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Project	**IEEE 802.16 Broadband Wireless Access Working Group <http://ieee802.org/16>**
Title	**Relay-Assisted HARQ**
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Re:	This document is in response to call for technical proposals IEEE 80216-06/027 dated 15 October 2006.
Abstract	This document describes HARQ procedures when relays are used.
Purpose	This contribution is provided as input for the IEEE 802.16j baseline document.
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Relay-Assisted Hybrid ARQ

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1 Introduction

This proposal introduces the use of relays to assist with the HARQ operation. The main idea is to allow multiple devices in the network to cooperate in order to provide reliable communication. For this scenario, the source sends a message to the destination while the relay listens to the transmission. If a retransmission is needed, the relay transmits the same message to the destination. The destination combines both sets of information it receives from the source and relay. As a result, diversity is achieved.

The proposal presented here has the following advantages:

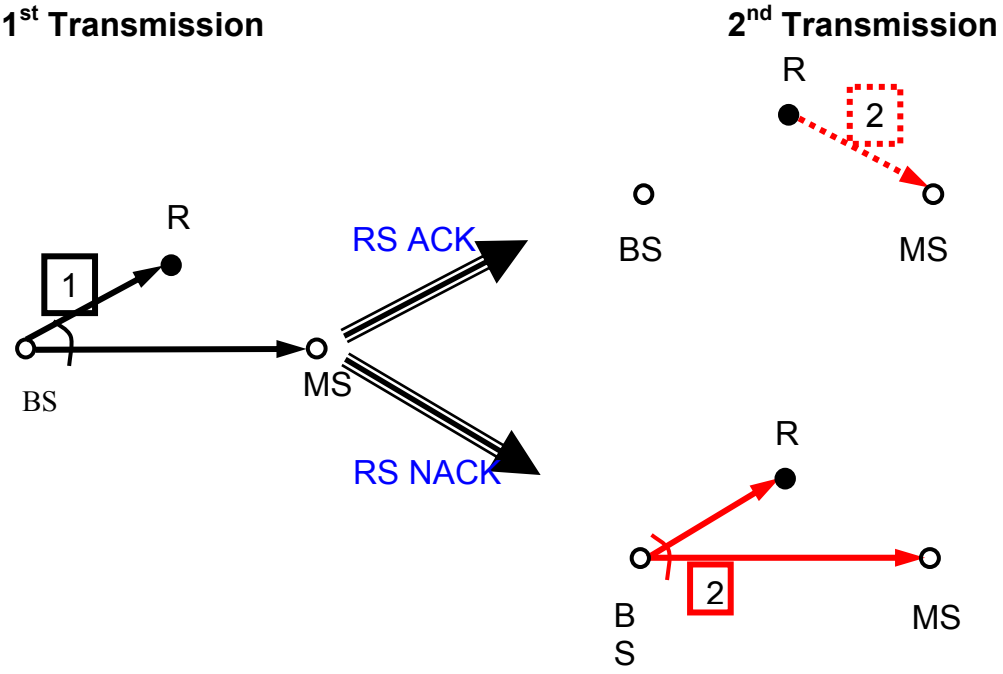
- The proposed DL procedure is transparent to the MS: the MS is not aware of any relaying operations.
- No further complexity is introduced into the system. Furthermore, HARQ mechanisms (except for the acknowledgments from RS organization) remain the same, since it is transparent to the MS whether the information comes from the RS or the BS.

2 General Description

The main idea of relay-assisted HARQ for the DL is to take advantage of the broadcasting nature of the wireless medium. When the BS transmits data to the MS for the first transmission, the RS can listen as well. Furthermore, the RS can decode the data received from the BS and forward it to the MS if a retransmission is necessary. The MS combines both received transmissions. Within this scenario, both chase combining (CC) and incremental redundancy (IR) could be implemented.

Since it is preferred to have the RS forwarded the data only if it decodes the message correctly, the RS needs to send an acknowledgement back to the BS. If the RS fails to decode the message, the next retransmission will come from the BS directly and the RS can listen again to improve its decoding performance for that packet. This enables the RS to have another opportunity to forward the data to the MS in the case that the MS requires further retransmissions.

3 Proposed relay-assisted HARQ



4 Proposed Text

[Insert new subclause 6.3.17.5]

Section 6.3.17.5. RS-Assisted HARQ

In order to improve data rates on the downlink, allowing retransmissions from an intermediate RS may be advantageous. Initially, the BS informs the RS about transmissions it needs to monitor. When the BS sends the first transmission to the MS, the RS can try to decode the same transmission as well. After the RS correctly decodes the data sent from the BS, the subsequent HARQ retransmissions may be transmitted by the RS. This process is transparent to the MS because the MS does not need to know that one transmission comes from the BS or the RS.

[Insert new subclause 6.3.17.5.1 and add figures]

Section 6.3.17.5.1 Operation of relay-assisted HARQ

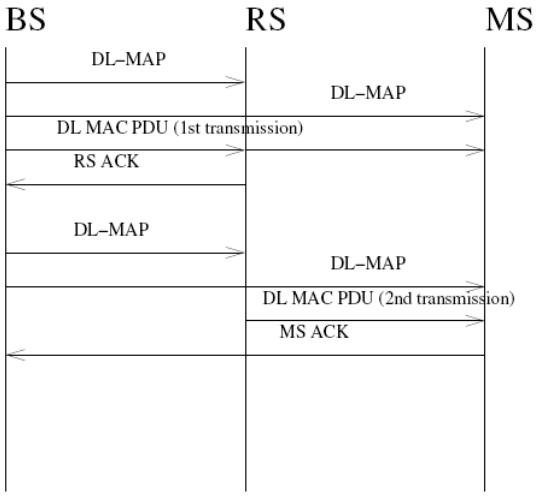


Figure 1. Relay-assisted HARQ when the RS decodes the first transmission successfully.

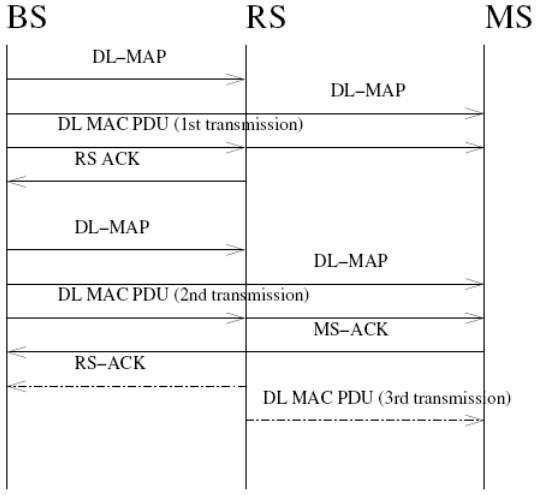


Figure 2. Relay-assisted HARQ where the RS fails to decode the first transmission.

The process of HARQ with RS assistance is shown in Figures 1 and 2. In the DL-MAP, the downlink resource allocations are sent to the MS and RS. In the downlink sub-frame, the BS sends the data to the RS, and the MS monitors that same transmission and attempts to decode it. Within the same frame, the BS allocates space for the acknowledgment of the RS. Depending on the acknowledgment of the RS, there are two possible cases. In the first case, if the RS replies with an ACK (meaning that the data has been correctly decoded at the RS), within the next frame, the BS will allocate space for the RS to send the HARQ data to the MS and at the same time the BS will allocate the space for the MS to acknowledge the received data. This process is illustrated in Figure 1. In the second case, if the RS replies with NACK (meaning that the RS was not able to decode the data during the first transmission), the BS will repeat the first transmission attempt to both the RS and MS during a second frame. Within this second frame, the BS will allocate the space for the MS to acknowledge the second transmission. This process is illustrated in Figure 2. Additionally, at this point, the BS can also allocate

the space for the RS to acknowledge second transmission. This will enable the RS to forward the data to the MS in the case the MS is still not able to decode the data after the second direct transmission from the BS.

Section 6.3.2.3.43.4 HARQ control IE

[Insert new field in table 94 (HARQ control IE format) as indicated:]

Syntax	Size	Notes
RSH	1 bit	0 = RS-assisted HARQ is enabled 1 = RS-assisted HARQ is disabled

[Insert new subclause 6.3.2.3.43.6.10 and add table:]

Section 6.3.2.3.43.6.10 Compact_DL-MAP MONITOR IE

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

Syntax	Size	Notes
Compact_DL-MAP_IE() {		
DL-MAP Type = 7	3 bits	
DL-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
}		
}		