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Re:	A response to a Call for Technical Proposal, http://www.ieee802.org/16/relay/docs/80216j-07_007r2.pdf	
Abstract	We propose HARQ methods for RS Grouping	
Purpose	To incorporate the proposed text into the P802.16j Baseline Document (IEEE 802.16j-06/026r3)	
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DL and UL HARQ Method for RS Group

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1 Introduction

RS Group concept is described in Subclause 6.3.9.16.3.1 of the baseline document 802.16j-06/026r3. Hybrid-ARQ is an optional capability in 16e. The HARQ procedure described in 16e is not sufficient to cover multi-hop relay networks. In this contribution, we propose techniques that enable HARQ for RS groups in the case of centralized scheduling.

2 RS Grouping

The baseline document C80216j-06/026r3 describes several characteristics of RS grouping. An RS-group may consist of either one MR-BS and a number of RSs, or only RSs one of them being a non-transparent RS. The criteria for forming a new group, joining an existing group, and leaving the group are implementation specific. The MR-BS (or the non-transparent member of the RS group) transmits preamble and FCH/MAP at all frames, while the other members may either transmit the same preamble/FCH/MAP as the group leader, or none of them transmits the preamble/FCH/MAP.

If an RS group includes an MR-BS, then the RS members of the group may be imagined as the second hop transparent RSs. If the group leader is a non-transparent RS, then this group leader may be imagined as a non-transparent RS at the k^{th} hop, and all other members as a transparent RS either at the $(k+1)^{\text{th}}$ hop. Two examples are provided in Figure 1.

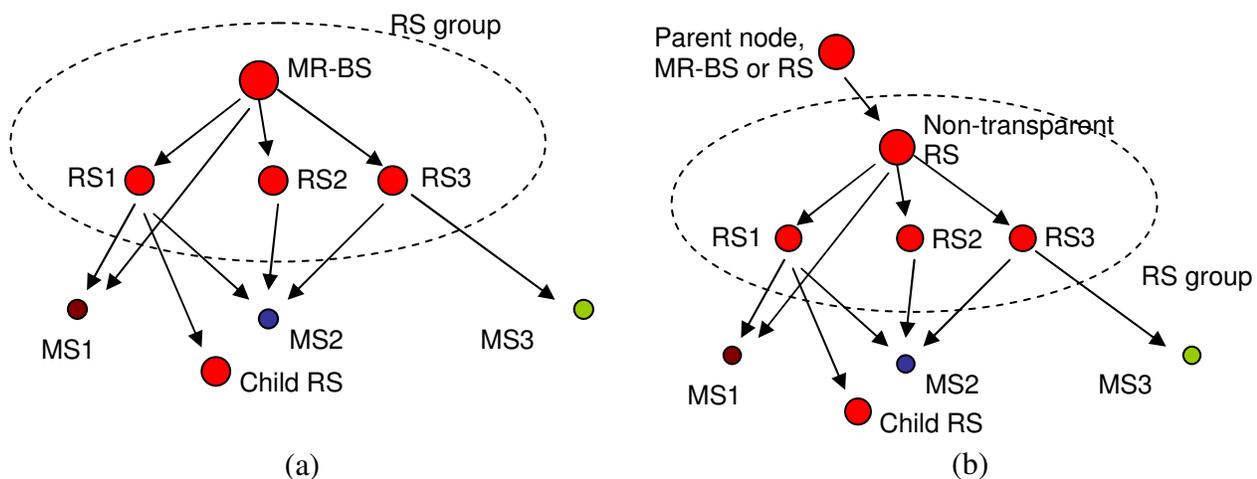


Figure 1 Example topologies for RS grouping

3 HARQ for RS Group

Viewing the RS group as a two-hop network with multiple branches, we can easily apply the HARQ methods designed for the multi-hop relay networks. In addition, due to the capabilities in an RS Group, we can improve the HARQ performance through various mechanisms. If HARQ is enabled, with centralized scheduler, the resources for HARQ packets are allocated in advance for all hops, for both DL and UL.

3.1 DL HARQ for RS Group with Centralized Scheduler

In terms of data forwarding method, a member of an RS group may operate in two modes: (i) Selective forwarding is enabled, (ii) selective forwarding is disabled. In (i), member RS may only forward the data for its associated nodes, while in (ii), it may forward all data traffic it receives from the group peer/parent leader. Selective forwarding may be enabled on a per-terminal basis (for all active CIDs for a subordinate node), or on a per-connection (CID) basis. As an example, in Figure 1.a, RS1 may be configured to forward the traffic for MS1 and MS2, while RS2 to forward the traffic for only MS2. These two links require different mechanisms for the HARQ.

The group peer/parent leader (from now on, referred as group leader) knows which member RSs are enabled with selective forwarding and which are not. The group leader uses this info along with the ACK/NACK responses to control HARQ burst flow.

The group leader transmits HARQ packet to the member RSs. The member RSs decode the data and respond to the group leader with ACK/NACK message. If at least one ACK message is received for a traffic burst that is to be forwarded by more than one member RS, only the member RSs with correct data forwards the burst to the subordinate node. If the subordinate node is an MS/SS, the member RS shall include the appropriate ACID or SPID in the MAC message. If all responses from member RSs are NACK, the group leader retransmits the HARQ packet.

If a subordinate node of the RS group is served only by one member RS and a NACK is received from this member RS for this connection/terminal, the group leader retransmits the HARQ burst for that node only.

If a subordinate node of the RS group can not decode the HARQ burst correctly, it transmits a NACK message, which may be received by all RS group members. Only the associated member RSs with correct HARQ burst re-transmits the HARQ packet. If the subordinate node is an MS/SS, the member RSs also includes the associated AI_SN and the appropriate SPID/ACID in to the MAC message.

Amplify-and-Forward DL HARQ:

If none of the member RSs could decode the HARQ packet correctly, and the associated subordinate node is able to receive data from multiple member RSs, an optional transmission scheme is to amplify-and-forward the received HARQ packet to this subordinate node. Through RF/diversity combining and superposition of received data, the subordinate node is more likely to decode the HARQ packet correctly. In this mode, the group leader waits for a ACK/NACK message that will be initiated by the subordinate node. Depending on the decoding result, the subordinate node transmits an ACK/NACK message which is forwarded to the group leader. If the group leader receives a NACK message, it retransmits the HARQ packet (along with suitable AI_SN, SPID/ACID if the subordinate node is MS/SS).

3.2 UL HARQ for RS Group

For the UL connection from a subordinate to a RS group, all RS members can receive the UL signal, though some of the UL connections may be weaker than others. In UL HARQ, all the member RSs attempt to decode the UL HARQ packet, and sends a ACK/NACK message to the group leader. If the group leader can correctly decode the HARQ packet, regardless of the ACK/NACK messages from member RSs, it sends UL HARQ success report to its serving station, and forwards the HARQ packet. It also sends ACK message to its member RSs and to the subordinate node (using DL HARQ_ACK_IE). If the decoding by group leader is not correct, it broadcast NACK message to member RSs if it has received ACK messages from them. Next, member RSs with correctly decoded HARQ packet forwards burst to the group leader. Upon successful decoding, the group leader transmits ACK message to its serving station and subordinate node (using DL HARQ_ACK_IE). If decoding is not successful at the leader RS, the group leader transmits a NACK message to the subordinate node so that it re-transmits the HARQ packet. Meanwhile, it sends a NACK message to serving station along with a dummy pattern. The upstream nodes do not attempt to decode the HARQ packets unless an ACK status is received from downstream ACK/NAK message.

Amplify-and-Forward UL HARQ:

If none of the member RSs could decode the HARQ packet correctly, the member RSs, upon reception of NACK message from the group leader, can amplify and forward the received signal to the group leader. The group leader soft combines its own packet with the signals from member RSs. Through superposition effect, the group leader is likely to perform correct decoding. If the group leader correctly decodes the HARQ packet, it sends an ACK message to the serving station along with the forwarded packet. It also sends ACK message to the subordinate nodes/MS/SS with DL HARQ_ACK_IE. According to the HARQ status, SPID/ACID needs to be modified as the MAC messages are forwarded upstream/downstream.

4 Suggested Text Changes

4.1 Insert subclause 6.3.17.x.y

[6.3.17.x.y MAC Support for HARQ for RS Grouping](#)

HARQ operation for multi-hop relay networks can be employed for RS group. A member of an RS group may operate in two forwarding data burst modes: (i) Selective forwarding is enabled; (ii) selective forwarding is disabled. In (i), member RS may only forward the data burst for its associated nodes, while in (ii), it may forward all data traffic it receives from the group peer/parent leader. Selective forwarding may be enabled on a per-terminal basis (for all active CIDs for a subordinate node), or on a per-connection (CID) basis.

The RS group leader has the knowledge of which member RS(s) are enabled with selective forwarding and which are not. The group leader uses this information along with the ACK/NAK responses to control HARQ packet flow.

4.2 Insert subclause 6.3.17.x.y.z

6.3.17.x.y.z DL HARQ for RS Grouping

If RS group leader is not an MR-BS, then it may be, say, k-hop away from the MR-BS. The HARQ operation for the multi-hop relay network can be applied, if the RS group leader received HARQ data packets.

Once the group leader receives a correctly decoded HARQ packet, it forwards HARQ packet to the member RSs. The member RSs decode the data and respond to the group leader with ACK/NAK message. If at least one ACK message is received for a data burst that is to be forwarded by more than one member RS, only the member RSs with correct data forwards the burst to the subordinate node. If the subordinate node is an MS/SS, the member RS shall include the appropriate ACID or SPID in the MAC message. If all responses from member RSs are NAK, the group leader retransmits the HARQ packet.

If a subordinate node of the RS group is served only by one member RS and a NAK is received from this member RS for this connection/terminal, the group leader retransmits the HARQ burst for that node only.

If a subordinate node of the RS group can not decode the HARQ burst correctly, it transmits a NAK message, which may be received by all RS group members. Only the associated member RSs with correct HARQ burst re-transmits the HARQ packet. If the subordinate node is an MS/SS, the member RSs also includes the associated AI SN and the appropriate SPID/ACID in to the MAC message.

Amplify-and-Forward DL HARQ:

If none of the member RSs could decode the HARQ packet correctly, and the associated subordinate node is able to receive data from multiple member RSs, an optional transmission scheme is to amplify-and-forward the received HARQ packet to this subordinate node. Through RF/diversity combining or superposition of received data, the subordinate node is more likely to decode the HARQ packet correctly. In this mode, the group leader waits for a ACK/NAK message that will be initiated by the subordinate node. Depending on the decoding result, the subordinate node transmits an ACK/NAK message which is forwarded to the group leader. If the group leader receives a NAK message, it retransmits the HARQ packet (along with suitable AI SN, SPID/ACID if the subordinate node is MS/SS).

4.3 Insert subclause 6.3.17.x.y.zz

6.3.17.x.y.zz UL HARQ for RS Grouping

For the UL connection from a subordinate to a RS group, all RS members may receive the UL signal. All the member RSs decode the UL HARQ packet, and sends a ACK/NAK message to the group leader. If the group leader can correctly decode the HARQ packet, regardless of the ACK/NAK messages from member RS(s), it sends UL HARQ success report to its serving station, and forwards the HARQ packet. It also sends ACK message to its member RSs and to the subordinate node (using DL HARQ ACK IE). If the decoding by group leader is not correct, it broadcast NAK message to member RSs if it has received ACK messages from them. Next, member RSs with correctly decoded HARQ packet forwards burst to the group leader. Upon successful decoding, the group leader transmits ACK message to its serving station and subordinate node (using DL HARQ ACK IE). If decoding is not successful at the leader RS, the group leader transmits a NAK message to the subordinate node so that it re-transmits the HARQ packet, it sends a NAK message to serving station along with a pilot and null data burst. The upstream nodes do not attempt to decode the HARQ packet unless an ACK status is received from downstream ACK/NAK message.

Amplify-and-Forward UL HARQ:

If none of the member RSs could decode the HARQ packet correctly, the member RSs, upon reception of NAK message from the group leader, can amplify and forward the received signal to the group leader. The group leader soft combines its own packet with the signals from member RS(s). If the group leader correctly decodes the HARQ packet, it sends an ACK message to the serving station along with the forwarded packet. It also sends ACK message to the subordinate nodes/MS/SS with DL HARQ ACK IE. According to the HARQ status, SPID/ACID needs to be modified as the MAC messages are forwarded upstream/downstream.

4.4 Insert new field in Table 91

[Insert new field in Table 91 (Frame Configuration IE format) as indicated:]

<u>Syntax</u>	<u>Size</u>	<u>Notes</u>
<u>AF_support_for_HARQ</u>	<u>1 bit</u>	<u>1 = Amplify-and-forward HARQ enabled for RS group</u> <u>0 = Amplify-and-forward HARQ disabled for RS group</u>