE can also be used to allocate CQICH at the new Anchor BS.

Table 300i - Anchor_BS_switch_IE format

Syntax	Size	Notes
Anchor_BS switch_IE() {		
Extended DIUC	4 bits	AS = 0x07
Length	4 bits	Length of the message in bytes
N_Anchor_BS_switch	4 bits	Number of Anchor BS switching indicated in this IE
for (i = 0; i< N_Anchor_BS_switch; i++) {		
CID	16 bits	Basic CID of a MSS whose anchor BS switching is indicated in this IE
Action code	2 bits	00 – The MSS shall switch to the Anchor BS specified in the fast Anchor BS selection information in the FAST FEEDBACK channel, at the default time specified by the switching period defined in the DCD. 01 – The MSS shall switch to the Anchor BS specified in this IE and at the action time specified in this IE. 10 – The MSS shall cancel all anchor switching procedure, stop switching timer and remain on the current anchor BS; 11 – reserved
If (Action code == 01) {		
Action time (A)	3 bits	In units of frames. 000 means the MSS shall switch at the default time specified by the switching period defined in the DCD
TEMP_BS_ID	3 bits	TEMP_BS_ID of the anchor BS to switch to. (TEMP_BS_ID is the assigned ID to the BS when it was added to the active set of a MSS)
}		
If (Action code == 00 || Action code == 01)		

{		
CQICH Alloction Indicator	1 bit	To indicate if CQICH allocation at the new Anchor BS is included in this IE.
If (CQICH Allocation Indicator == 1) {		
CQICH_ID	Variable	Index to uniquely identify he CQICH resource assigned to the MSS after the MSS switched to the new anchor BS
Feedback channel offset	6 bits	Index to the fast feedback channel region of the new Anchor BS marked by UIUC=0
Period (=p)	2 bits	A CQI feedback is transmitted on the CQICH every 2^p frames.
Frame offset	3 bits	The SS starts reporting at the frame of which the number has the same 3 LSB as the specified frame offset. If the current frame is specified, the SS should start reporting in 8 frames
Duration (=d)	3 bits	A CQI feedback is transmitted on the CQI channels indexed by the CQICH_ID for 10 x 2^d frames. If d ==0, the CQI-CH is de-allocated. If d == 111, the SS should report until the BS command for the SS to stop.
MIMO_permutation_feedback_cycle	2 bits	00 = No MIMO and permutation mode feedback 01 = the MIMO and permutation mode indication shall be transmitted on the CQICH indexed by the CQICH_ID every 4 frames. The first indication is sent on the 8th CQICH frame. 10 = the MIMO mode and permultation mode indication shall be transmitted on the CQICH indexed by the CQICH_ID every 8 frames. The first indication is sent on the 8th

		CQICH frame. 11 = the MIMO mode and permultation mode indication shall be transmitted on the CQICH indexed by the CQICH_ID every 16 frames. The first indication is sent on the 16th CQICH frame.
}		
MAC SDU SN included	1 bit	1: MAC SDU sequence number is included in this IE 0: MAC SDU sequence number is not included in this IE
if (MAC SDU SN included == 1) {		
For (i=0; i<number of connections; i++){		Number of connections is the number of non-ARQ connections that have sequence number feedback enabled. It is known between the BS and the MSS after connection setup.
MAC SDU SN	6 bits	MAC SDU sequence number
}		
}		
}		
}		

[…]

[Add a new section 11.7.8.9]

11.7.8.9 FBSS_SN support

This field indicates whether or not the SS supports FBSS_SN_Feedback. A value of 0 indicates no support for FBSS_SN Feedback. A value of 1 indicates that the SS supports FBSS_SN Feedback.

Type	Length	Value	Scope
18	1	0 No FBSS_SN Feedback 1 Supports FBSS_SN Feedback (default)	REG_REQ REG_RSP

[Add a new section 11.13.20]

11.13.20 FBSS_SN Support

This field indicates whether or not the FBSS_SN_Feedback is enabled for the given connection. A value of 0 indicates that the FBSS_SN Feedback is not enabled. A value of 1 indicates that the FBSS_SN Feedback is enabled.

Type	Length	Value	Scope
[145/146].28	1	0 FBSS_SN Feedback not enabled 1 FBSS_SN Feedback enabled (default)	DSA_REQ DSA_RSP