Project	**IEEE 802.16 Broadband Wireless Access Working Group <http://ieee802.org/16>**
Title	**HARQ with Relays**
Date Submitted	**2006-11-07**
Source(s)	Haihong Zheng, Yousuf Saifullah, Shashikant Maheshwari Nokia 6000 Connection Drive, Irving, TX Voice: 972 894 5000 Fax: haihong.1.zheng@nokia.com, shashikant.maheshwari@nokia.com, Yousuf.saifullah@nokia.com
Re:	This is in response to the call for proposals 80216j-06_027.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)
Notice	
Release	
Patent Policy and Procedures	

HARQ with Relays

Haihong Zheng, Yousuf Saifullah, and Shashikant Maheshwari

Nokia

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 MMR-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-MMR-BS as shown in Figure 1).

Shashikant Mahesh…, 11/15/06 11:07 AM
Deleted: Figure 1

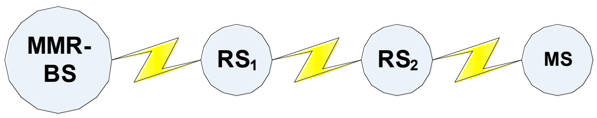

Figure 1: Illustration of Multi Hops in relay System

Both centralized and distributed MAP allocation mechanisms could be adopted in relay system. In centralized MAP allocation, the MMR-BS allocates MAP for all the links. Any need for bandwidth request should go to the MMR-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 MMR-BS, then a mechanism is needed for indicating this failure to the MMR-BS. So MMR-BS can grant bandwidth for retransmission on the effected links.

HARQ scheme with centralized scheduling

This contribution suggests a mechanism for indicating the last RS on the relay path that has successfully received the HARQ packet to MMR-BS. The feedback indication is only sent when the last RS receives NAK from the next station in the relay path. It is not sent when a HARQ packet is successfully transmitted on all the hops. The MMR-BS uses this feedback indication and keep the resources reserved or allocates MAP accordingly so the retransmission could start from the last RS and onward.

This contribution is suggesting a mechanism that will work on any centralized MAP allocation scheme. It does not suggest a centralized MAP allocation scheme. It utilizes a orthogonal code sequences on UL ACK channel for DL HARQ and bandwidth request mechanism for UL HARQ as proposed in [1].

DL HARQ Transmission

In case of a centralized scheduling, BS schedules resources for all the links. Therefore BS need to know at which hop the HARQ packet is lost so that it can keep the resources reserved for the those hops over which the packet is not transmitted successfully. The BS determines the first node that fails on decoding based on the feedback information sent from the nodes on the path.

HARQ mechanism in IEEE 802.16 has synchronous UL ACK Channel where the MS sends ACK/NACK information based on decoding result of HARQ packet. If HARQ packet is transmitted in frame *N*, then synchronous UL ACK channel is reserved in *N* + HARQ_DL_ACK_DELAY frame. We propose to use the same UL ACK channel to send feedback information from RS if decoding is failed in between. Therefore no extra resources are required to send feedback information.

In IEEE 802.16e-2005 std., the uplink ACK (Acknowledgement) provides feedback for Downlink Hybrid ARQ. The SS/MS transmits ACK or NAK feedback for Downlink packet data. One ACK channel occupies a half subchannel, which is three pieces of 3×3 uplink tile in the case of optional PUSC or three pieces of 4×3 uplink tile in the case of PUSC. The even half subchannel consists of Tile(0), Tile(2), and Tile(4). The odd half subchannel consists of Tile(1), Tile(3), and Tile(5). The acknowledgement bit of the n-th ACK channel shall be ‘0’ (ACK) if the corresponding downlink packet has been successfully received; otherwise, it shall be ‘1’ (NAK). This ACK or NAK bit is encoded into a length 3 code-word over 8-ary alphabet for the error protection as shown in below.

ACK/NAK 1-bit symbol	**Vector Indices per Tile Tile(0), Tile(1), Tile(2)**
0 (ACK)	0, 0, 0
1 (NAK)	4, 7, 2

Table 1: ACK / NAK Encoding in 802.16e

Vector indices are defined in Table 2 [802.16e].

Vector index	**Mn,8m, Mn,8m+1 , ... ,Mn,8m+7**
0	P0, P1, P2, P3, P0, P1, P2, P3
1	P0, P3, P2, P1, P0, P3, P2, P1
2	P0, P0, P1, P1, P2, P2, P3, P3
3	P0, P0, P3, P3, P2, P2, P1, P1
4	P0, P0, P0, P0, P0, P0, P0, P0
5	P0, P2, P0, P2, P0, P2, P0, P2
6	P0, P2, P0, P2, P2, P0, P2, P0
7	P0, P2, P2, P0, P2, P0, P0, P2

Table 2: Orthogonal Modulation Index in UL ACK Channel

where,

P0 = exp(j.π/ 4)
P1 = exp(j.3 π/4)
P2 = exp(- j.3 π/4)
P3 = exp(- j. π /4)

It can be seen that SS/MS when transmit 0 (ACK), it transmit sequence of 0 0 0 vector indices which are mapped to UL ACK Channel tile. Similarly when SS/MS transmit 1 (NAK), it transmit sequence of 4 7 2. BS demodulates the sequence and decode whether it is ACK or NAK.

Assuming there are *n* RSs over the link between BS and MS as shown in Figure 2. Note that RS_0 = BS, and RS_{n+1} = MS/SS.

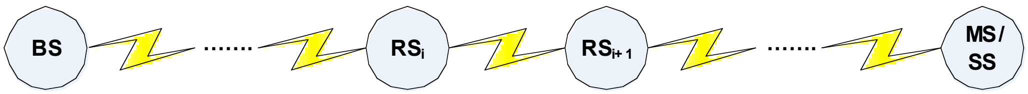

Figure 2: Relay Network with One or Multiple Relay Stations

This contribution proposes to define new sequences to be used to identify at BS where exactly the HARQ packet is lost over the multi-hop. This new sequences are sent by the RS(s) over the same UL ACK channel defined to sent ACK/NAK.

Link between the BS (RS_0) and RS_1 is called 1^{st} hop, link between RS_1 and RS_2 is called 2^{nd} hop and so on. The new sequences 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 RS_{j+1}, then BS should identify RS_j. It is also assumed that for the HARQ packet under consideration, no transmission can take place from RS_{j+1} onwards. We start with the observation that the vectors in Table 2 define orthogonal modulation sequences, that is $V_i * V_j^H = 0$, for $i \sim= j$, where $(.)^H$ denotes the Hermitian transpose and V_i [$i \in \{0, 1, \ldots, 7\}$] is the modulation vector corresponding to index *i*, as defined in Table 2. One instance of the sequences are generated by using the unused vector indices (1, 3 and 5) to generate a unique code, and the rest of the codes are generated using cyclic shifts of two sequences (4, 7, 2) and (3, 5, 1). This scheme is described in table 3a for a hop-distance of 5, i.e. 4 relay stations, BS and MS/SS. It should be noted that the scheme can be extended further if more hops are involved.

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)	4, 7, 2	C_1
2	1 (NAK)	3, 5, 1	C_2
3	1 (NAK)	7, 2, 4	C_3
4	1 (NAK)	5, 1, 3	C_4
5	1 (NAK)	2, 4, 7	C_5

Table 3a: ACK / NAK Encoding for multi-hop relay in 802.16j

In Table 3b the codes are defined such that they are not necessarily cyclic shift of any of the sequence.

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)	4, 7, 2	C_1
2	1 (NAK)	3, 5, 1	C_2
3	1 (NAK)	6, 2, 3	C_3
4	1 (NAK)	5, 1, 7	C_4
5	1 (NAK)	2, 6, 5	C_5

Table 3b: ACK / NAK Encoding for multi-hop relay in 802.16j

As an example, consider a multi-hop network, where an MS/SS is connected to a BS via two RSs (RS1 and RS2) as shown in figure 3. The links between BS-RS, RS-RS and RS-MS/SS are labeled sequentially as shown. The link-label also defines the dept of the link.

Figure 3: An example of 2-hop BS-MS/SS link

BS transmit HARQ packet to MS in frame N. Following 4 cases can occur.

Case 1: HARQ packet is transmitted successfully at all the link and MS/SS received is correctly. MS will send ACK to RS2, which in turn will send ACK to RS1, which in turn will send ACK to BS, all in N+ HARQ_DL_ACK_DELAY frame.
Case 2: If HARQ packet is successfully received by RS1 and RS2 but failed on link-3 (between RS2-MS). MS will send original NAK sequence, in table referred to as (C_1) to RS2 in N+ HARQ_DL_ACK_DELAY frame. RS2 knows that packet failed on its link so it will keep the packet in its queue and transmit 2nd hop code sequence (C_2) as defined in table 3a or table 3b to RS1. When RS1 received the 2nd hop code sequence (C_2) instead of original ACK/NAK code sequences ((C_0 / C_1), it knows that packet is received successfully on the next hop but failed on the link that is 2 hops away from itself. RS0 clears the packet from its queue and transmits 3rd hop code sequence (C_3), i.e. (received code sequence + 1), to upstream node (in the current example, to BS). BS upon receipt of 3rd hop code sequence (C_3) in UL ACK Channel assumes that packet is lost on the link that is 3 hops away and clears its queue. This acts as an implicit request to keep the resources reserved on the 3rd hop, or in general 3rd hop onwards. RS2 will retransmit the HARQ packet in N + HARQ_DL_ACK_DELAY + HARQ_NEXT_RETRANS_DELAY frame.
(HARQ_NEXT_RETRANS_DELAY is configurable parameter)

Case 3: HARQ packet is received successfully by RS1 but failed at RS2 (i.e. link-2 failed). In this case RS2 will transmit original NAK code sequence defined for 1st hop (C_1) to RS1 in UL ACK channel slot specified for RS2-to-RS1. RS1 knows it received packet successfully but that packet failed at next hop (RS2), therefore it will keep the received packet in its queue and transmit 2nd hop code sequence (C_2) as defined in table 3a or table 3b to upstream node (in this case, to BS). Also RS1 assumes that same resources that he used to transmit the packet to RS2 are reserved for next retransmission in HARQ_NEXT_RETRAN_DELAY frame. This HARQ_NEXT_RETRANS_DELAY is configurable and indicated to RS in broadcast message. When BS decode the 2nd code sequence (C_2) in the UL ACK channel, it knows that HARQ packet is failed at link that is 2 hop away (i.e. at RS2) and therefore knows that RS1 will retransmit same packet again in frame N + HARQ_DL_ACK_DELAY + HARQ_NEXT_RETRANS_DELAY.

Case 4: HARQ packet failed at RS1. RS1 transmit original NAK code sequence defined for 1st hop (C_1) to BS. Again, the original NAK code implies the same sequence as defined in IEEE 802.16e-2005 std for NAK.

Table 4 depicts the functioning of the protocol using the sequence defined in table 3b for the multi-hop relay example under consideration. The scheme, as obvious, can be extended to multiple links.

H-ARQ Attempt (PASS / FAIL)			**UL ACK/NAK Message**			**BS Infers**
Link-1	**Link-2**	**Link-3**	**Link-3**	**Link-2**	**Link-1**	
PASS	PASS	PASS	0, 0, 0	0, 0, 0	0, 0, 0	C0: Successful transmission
PASS	PASS	FAIL	4, 7, 2	3, 5, 1	6, 2, 3	C3: Link-3 failed, other links are okay
PASS	FAIL	---[1]	---	4, 7, 2	3, 5, 1	C2: Link-2 failed, Link-1 okay, no transmission beyond link-2
FAIL	---	---	---	---	4, 7, 2	C1: Link-1 failed, no transmission beyond link-1

[1]No ACK/NAK message is transmitted as the there was no transmission on the specified link due to a failure at some earlier link

Table 4: Example of UL ACK/NAK message encoding, transmission and interpretation for proposed H-ARQ scheme for a multi-hop network with 2 relay stations between BS and MS/SS

The encoding algorithm for UL ACK/NAK message can be described as follows:

@ MS:

if (DL_HARQ_ATTEMPT == SUCCESS)
Send UL ACK code: C_0
else
Send UL NAK code: C_1
end

@ RS:

if (DL_HARQ_ATTEMPT == SUCCESS)
if (UL_HARQ_ACKNAK_CODE == C_0)
Send UL ACK code: C_0
else (UL_HARQ_ACKNAK_CODE == C_k, $k \neq 0$)
Send UL ACK code: C_{k+1}
else
Send UL NAK code: C_1
end

BS Interprets:

if (UL_HARQ_ACKNAK_CODE == C_0)
Transmission Okay
elseif (UL_HARQ_ACKNAK_CODE == C_k)
Link # k is Failed. No transmission beyond link-k for the same sub-packet
Reserve downlink resources for HARQ re-transmission
Reserve uplink ACK/NAK resources (simply keep the current UL ACK/NAK resources for the failed packet)
end

More sequences can be defined by utilizing the vectors defined in Table 2 such that these sequences are orthogonal to each other. Also different combination can also be defined from these vectors such that all combinations are orthogonal to each other. Furthermore, it is also possible to define a new set of orthogonal sequences and use them to create the H-ARQ ACK/NAK code sequences as specified in table 3a or table 3b.

Since retransmission is performed by RS where the HARQ packet is not successfully delivered to another RS or MS, the UL ACK channel resources must be remained assigned by BS to deliver the outcome to the retransmission. This is required for BS to know if any of the subsequent re-transmission by any of the RS is successful. This mechanism allows end-to-end signaling between BS and MS/SS for H-ARQ, as in the standards. To transmit the outcome of the retransmitted packet by RS, BS will keep the same UL ACK region for the RS(s) to transmit feedback. BS may broadcast/transmit empty map message to avoid any spurious transmission by any other RS(s) or MS/SS in the reserved region in UL. This simple mechanism avoids overhead of further UL resource reservation by RSs or BS. If, the BS does not receive ACK code sequence (C_0), in the prescribed number of re-transmissions (re-transmission by other RS, BS just verifies ACK message in

UL), both RS and BS will discard the packet and clear the queue. BS can then perform normal signaling as if packet is not received by MS even with *n* re-transmissions.

Simulation Results

This section describes the comparison of proposed HARQ scheme and end-to-end HARQ scheme. Simulation is performed to analyze the gain in the spectral efficiency and PER with the proposed HARQ scheme. Following table shows the simulation parameters used in the simulation.

Scheduler	Round Robin (goes through HARQ Channels of MSs)	HARQ_DL_ACK_DELAY	1 frame
No of HARQ Channels scheduled per MS in one frame	2	HARQ_NEXT_RETRANS_DELAY	3 frames
No of MS in system	20	MAX_RETX_COUNT	4
No of HARQ Channels per MS	6	UL and DL overhead for resource request	10 bytes
Total HARQ Channels available in one frame	15	Resource Request latency at RS	3 frames
Frame Duration	5 ms	Queue Length at RS	variable
Simulation Duration	60000 frames	No of Hops	variable
Error generation	Uniform random error generation with BLER of 10 %	Flow control	supported

Table 1: Simulation parameters

It can be seen from the figure 2 that proposed scheme provides more than 10% gain in spectral efficiency in case of 2 hops. It is expected that gain in the spectral efficiency is increase as number of hops increases as can be seen from the figure 2.

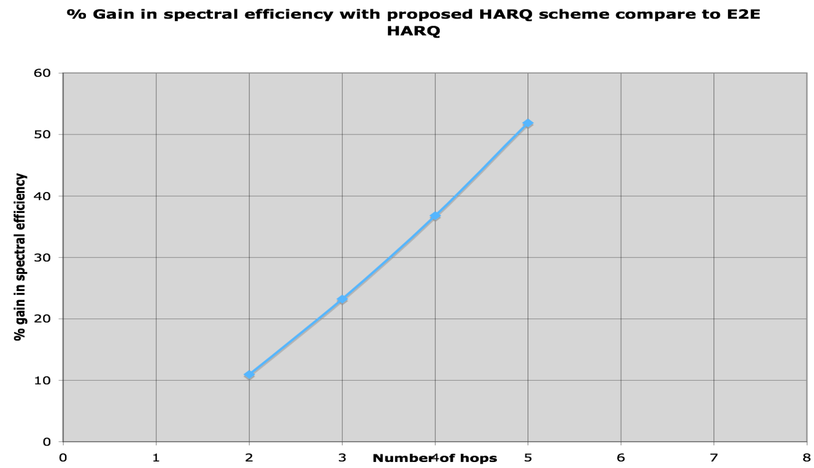

Figure 2: Gain in spectral efficiency (E-HARQ Vs E2E HARQ) QLength at RS = 4 Packets

Shashikant Mahesh…, 11/15/06 11:07 AM
Deleted: 2

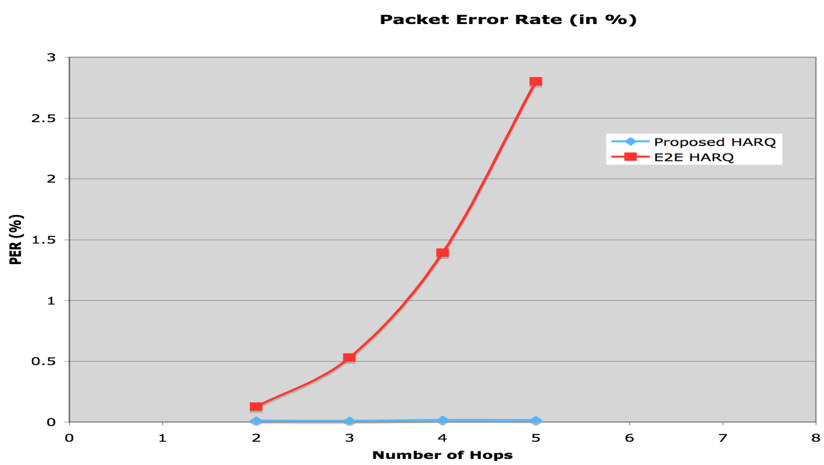

Figure 3: Packet Error Rate (After Max Retransmission for HARQ) for Proposed HARQ and E2E HARQ. (Qlength at RS is 4 packets)

Shashikant Mahesh…, 11/15/06 11:07 AM
Deleted: 3

Figure 3 describes the Packet Error Rate (PER) after maximum number of retransmission for HARQ is exhausted. It can be seen from the figure 3 that PER is increase as number of hops are increase for end-to-end HARQ while the PER for proposed scheme remains the same. Also PER for proposed HARQ scheme is significantly lower than end-to-end HARQ for 2 hops.

Figure 4 analyzes the requirement of queue length at the RS. It can be seen that increasing the queue length beyond threshold does not increase the performance. Also the requirement of queue length at the RS is not significant (3 packets)

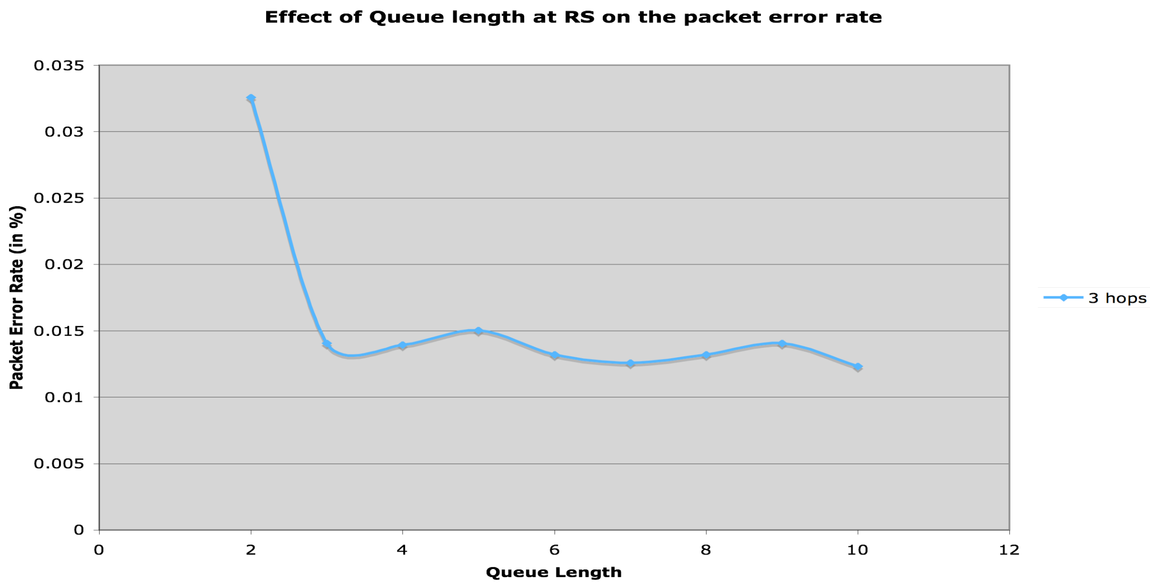

Figure 4: Effiect of Queue length on the Packet Error Rate for Proposed HARQ (for E2E HARQ, Qlength is not required. For E2E HARQ: PER is : 0.53%)

Shashikant Mahesh..., 11/15/06 11:07 AM
Deleted: 4

Summary

This contribution provides a mechanism for the working of HARQ in centralized scheduling. The proposal is bandwidth efficient, and works on top of the existing HARQ mechanism. It introduces error reporting for indicating the RS, where the HARQ transmission has failed; and the HARQ packet that has failed. It doesn't modify access link. The related changes to the specification are also proposed.

Specification changes

Insert new sub-clause 6.3.17.5

6.3.17.5 Relay support for HARQ in centralized scheduling

MMR-BS schedules a HARQ packet on all the links between MMR-BS and MS. DL transmisstion failure on a relay link is indicated by the orthogonal code on the UL ACK Channel while UL transmission failure on a relay link is indicated to MMR-BS in a HARQ RS report, so the MMR-BS can schedule the retransmission only for the links that didn't transmit packet in the last attempt. The mechanism is different for UL and DL, and it is described below.

Insert new sub-clause 6.3.17.5.1

6.3.17.5.1 DL HARQ transmission

When MMR-BS sends a first HARQ attempt, it allocates bandwidth over all the links from the MMR-BS to the MS. Each RS on the relay path receives the downlink HARQ packet, and decodes it. If the decoding succeeds, it sends an ACK back to the previous RS/MMR-BS after HARQ_DL_ACK_DELAY frames, and forwards the HARQ packet to the next hop. The previous RS clears the HARQ packet from its buffer after receiving the ACK. If the decoding fails, the RS sends a NAK back to the previous RS/MMR-BS. If the previous station is RS, then it is the last RS that has received the HARQ packet successfully. The last RS sends code C_2 defined in table xxx.If the upstream RS receives the code C_k, *$k \neq 0$, and $k \neq 1$, it will send UL ACK code*= C_{k+1}. *MMR*-BS upon receipt of k^{th} hop code sequence (C_k) in UL ACK Channel assumes that packet is lost on the link that is k hops. If MMR-BS receives code $C_{0,}$ it indicate that the HARQ packet is successfylly received by SS/MS. If MMR-BS receives code $C_{1,}$ it indicate that the HARQ packet is failed on the first hop. This acts as an implicit request to keep the resources reserved on the K^{th} hop, or in general k^{th} hop onwards. RS_{k-1} will retransmit the HARQ packet in N + HARQ_DL_ACK_DELAY + HARQ_NEXT_RETRANS_DELAY frame.

The encoding algorithm for UL ACK/NAK message can be described as follows:

@ MS:

if (DL_HARQ_ATTEMPT == SUCCESS)
Send UL ACK code: C_0
else
Send UL NAK code: C_1
end

@ RS:

if (DL_HARQ_ATTEMPT == SUCCESS)
if (UL_HARQ_ACKNAK_CODE == C_0*)*
Send UL ACK code: C_0
else (UL_HARQ_ACKNAK_CODE == C_k*,* $k \neq 0$*)*
Send UL ACK code: C_{k+1}
else
Send UL NAK code: C_1
end

BS Interprets:

if (UL_HARQ_ACKNAK_CODE == C_0*)*
Transmission Okay
elseif (UL_HARQ_ACKNAK_CODE == C_k*)*
Link # k is Failed. No transmission beyond link-k for the same sub-packet
Keep downlink resources reserved for HARQ re-transmission
Reserve uplink ACK/NAK resources (simply keep the current UL ACK/NAK resources for the failed packet)
end

Since retransmission is performed by RS where the HARQ packet is not successfully delivered to another RS or MS, the UL ACK channel resources must be remain assigned by BS to deliver the outcome to the retransmission. This is required for BS to know if any of the subsequent re-transmission by any of the RS is successful. This mechanism allows end-to-end signaling between BS and MS/SS for H-ARQ. To transmit the outcome of the retransmitted packet by RS, BS will keep the same UL ACK region for the RS(s) to transmit feedback. BS may broadcast/transmit empty map message to avoid any spurious transmission by any other RS(s) or MS/SS in the reserved region in UL. This simple mechanism avoids overhead of further UL resource reservation by RSs or BS. If, the BS does not receive ACK code sequence (C_0), in the prescribed number of re-transmissions (re-transmission by other RS, BS just verifies ACK message in UL), both RS and BS will discard the packet and clear the queue. BS can then perform normal signaling as if packet is not received by MS even with *n* re-transmissions.

Insert new sub-clause 6.3.17.5.1.1

6.3.17.5.1.1 ACK / NAK Encoding for multi-hop relay

MMR-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 downstream RS RS_{j+1}, then BS should identify RS_j.
instance of the sequences are generated by using the unused vector indices (1, 3 and 5) to generate a unique code, and the rest of the codes are generated using cyclic shifts of two sequences (4, 7, 2) and (3, 5, 1). This scheme is described in table 3a for a hop-distance of 5, i.e. 4 relay stations, BS and MS/SS.

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)	4, 7, 2	C_1
2	1 (NAK)	3, 5, 1	C_2
3	1 (NAK)	7, 2, 4	C_3
4	1 (NAK)	5, 1, 3	C_4
5	1 (NAK)	2, 4, 7	C_5

Table xxx: ACK / NAK Encoding for multi-hop relay (Cyclic shift)

In Table 3b the codes are defined such that they are not necessarily cyclic shift of any of the sequence.

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)	4, 7, 2	C_1
2	1 (NAK)	3, 5, 1	C_2
3	1 (NAK)	6, 2, 3	C_3
4	1 (NAK)	5, 1, 7	C_4
5	1 (NAK)	2, 6, 5	C_5

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

Insert new sub-clause 6.3.17.5.2

6.3.17.5.2 UL HARQ transmission
When MMR-BS sends a HARQ attempt, it allocates bandwidth over all the links from the MMR-BS to the MS. Each RS on the relay path receives the uplink HARQ packet, and decodes it. If the decoding succeeds, it sends an ACK to the previous RS/MS in current frame + HARQ_DL_ACK_DELAY frame and forwards the HARQ packet to the next hop. The previous RS/MS clears the HARQ packet from its buffer after receiving the ACK. If

the decoding fails, the RS sends a NAK back to the previous station. If the previous station is a RS, then it is the last RS that has received the HARQ packet successfully. The last RS sends HARQ RS Report Extended subheader to the MMR-BS indicating the HARQ packet and itself. The subheader can either be sent in the same allocation allocated for the HARQ packet or uses the fast resource request mechenism define in [1]. The MMR-BS sends UL-MAP accordingly, allowing retransmission from the last RS onwards, thus, retransmitting only on the links that didn't relay the HARQ packet.

The MS behavior is unchanged with the introduction of RS. The MS does not send HARQ RS Report Extended subheader.

The ACK/NAK is sent by HARQ ACK Bitmap IE. Each RS generates HARQ ACK bitmap IE for its received HARQ packets. The UL burst positions could be altered by RS on a hop, but each receiving RS/MMR-BS keeps its mapping, and generates its HARQ ACK bitmap accordingly. 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.

Insert new sub-clause 6.3.17.5.3

6.3.17.5.3 Resource Request for HARQ RS Report

The HARQ RS Report is sent by a RS using any available bandwidth grant from the MMR-BS at the moment. It is possible that the RS may not have any bandwidth grant for sending the report. In this case, a CDMA ranging code method is used for requesting bandwidth grant from the MMR-BS.

The MMR-BS allocates a specific RS CDMA ranging code to a RS during initial ranging by sending RS_CDMA_Codes TLV in RNG-RSP. The code is allocated for requesting UL resource for sending HARQ RS Report Extended subheader. When RS needs to send HARQ RS Report, it sends the allocated CDMA ranging code toward the MMR-BS. The MMR-BS recognizes the RS with the help of the assigned RS code. It assigns uplink allocation for sending HARQ RS Report Extended subheader using CDMA Allocation IE for all the links up to the RS.

Modify Table 13c in sub-clause 6.3.2.2.7

ES type	Name	ES body size	Description
5	HARQ RS Report extended subheader	TBD (= size of RSID) Need to give size	See section 6.3.2.2.7.9
~~5~~6-127	Reserved	-	-

Insert new sub-clause 6.3.2.2.7.9

6.3.2.2.7.9 UL HARQ RS Report extended subheader

Specify the last RS that has received the UL HARQ attempt successfully. The subheader is sent with a MAC header containing basic CID for the RS. The RS basic CID helps MMR-BS in identifying the RS. The format of HARQ RS Report extended subheader is as described in table T1.

Table T1 – HARQ RS Report Extended Subheader

Name	**Size**	**Description**
CID	16 bits	CID of the MS connection
AI_SN	1 bit	HARQ ID Seq. No
SPID/Reserved	2 bits	Subpacket ID when IR is defined by the FEC mode, otherwise reserved (encoded 0b00)
ACID	4 bits	The ID of the HARQ channel that carries the UL HARQ attempt.
Next Transmission Flag Included	1 bit	= 1, Next Transmission Flag is applicable = 0, Next Transmission Flag is don't care
Next Transmission Flag	1 bit	= 1, request to MMR-BS for stopping next HARQ packet transmission = 0, request to MMR-BS for resuming next HARQ packet transmission
UL/DL-HARQ	1 bit	= 1, indicates the report is related to UL HARQ = 0, indicates the report is related to DL HARQ
Reserved	6 bits	

The following changes are on top of the changes proposed in [1].

Insert new subclause 11.19.1:

11.19 RS_RNG-RSP management message encodings
The encodings described in this subclause are specific to the RS_RNG-RSP message.

Insert new subclause 11.19.1:

11.19.1 RS CDMA Codes TLV

Name	Type (1 byte)	Length	Value
RS CDMA Code	-	3	The TLV carries 1 byte ranging code in the following order - HARQ Error Report

References

[1] C80216j-06_189 Resource Request for Bandwidth (Yousuf Saifullah, Shashikant Maheshwari, Haihong Zheng; 2006-11-07)