
Project **IEEE 802.16 Broadband Wireless Access Working Group** <<http://ieee802.org/16>>

Title **UL HARQ with Relays**

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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

Junichi Suga
Fujitsu Laboratories Ltd.
Kamikodanaka 4-1-1,
Kawasaki, 211-8588, Japan

Voice: +81-44-754-2811
Fax: +81-44-754-2786
Email : suga.junichi@jp.fujitsu.com

Michiharu Nakamura
Fujitsu Laboratories LTD
5-5, Hikarinooka
Yokosuka, Japan. 239-0847

Voice: +81-46-839-5371
Fax: +81-46-839-5560
Email : michi@labs.fujitsu.com

Aik Chindapol, Jimmy Chui, Hui Zeng
Siemens Corporate Research
755 College Road East, Princeton, NJ,
USA

Voice: +1 609 734 3364
Fax: +1 609 734 6565
Email: aik.chindapol@siemens.com

Byung-Jae Kwak, Suchang Chae,
Young-il Kim
ETRI
161, Gajeong-Dong, Yuseong-Gu,
Daejeon, Korea 305-350

Voice: +82-42-860-6618
Fax: +82-42-861-1966
bjkwak@etri.re.kr

Kyu Ha Lee
Samsung Thales
San 14, Nongseo-Dong, Giheung-Gu,
Yongin, Gyeonggi-Do, Korea 449-712

Voice: +82-31-280-9917
Fax: +82-31-280-1562
Email: kyuha.lee@samsung.com

[Yanling Lu, Ting Li](#)
[Hisilicon Technologies](#)

Juyanling@hisilicon.com

[David Comstock, John Lee,Zheng](#)
[Shang, Jingning Zhu](#) dcomstock@huawei.com
[Huawei Technologies](#)

Re:	This is in response to the call for proposals 80216j-06_034.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-06/026r1)
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UL HARQ with Relays

Haihong Zheng, Yousuf Saifullah, and Shashikant Maheshwari - Nokia

Junichi Suga, and Michiharu Nakamura - Fujitsu

Aik Chindapol, and Jimmy Chui – Siemens

Byung-Jae Kwak, Suchang Chae, Young-il Kim - ETRI

Kyu Ha Lee - Samsung Thales

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).

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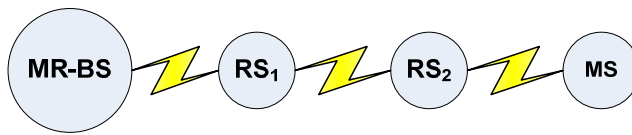


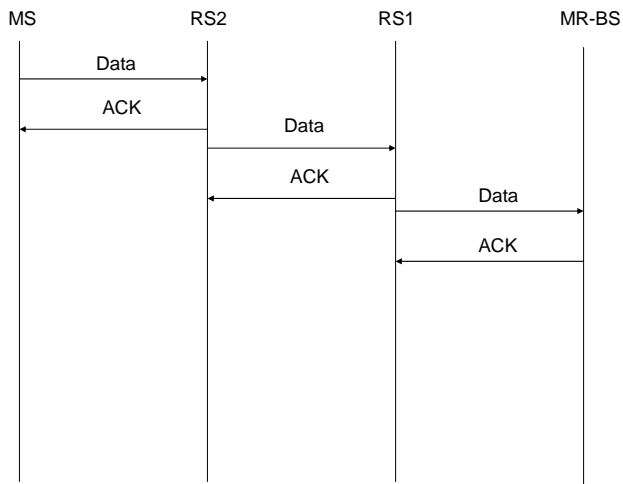
Figure 1: Illustration of Multi Hops in relay System

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.

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UL 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 MR-BS. The 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 MR-BS uses this indication and allocates MAP accordingly so the retransmission could start from the last RS and onward.



[Figure 2. Message Flow for 3-hop UL HARQ](#)

In Figure 2, the data is transmitted from the MS to RS 2 and is forwarded to RS 1 and finally to the MR-BS. As a response to a successful reception of the data, ACK is generated per hop by each receiving station and the data is removed from the buffer of the transmitting station.

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 bandwidth request mechanism proposed in [1].

This contribution describes the HARQ procedure for UL only. For the DL HARQ procedure, please consult [2].

Specification changes

Insert new sub-clause 6.3.17.5

6.3.17.5 Relay support for HARQ in centralized scheduling

MR-BS schedules a HARQ packet on all the links between MR-BS and MS. DL transmission 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 MR-BS in a HARQ RS report, so the MR-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. It is also described for the following cases:

- UL HARQ for non-Transparent RS
- UL HARQ for Two Hop Transparent RS

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Insert new sub-clause 6.3.17.5.3

6.3.17.5.3 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. 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 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 MR-BS indicating the HARQ packet and itself. 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 packet.

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Deleted: [The subheader is sent in the same allocation allocated for the HARQ packet.](#)

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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/MR-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.

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6.3.17.5.4 UL HARQ for two-hop transparent RS

When the RS receives the HARQ sub-burst correctly from MS, the RS forwards the sub-burst toward the MR-BS and saves it for any possible retransmission. When the RS does not successfully receive the HARQ sub-burst, the RS shall not forward the sub-burst.

It is also possible for MR-BS to receive the first transmission from MS directly. At the same time, MR-BS informs the RS about the transmissions it needs to monitor via Compact UL-MAP MONITOR IE. The RS, having the information on uplink resource allocations sent in UL-MAP for MS, monitors the HARQ sub-burst transmission sent by MS to MR-BS directly and attempts to decode it. When the RS receives the HARQ sub-burst correctly, the RS saves it for possible retransmission.

When RS receives the correct HARQ sub-burst from MS, RS informs MR-BS that RS can retransmit the HARQ sub-burst instead of MS by sending HARQ RS Report Extended subheader. When retransmission of the HARQ sub-burst is needed, MR-BS which receives this subheader, requests RS to retransmit the HARQ sub-burst and sends ACK on HARQ ACK Bitmap IE to MS directly. Otherwise MR-BS sends NAK to MS to retransmit the HARQ sub-burst.

Insert new sub-clause 6.3.17.5.5

6.3.17.5.5 Resource Request for HARQ RS Report

The HARQ RS Report is sent by a RS using any available bandwidth grant from the MR-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 MR-BS.

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The MR-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 MR-BS. The MR-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.

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Modify Table 13c in sub-clause 6.3.2.2.7

ES type	Name	ES body size	Description
<u>5</u>	<u>HARQ RS Report extended subheader</u>	<u>TBD (= size of RSID)</u> <u>Need to give size</u>	<u>See section 6.3.2.2.7.9</u>
56-127	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 MR-BS in identifying the RS. The format of HARQ RS Report extended subheader is as described in table T1.

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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 <u>MR-BS</u> for stopping next HARQ packet transmission = 0, request to <u>MR-BS</u> for resuming next HARQ packet transmission
Reserved	<u>7</u> bits	

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Deleted: UL/DL-HARQ

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[Insert new subclause 6.3.2.3.43.6.11 and add table:]

6.3.2.3.43.6.11 Compact_UL-MAP MONITOR IE

The Compact UL-MAP MONITOR IE provides the list of CIDs of the MS whose transmissions need to be monitored in the UL part of the current frame and relayed in the next frame to the MS.

Syntax	Size	Notes
Compact UL-MAP IE() {		
UL-MAP Type = 7	3 bits	
UL-MAP subtype	5 bits	
Number of CIDs	4 bits	Number of CIDs in the IE
for(i=0; i<Number of CIDs; i++)		
{		
CID(i)	16 bits	The CIDs of the connections that RS shall monitor in the current frame
}		
}		

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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 for indicating HARQ Error Report.

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Deleted: in the following order HARQ Error Report

References

[1] Resource Request for Bandwidth, C80216j-07_39.doc; Shashikant Maheshwari, Yousuf Saifullah, Shashikant Maheshwari, Haihong Zheng, Masato Okuda, Kerstin Johnsson, Jerry Sydir, Wendy Wong, Hannah Lee; Nokia; Fujitsu; Intel

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[2] DL HARQ with Relays, C80216j-07_002.doc, Junichi Suga, Michiharu Nakamura, Haihong Zheng, Yousuf Saifullah, Shashikant Maheshwari, Aik Chindapol, Jimmy Chui, Hui Zeng, Byung-Jae Kwak, Suchang Chae, Young-il Kim, Kyu Ha Lee; Fujitsu, Nokia, Siemens, ETRI, Samsung Thales,

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Deleted: [2] DL HARQ method for user-transparent relaying, C80216j-06_126r3.doc, Junichi Suga, Michiharu Nakamura, Aik Chindapol, Kyu Ha Lee, Young-il Kim; 2006-11-16

UL/DL-HARQ	1 bit	= 1, indicates the report is related to UL HARQ = 0, indicates the report is related to DL HARQ
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