Project	**IEEE 802.16 Broadband Wireless Access Working Group <http://ieee802.org/16>**
Title	**The Active Multi-hop Relaying HARQ Mechanism**
Date Submitted	**2007-03-05**
Source(s)	Wei Ni, Gang Shen, Shan Jin Alcatel-Lucent, Research & Innovation No. 388, Ningqiao Rd., Pudong Jinqiao, Shanghai, P. R. C Voice: 86-21-50554550 Fax: 86-21-50554554 mailto: wei.a.ni@alcatel-sbell.com.cn Fang Liu, Lan Chen, Xiaoming She, Daqing Gu DoCoMo Beijing Lab 7/F, Raycom Infotech Pack Tower A No.2 Kexueyuan South Rd., Haidian District, Beijing, China Voice: +86-10-82861501 ex.331 Fax: +86-10-82861506 mailto: {liu, gu}@docomolabs-beijing.com.cn Fujio Watanabe DoCoMo USA Labs 3240 Hillview Avenue, Palo Alto, CA Voice: 650-496-4726 watanabe@docomolabs-usa.com
Re:	Response to “Call for Technical Comments and Contributions regarding IEEE Project P802.16j” (IEEE 802.16j-07_007r2)
Abstract	This document proposes an active MR HARQ mechanism on the per-hop basis. This mechanism supports functions such as high mobility of the RS, CID update and traffic congregation. Relatively fewer resources are required for HARQ retransmissions.
Purpose	Add the proposed spec changes indicated in this document into the 802.16j Baseline Document (IEEE 802.16j-06/026r2)
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>.

The Active Multi-hop Relaying HARQ Mechanism

I. Introduction

In relay based wireless communication systems, the efficiency of Hybrid ARQ (HARQ) mechanism is critical owing to its great impact on the transmission delay and the system capacity.

As illustrated in Figure 1, an active Multi-hop Relaying (MR) HARQ mechanism is proposed which is a per-hop mechanism performed over a single hop to compensate for the in-between fast fading and shadowing, and therefore the use of this mechanism allows for high mobility of the RS, i.e., metro and highway. In addition, it is easier for the RS with the active MR HARQ to perform CID change for the purpose of traffic congregation.

This proposal focuses on mechanisms and procedures regardless of HARQ coding and combining techniques, and both soft combining and Incremental Redundancy (IR) combining are supported. This scheme applies to both uplink and downlink.

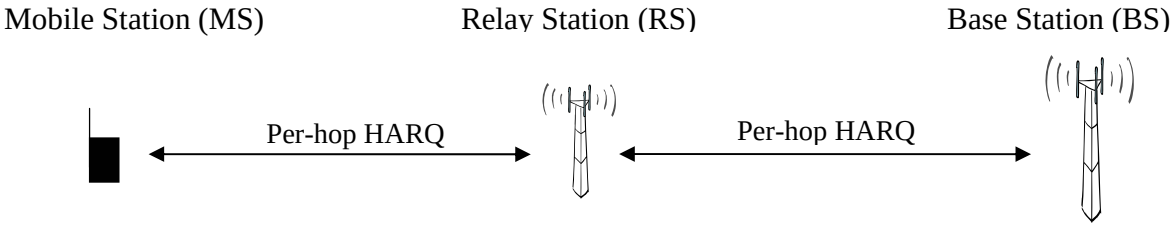


Fig. 1: The per-hop HARQ in multi-hop relaying networks

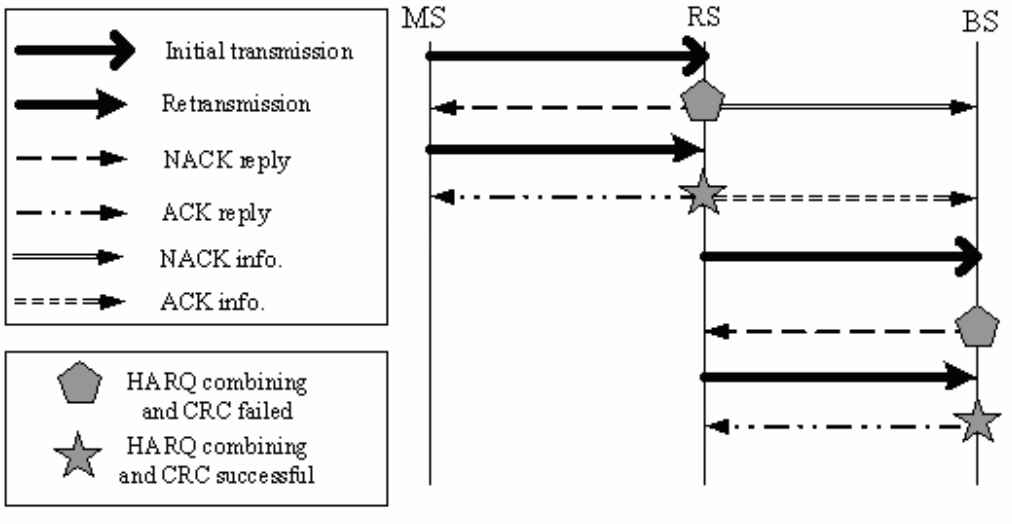
II. System Description

In this mechanism, the per-hop HARQ is performed over each single hop. The RS reports to the BS "actively" through multi-hop backhauling a certain MAC management message (denoted by "ACK/NACK information" in Figure 2) that contains information such as the CID of the link and its CRC results, whenever an ACK or a NACK is replied in uplink and received in downlink. Correspondingly the BS allocates the resources for the following HARQ retransmission.

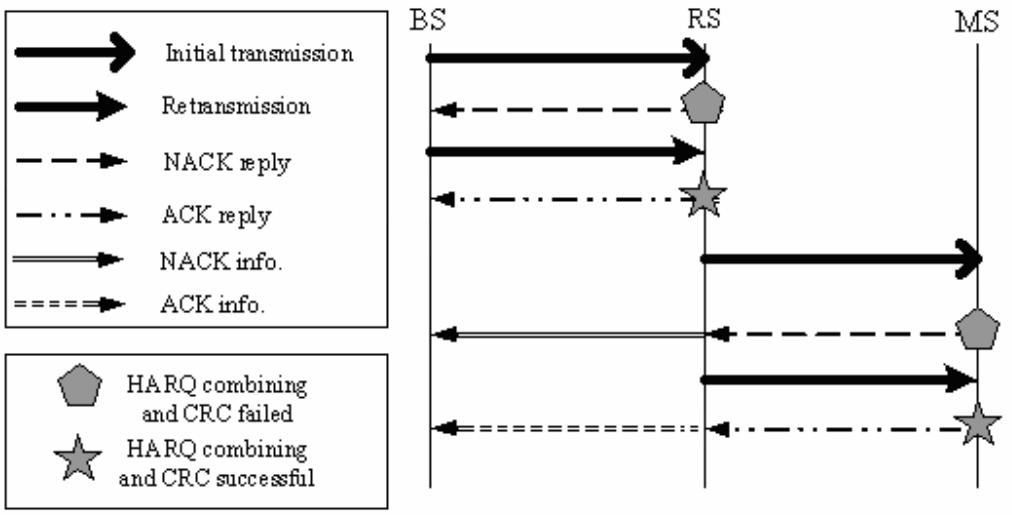
The principle and procedure of this mechanism is illustrated in Figure 2, where typical 2-hop HARQ procedures in both uplink and downlink are given as examples.

As shown in Figure 2, only the packets which are possibly correct after HARQ combining or whose maximum number of retransmission attempts is reached will be forwarded. For example, the RS receives an uplink packet correctly while an "NACK" is received at the BS, that means the errors happens within the hop between the RS and the BS, and then the RS goes on with retransmission and informs the MS of the correct reception with an "ACK". In this case, it is the BS that allocates the resources for HARQ retransmissions exclusively.

To avoid serious delay due to relaying and retransmission, multiple HARQ retransmissions are proposed to be scheduled within one frame for time diversity if free resources are enough for hops with no MS involved. The support of the BS is expected in this scheme.



(a) The principle and procedure in uplink



(b) The principle and procedure in downlink

Fig. 2: The principle and procedure in the active MR HARQ mechanism

Furthermore, the use of the per-hop HARQ retransmission allows for the different CIDs for the RS and the MS. That means this mechanism can support some special functions in the RS, such as traffic congregation.

III. Summary

The active MR HARQ is proposed on the per-hop basis to allow for high mobility of the RS and special functions, i.e., CID update and traffic congregation. Fewer resources are required for HARQ retransmissions.

IV. Proposed Text Changes

6.3.2.3 MAC Management messages

[Change the Table 14 as indicated:]

Type	Message name	Message description	connection
67	HQ_INFO	CRC verification result	basic
68-255		*reserved*	---

[Insert Table 94b as indicated (note that the original Table 94 is changed to be Table 94a)]

Table 94b MR_HARQ_Control_IE format

Syntax	Size	Notes
HARQ_Control_IE()	---	---
Prefix	1 bit	0 = Temporary disable MR HARQ 1 = enable MR HARQ
If (Prefix == 1) {	---	---
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	HARQ CH ID
MHH	1 bit	0 = active MR HARQ is enabled 1 = passive MR HARQ is enabled
Reserved	3 bits	Shall be set to zero
} else {	---	---
Reserved	3 bits	Shall be set to zero
}	---	---
}	---	---

MHH

Indicates which multi-hop HARQ is used, active MR HARQ or passive MR HARQ (which is an alternative mechanism for stable propagation environments)

[Insert new sub-clause and Table 101f as follows]

Section 6.3.2.3.43.6.10 HQ_INFO message

Table 101f —HQ_INFO message format

Syntax	Size	Notes
HQ_INFO_Message_Format () {		
CID	16 bits	Indicates the link with this CID which is achieved from MS involved within current HARQ retransmission attempt
CRC verification result	1 bit	0 = ACK_Info 1 = NACK_Info

}		

[Insert new sub-clause 6.3.17.4.1 and add figures]

Section 6.3.17.4.1 Active MR HARQ mechanism

Fundamentally the active MR HARQ is a per-hop HARQ mechanism which allows for CID update and high mobility of RS. The principle and process of this mechanism is shown in Figure 130ja and 130jb. Its key feature is that besides the "ACK/NACK" reply, the intermediate RS is expected to transmit the associated "ACK/NACK information" to the BS.

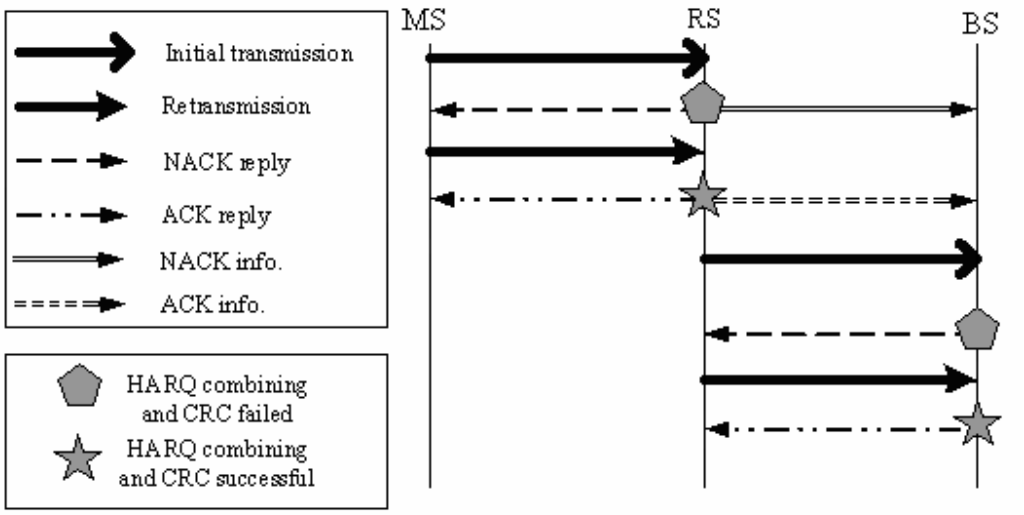


Figure 130ja: The active MR HARQ principle and process in the uplink

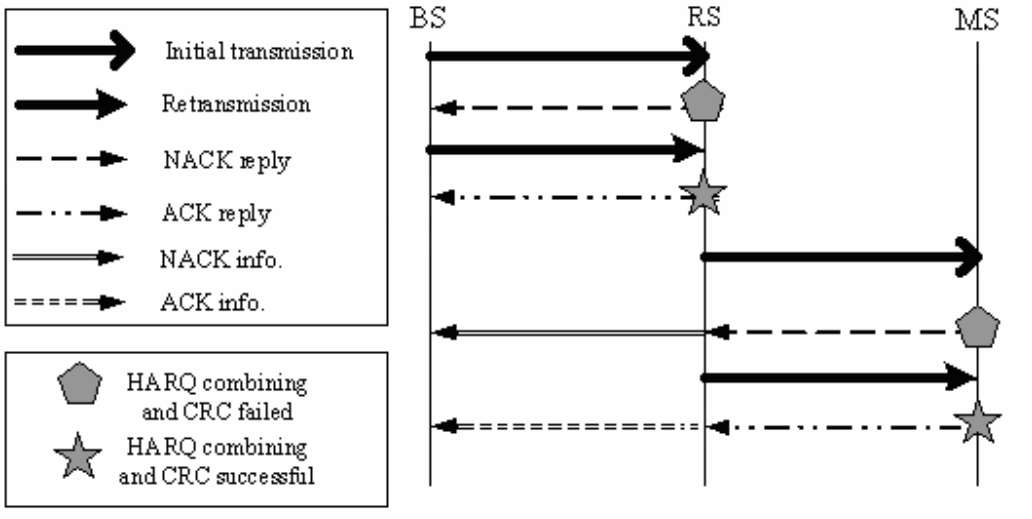


Figure 130jb: The active MR HARQ principle and process in the downlink

In the uplink, the MS transmits its packet through a certain radio channel which is allocated by the BS and broadcasted in the previous DL-MAP. The RS receives and decodes this packet exclusively if no cooperative relay is taken into account. If the received packet passes the CRC verification after HARQ combining, the RS then replies the MS an "ACK" after a fixed delay defined by HARQ_ACK_Delay for UL burst which is

specified in DCD message (see Table 358), and meanwhile an “ACK_Info” is forwarded to the BS if there are more than two hops. Otherwise, if this packet fails in CRC verification, a “NACK” is sent to the MS within the duration defined by HARQ_ACK_Delay for UL_burst and an associated “NACK_Info” is then sent to the BS. Due to the stop-and-wait protocol, the retransmissions are only sent after receiving a NACK for the previous transmission or the ACK has not been received within the duration defined by HARQ_ACK_Delay. The similar process happens in the multi-hop links.

In the downlink, the process is similar to that of the uplink case except that it is the sender that transmits the HARQ_result_message (HQ_INFO) which comes from the received ACK or NACK. Therefore, the BS is kept monitoring the HARQ processes of each hop and consequently allocates the resources for HARQ retransmissions.