Project	**IEEE 802.16 Broadband Wireless Access Working Group <http://ieee802.org/16>**
Title	**DL HARQ for non-transparent Relays**
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Re:	This is in response to the call for proposals 80216j-07_007.pdf

Abstract	This contribution proposes a procedure for handling retransmission of HARQ failure attempts in a relay system.

Purpose	Add proposed spec changes in P802.16j Baseline Document (IEEE 802.16j-06/026)

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>.

Downlink HARQ with Relay

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Specific text changes

Insert new sub-clause 6.3.17.5
6.3.17.5 DL HARQ support for Relay in centralized scheduling

MR-BS schedules an initial transmission of HARQ packet on all the links between MR-BS and MS. DL transmission failure on a relay link is indicated by an encoded ACK/NAK on the UL ACK Channel.

Burst allocations for DL HARQ retransmissions shall be signaled to the intermediate RSs on the N-hop path between a MR-BS and MS in the HARQ DL MAP IE defined in Section 8.4.5.3.21. It also schedules the bandwidth for relaying upstream ACK/NACK on the UL ACK channel for all the hops from MS to MR-BS.

If a packet fails at any of the intermediate RSs, the RS transmits code C_1 defined in the table xxx as a NAK back to the previous IS and transmits to the next hop station the pilot subcarriers and may transmit null data subcarriers. It shall not `reencode` the erroneous packet to `transmit` to the next hop station. Subsequently, the MR-BS may schedule a retransmission on the failed link as well as on all the subsequent links. The RS replaces the CID in the corresponding HARQ sub burst IE with its own basic CID.

~~MR-BS schedules an initial transmission of HARQ packet on all the links between MR-BS and MS. DL transmission failure on a relay link is indicated by an encoded ACK/NAK on the UL ACK Channel.~~

~~If a packet fails at any of the intermediate RSs, the MR-BS schedules a retransmission on the failed link as well as on all the subsequent links.~~

~~In an N-hop relaying path with centralized scheduling, the resource allocation for the data forwarding is assigned by MR-BS at the same time on a per-HARQ channel basis. All HARQ retransmissions shall be scheduled at the MR-BS. Burst allocations for DL HARQ retransmissions shall be signaled to the intermediate RSs on the N-hop path between the MR-BS and a destination MS in the HARQ DL MAP IE defined in Section~~

8.4.5.3.21. Burst allocations for UL HARQ retransmissions shall be signaled to the intermediate RSs on the N-hop path between a source MS and the MR-BS in the HARQ UL MAP IE defined in Section 8.4.5.4.24.

Each RS on the N-hop relaying path from MR-BS to MS or vice versa, on a per-HARQ channel basis, should:

- buffer all received HARQ packets until it receives the explicit ACK indication to it
- forward either correctly decoded packets from its predecessor to its successor, and apply the erroneous packet handling procedure if the decoded packet is incorrect
- re-transmit correctly decoded packets to the successor and report the status of retransmission arrangement to the MR-BS if it is scheduled to retransmit
- report the ACK/NACK to the MR-BS according to the status of decoding the received packet
- relay the ACK/NACK to the next station
- stop forwarding packets and release buffer if it receives the explicit ACK

A DL HARQ status report channel, on a per-HARQ channel basis, is assigned to each RS to report the HARQ forwarding status to indicate the failure hop number and the ACK/NACK channel allocation to the RS(s) is not required. An UL HARQ status report channel, on a per-HARQ channel basis, is assigned to each RS to report the HARQ forwarding status to indicate the failure hop number if any. Such a HARQ status report channel is signaled by a physical channel called as UL HARQ report channel.

Insert new sub-clause 6.3.17.5.1
6.3.17.5.1 DL HARQ for non-Transparent RS

DL transmission failure on a relay link shall be indicated by the orthogonal code on the UL ACK Channel. The MR-BS identifies the RS for retransmission with the help of ACK/NACK encoding suggested in table xxx. This does not require each RS on the path and MS to send separate ACK/NAK signals back to the MR-BS. Thus, conserves the bandwidth by utilizing the same ACK channel.

When MR-BS sends the first HARQ attempt, it allocates bandwidth over all the links from the MR-BS to the MS. Each RS on the relay path receives the downlink HARQ packet, and decodes it. If the decoding succeeds, it forwards the HARQ packet to the next hop and waits for the UL ACK from the next-hop RS or MS. If the decoding fails, the RS transmits code C_1 defined in the table xxx as a NAK back to the previous IS and transmits to the next hop station only the designated pilot subcarriers instead of the originally scheduled burst. The RS replaces the CID in the corresponding HARQ sub burst IE with its own basic CID.

When a RS receives code C_0, indicating that the HARQ packet is successfully received by the next station, it sends code C_0 to the previous IS on its UL ACK channel.Whenchannel. When a RS receives code C_k, $k \neq 0$, it sends UL ACK code= C_{k+1} on its UL ACK channel. MR-BS upon receipt of kth hop code sequence (C_k) in UL ACK Channel assumes that packet is lost on the link that is the kth hop, and it will schedule retransmission from (k-1)th RS. If MR-BS receives code C_0 it indicates that the HARQ packet is successfully received by SS. If MR-BS receives code C_1 it indicate that the HARQ packet is failed on the first hop.

When the orthogonal encoded UL ACK scheme is employed, the UL ACK channel resources must be assigned so that the UL ACK channel from MS to its previous RS first and upto MR-BS in reverse order of the DL transmission path. If, the MR-BS does not receive ACK code sequence (C_0), in the prescribed number of re-transmissions, both RS and MR-BS will discard the packet and clear the queue. BS can then perform normal signaling as if the packet is not received by MS.

Insert new sub-clause 6.3.17.5.1.1

6.3.17.5.1.1 ACK / NAK Encoding for multi-hop relay

MR-BS needs to identify the failed link over the multi-hop chain in case of HARQ. Therefore new sequences based on Table ~~301a~~ xxx in section 8.4.5.4.13.1 are defined in order to uniquely identify the failed link. Further, it should be noted that BS only needs to identify the failed link, i.e. if the HARQ attempt is failed between RS_j and its downstream RS RS_{j+1}, then BS should identify RS_j. For two hop case, only C_0 to C_2 are needed.

~~Link Distance/Depth~~	~~ACK/NAK 1-bit symbol~~	~~Vector Indices per Tile Tile(0), Tile(1), Tile(2)~~	~~Code #~~
~~Any Distance~~	~~0 (ACK)~~	~~0, 0, 0~~	~~C_0~~
~~1~~	~~1 (NAK)~~	~~1, 1, 1~~	~~C_1~~
~~2~~	~~1 (NAK)~~	~~2, 2, 2~~	~~C_2~~
~~3~~	~~1 (NAK)~~	~~3, 3, 3~~	~~C_3~~
~~4~~	~~1 (NAK)~~	~~4, 4, 4~~	~~C_4~~
~~5~~	~~1 (NAK)~~	~~5, 5, 5~~	~~C_5~~
~~6~~	~~1 (NAK)~~	~~6, 6, 6~~	~~C_6~~
~~7~~	~~1 (NAK)~~	~~7, 7, 7~~	~~C_7~~

Table xxx: ACK / NAK Encoding for multi-hop relay

[Insert the proposed text at the end of section 6.3.~~2.3.61~~17.5.x]

6.3.17.5.x Resource Request for HARQ Error Report

If the intermediate RS detects an error, it may transmit either HARQ RS Error report header or HARQ Error Report message. In case of HARQ RS Error report header, the order of Bitmap from MSB to LSB follows the order of sub-burst. In case of HARQ Error Report message, CID, ACID and SPID (in case of IR) will be reported to the MR-BS. Using this message, the failed transmission can be reported to the MR-BS without any additional delay as long as there is UL data to be transmitted.

The HARQ Error Report is sent by an RS in an unsolicited manner using UL bandwidth grant that may be available at the time of the report transmission.

If the RS does not have any UL bandwidth available for sending the error report, then CDMA bandwidth ranging method is used for requesting the UL bandwidth from the MR-BS. The MR-BS allocates a specific RS CDMA ranging code to a RS during initial ranging for the purpose of requesting bandwidth for transmitting HARQ error report. The code is granted by sending RS_CDMA_Codes TLV in RNG-RSP. When an RS needs to send a HARQ Error Report, it sends the allocated CDMA ranging code towards the MR-BS. The MR-BS recognizes the RS with the help of the assigned RS code. Subsequently, it assigns uplink allocation for sending the report.

[*Change the table X1 as indicated*]

Table X-1—Extended Type field encodings for Extended MAC signaling header type II

Extended Type field	MAC header Type	Reference figure	Reference table
3	HARQ RS Error Report Header	xxx	yyy
4-7	*Reserved*		

[*Insert new subclause 6.3.2.1.2.2.3*]

6.3.2.1.2.2.2.3 HARQ RS Error Report Header

The RS HARQ Error Report header is used for RS to provide ACK/NAK when RS is unable to decode HARQ DL data successfully. The RS can send this header to MR-BS or parent RS as an unsolicited feedback in UL relay zone. The header format is illustrated in Figure xxx.
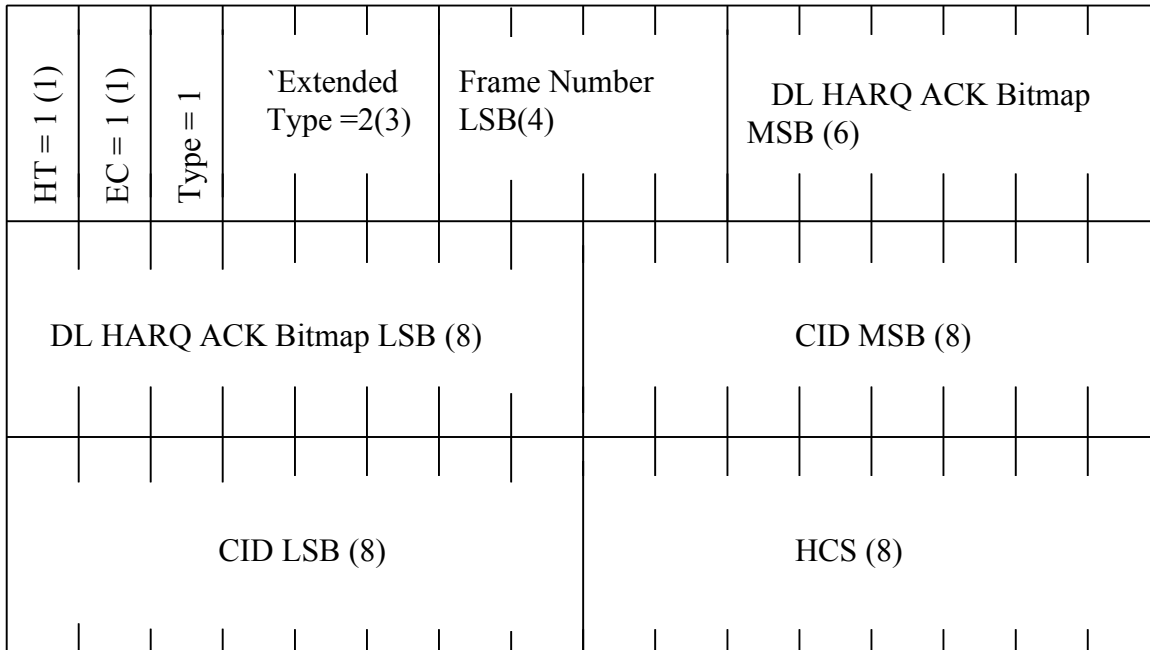
HT = 1 (1)	EC = 1 (1)	Type = 1	`Extended Type =2(3)	Frame Number LSB(4)	DL HARQ ACK Bitmap MSB (6)
DL HARQ ACK Bitmap LSB (8)				CID MSB (8)	
CID LSB (8)				HCS (8)	

Figure xxx. HARQ RS Error Report Header Format

Table yyy— Description of fields in HARQ RS Error Report header

Name	Length (bits)	Description
DL HARQ ACK/NAK bitmap	14	RS transmits ACK/NAK Bitmap of DL HARQ data of previous frame. The order of Bitmap from MSB to LSB follows the order of DL HARQ sub-burst
Frame Nmber	4	Least significant 4 bits of frame number where the DL HARQ burst is received by the RS

CID	16	Basic CID of the RS for which the RS bandwidth request header is sent.
HCS	8	Header Check Sequence (same usage as HCS entry in Table 5).

[Insert the new subclause 6.3.2.3.6x]

6.3.2.3.6x HARQ Error Report message for multi-hop relay

When an RS receives an HARQ burst in error, the RS may report the error using the HARQ Error Report message. To specify the burst that is in error, the RS shall include CID as well as the ACID in case of Chase HARQ, and include the CID, ACID and the SPID in case of IR HARQ, in the MAC message.

HARQ Error Report messages are shown in Table xxx and Table yyy. Table xxx is the HARQ_CHASE_ER_REP_Message. Table yyy is the HARQ_IR_ER_REP_Message.

Table xxx – HARQ_CHASE_ ER_REP _message

Syntax	Size	Notes
HARQ_CHASE_ ER_REP _message _format() {		
Management Message Type = xx		
Num_HARQ_Data	4bit	
For(i=0 ;i<Num_HARQ_Data ;i++) {		
RCID()	variable	
ACID	4bit	
}		
Padding	variable	
}		

Table yyy – HARQ_IR_ ER_REP_message

Syntax	Size	Notes
HARQ_IR_ ER_REP_message _format() {		
Management Message Type = xx+1		
Num_HARQ_Data	4bit	
For(i=0 ;i<Num_HARQ_Data ;i++) {		
RCID()	variable	
ACID	4bit	
SPID	2bit	
}		
Padding	variable	
}		

[Add the following parameter to table in 11.19.1]

11.19.1 CDMA Codes TLV

Name	Type	Length	Value
RS CDMA Code	-	4	- Resource Request for HARQ Error Report (UL)

Insert the following text at the end of the subclause
8.4.5.4.25 HARQ ACK region allocation IE

 This IE may be used by MR-BS to define an ACK channel region on the R-UL to include one or more ACK channel(s) for RS.

When RS receives HARQ DL sub-burst for relaying to MS at frame i, it shall transmit the encoded ACK/NAK signal through ACK Channel in the ACKCH region at frame (i + n) where n is calculated at each RS according to the following equation.

$$n = H*p + (H+1)*j \qquad ……………..[1]$$

H is defined by "number of hops RS is away from the MS".
p is defined by the "static delay at the RS in number of frames"
j is defined by the "HARQ_ACK_Delay for DL Burst" field in the DCD messages.

In 2-hop case, there is only one RS and n=p + 2*j.

If the frame structure allows relaying either HARQ DL sub-burst or encoded ACK/NAK in the same frame, then the above equation will change. If encoded ACK/NAK is relayed in the same frame, then n=H*p+j. Similarly, if RS can relay the HARQ DL Sub-burst signal in the same frame, then n=p+ (H+1)*j.

References

[1] C802.16j-06_132, "Relaying methods proposal for 802.16j"

[2] C802.16j-06_266r1, "Relay-Assisted Hybrid ARQ"

[3] C802.16j-06_197r1, "HARQ with Relays"

[4] – C802.16j-07_xxx "HARQ for Transparent Relays"

[5] C802.16-07_185r6, "HARQ in Multi-hop Relay System"