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Re:	This is in response to the call for proposals 80216j-07_07r2.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-06/026r2)
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UL HARQ with Relays

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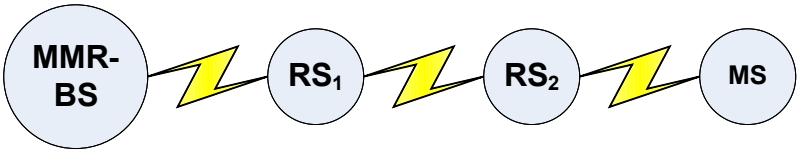
~~Problem Description~~

~~In single hop system, HARQ is performed directly between BS and MS. However, in the relay system, there could be one or more RSs between an MR-BS and an MS. HARQ could be performed in the fashion of hop-by-hop (i.e., between every two adjacent stations - MS-RS2, RS2-RS1 and RS1-MR-BS as shown in~~ Figure 1~~).~~



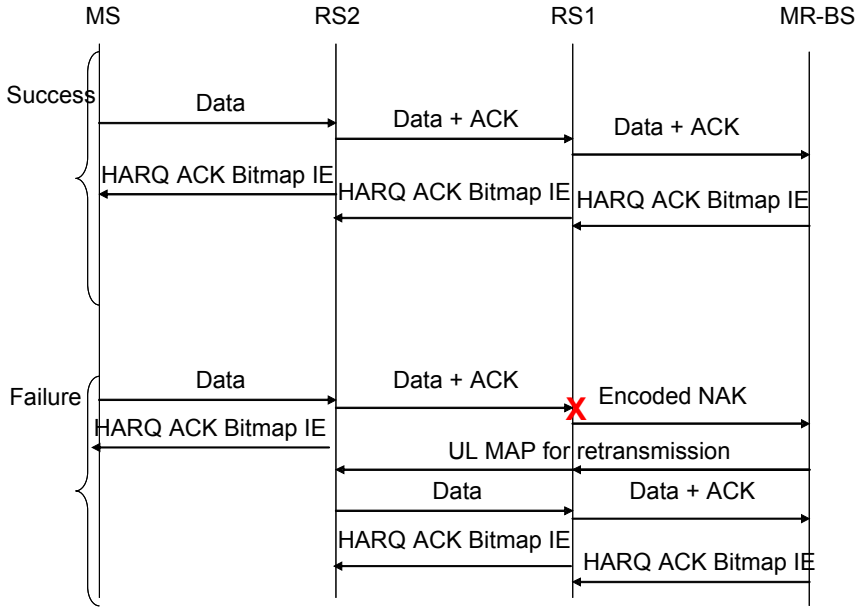
~~Figure 1: Illustration of Multi Hops in relay System~~

~~Both centralized and distributed MAP allocation mechanisms could be adopted in relay system. In centralized MAP allocation, the MR-BS allocates MAP for all the links. Any need for bandwidth request should go to the MR-BS. In distributed MAP allocation, each station allocates MAP for the adjacent link. In centralized allocation, if a HARQ packet transmission failure occurs on a non-adjacent link from MR-BS, then a mechanism is needed for indicating this failure to the MR-BS. So MR-BS can grant bandwidth for retransmission on the effected links.~~

~~UL HARQ scheme with centralized scheduling~~

~~This contribution suggests a mechanism for retransmitting a failed UL HARQ attempt only on the failed links,~~

~~instead of retransmitting again from the MS. This is achieved by indicating the last RS on the relay path to MR-BS, which has successfully received the UL HARQ packet. The MR-BS uses this indication and allocates MAP accordingly so the retransmission could start from the last RS and onward. If the MR-BS receives the HARQ packet successfully, it doesn't allocate MAP for retransmission.~~



~~Figure 2. Message Flow for 3-hop UL HARQ~~

~~MR-BS allocates UL-MAP for transmitting HARQ burst on the access link. On the relay links, it also allocates a per hop HARQ ACK channel along with the HARQ packet burst allocation. The per-hop HARQ ACK channel carries the status of reception at the last RS. If the HARQ packet is received correctly on all the links, each subsequent RS sends ACK. If the HARQ packet is received incorrectly at an RS, it will not forward the incorrectly received packet to next hop RS, instead it will send encoded NAK to the next RS in the per hop HARQ ACK channel as in table xxx. The receiving RS first looks at the per hop ACK channel. If it receives encoded NAK (other that ACK), it discards any information received in the HARQ burst, and sends encoded NAK to the next Infra-Station (IS). If RS receives the encoded NAK Cx (x!= 0) than it will send the encoded NAK Cx+1 to next hop RS/BS. If BS receives encoded NAK Cx than it knows that packet is failed on x+1 hop from MR-BS, therefore it will schedule retransmission only on the failed links.~~
~~If RS/MR-BS receives ACK on the per hop ACK channel, it decodes the HARQ burst. Figure 2 illustrates a successful and a failure case.~~

~~The access RS sends HARQ ACK bitmap IE as in current 16e spec to the MS for acknowledging received HARQ bursts. Similarly receiving RS/MR-BS sends HARQ ACK bitmap IE to the transmitting RS for acknowledging received HARQ burst. This helps RS to clear its buffer accordingly.~~
~~This contribution describes the HARQ procedure for UL only. It is suggesting a mechanism that will work on any centralized MAP allocation scheme. It does not suggest a centralized MAP allocation scheme.~~

Specification changes

++++++++++++++++++++++++++++++++++++ Begin ++

Insert new sub-clause 8.4.5.413.1

8.4.5.4.13.1 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 in section 8.4.5.4.13 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 upstream RS RS_{j+1}, then BS should identify RS_j. For two hop case, only C_0 to C_1 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 for UL HARQ

[Insert new sub-clause 6.3.17.6]

6.3.17.6 Relay support for UL HARQ in centralized scheduling

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

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. It also schedules the bandwidth for relaying upstream ACK/NACK on the UL ACK channel from RS 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.

Every ACK/NACK on UL ACK channel is forwarded by upstream RS(s) and finally to the MR-BS.

MR-BS identifies the multi-hop link(s) of UL transmission failure by checking the received encoded ACK/NACK.

[Insert new sub-clause 6.3.17.6.3]

6.3.17.6.3 UL HARQ for non-transparent RS

When MR-BS schedules a HARQ attempt, it allocates bandwidth over all the links from the MS to the MR-BS. It also allocates bandwidth for the ACK/NAK channel on the relay links between access RS and MR-BS. Each RS on the relay path receives the uplink HARQ burst, and decodes it. If the decoding succeeds, it forwards the HARQ burst to the next IS along with an ACK. If the decoding fails, the RS only sends an encoded NAK to the next IS. In case of multiple hop, each subsequent RS in the path places encoded NAK according to table xxx. In case of two hops, encoded NAK is not needed. Encoded NAK informs MR-BS where the packet transmission was unsuccessful. If RS receives the encoded NAK C_x (x not equal to 0) than it will send the encoded NAK C_{x+1} to next hop RS/MR-BS. If MR-BS receives encoded NAK Cx than it knows that packet is failed on x+1 hop from MR-BS, therefore it will schedule retransmission only on the failed links. The MR-BS sends UL-MAP accordingly, allowing retransmission from the last RS onwards, thus, retransmitting only on the links that didn't relay the HARQ burst successfully.

The receiving RS first looks at the per hop ACK channel. If it receives encoded NAK, it discards any information received in the HARQ, and sends encoded NAK to the next Infra Station (IS). If it receives ACK, it decodes the HARQ burst.

The ACK/NAK is sent in HARQ ACK Bitmap IE. Each RS also generates per hop HARQ ACK bitmap IE for its received HARQ bursts. Each receiving RS/MR-BS keeps its mapping, and generates its HARQ ACK bitmap accordingly. The MR-BS allocates the resource to transmit HARQ ACK bitmap IE from each RS. The receiver of the bitmap clears the buffer corresponding to the ACK bits in the bitmap, and saves the buffer corresponding to the NAK bits.

8.4.5.4.25 HARQ ACK region allocation IE

[Insert the following text at the end of the subclause]

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.

In case of non-transparent RS, RS receives HARQ UL sub-burst, from MS or sub-ordinate RS for relaying to MR-BS at frame *i*. It shall transmit the ACK/NAK signal through the ACK Channel in the ACKCH region along with the UL MS HARQ sub-burst at frame (*i*+*k*). RS shall transmit the ACK/NAK signal according to the order of UL HARQ sub-burst in the UL-MAP. The frame offset *k* is defined by the "HARQ ACK Delay for UL Burst for MR" field in the UCD message.

[Insert the following table after table 302t]

Table 302xx—HARQ ACKCH region allocation for UL Data IE

Syntax	Size	Notes
HARQ ACKCH_Region_for UL Data IE() {		

Extended-2 UIUC	4 bits	0xYY
Length	8 bits	Length in bytes
OFDMA Symbol offset	8 bits	
Subchannel offset	7 bits	
No.OFDMA symbols	5 bits	
No.subchannels	4 bits	
}		

~~*[Insert new sub-*~~clause ~~*6.3.17.89]*~~

~~6.3.17.89 HARQ Dummy Pattern~~

~~For each UL/DL multi-hop HARQ channel, MR-BS may pre-allocate bandwidth for links on relay path. When HARQ burst is corrupted by interference and noise, RS should not forward erroneous HARQ burst to the next hop. Instead, RS may send none by modifying the MAP sent by it. However, it is impossible to change the MAP for transparent RS and a station is expecting to receive data from the superordinate station. To resolve the issue, a dummy HARQ pattern which is designed and used for the pre-allocated transmissions when a RS cannot decode HARQ packet correctly. The dummy HARQ pattern is designed for facilitating receiver to perform channel quality measurement. The dummy HARQ pattern shall not cause any performance degradation on HARQ reception and no impact on the behavior in receiver.~~

~~The dummy HARQ pattern for an OFDMA symbol may be one of two kinds of formations. One formation is null data with pilot. The other formation is the erroneous data with dedicated pilot. The latter is used for amplify-and-forward purpose.~~

++++++++++++++++++++++++++++++++++++ End ++