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| 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

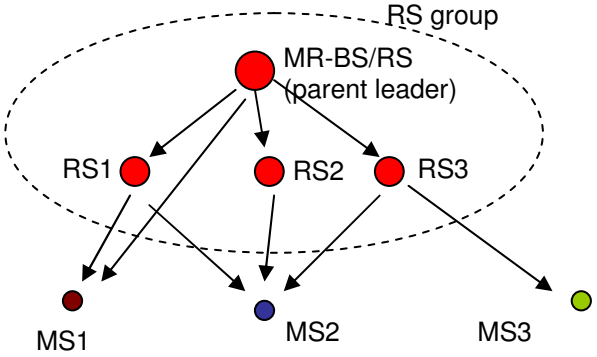
*Israfil Bahceci, Hang Zhang, Peiying Zhu, Mo-Han Fong, Wen Tong,David Steer, Gamini Senarath, Derek Yu, Mark Naden, G.Q. Wang*

## 1 Introduction

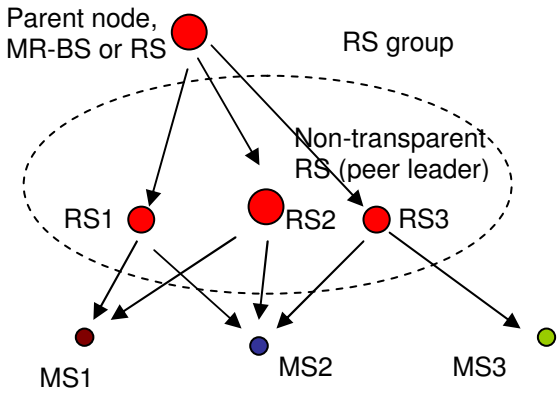
RS Group concept is described in Subcaluse 6.3.9.16.3.1 of the baseline document 802.16j-06/026r3. Hybrid-ARQ is an optional capability in 16e. The HARQ procedure described in 16e is not sufficient to cover multi-hop relay networks. In this contribution, we propose techniques that enable HARQ for RS 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. If an RS group includes an MR-BS as a member, than the RS members of the group may be imagined as the second hop transparent RSs. If the group is a non-transparent RS group, then the parent of the group (if not MR-BS) may be imagined as a non-transparent RS at the $k^{th}$ hop, and all other members as a transparent RS at the $(k+1)^{th}$ hop. Two simple examples are provided in Figure 1.




(a) Parent is a member of the RS group and all group members share the same preamble index




(b) Parent is not a group member. Group members employ a different preamble index from that of the parent.

Figure 1Example topologies for RS grouping

# 3 HARQ for RS Group

Viewing the RS group as a two-hop network with multiple braches, 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.

In terms of data forwarding method, a member of an RS group may operate in two modes: (i) it forwards traffic burst only for some specified terminals or connections, (ii) it may forward all traffic data it receives from the parent. Data forwarding may be enabled on a per-terminal basis (for all active CIDs for a subordinate terminal), 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. The HARQ procedure shall take care of these associations.

The group parent is aware of all member RS-subordinate terminal associations, and thus, may use this information along with the ACK/NAK responses during the HARQ burst flow.

## *3.1 DL HARQ for RS Group*

In the DL, the group parent transmits HARQ packet to the member RSs. The member RSs decode the data and respond to the parent with ACK/NAK 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 NAK, the parent retransmits the HARQ packet.

If a subordinate terminal 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 parent retransmits the HARQ burst for that terminal only.

If a subordinate terminal of the RS group can not decode the HARQ packet 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 terminal 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/macro-diversity combining and superposition of

received data, the subordinate terminal is more likely to decode the HARQ packet correctly. In this mode, upon reception of the NAK messages from all group members, the parent has the group members perform amplify-and-forward transmission for the HARQ packet. Then, the parent waits for an ACK/NAK message that will be initiated by the subordinate terminal. Depending on the decoding result, the subordinate terminal transmits an ACK/NAK message which is forwarded to the parent. If the parent receives a NAK message, it retransmits the HARQ packet (along with suitable AI_SN, SPID/ACID if the subordinate terminal is MS/SS).

### *3.2 UL HARQ for RS Group*

For the UL connection from a subordinate terminal 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/NAK message to the parent. If the parent can correctly decode the HARQ packet, regardless of the ACK/NAK 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 terminal (using DL HARQ_ACK_IE). If the decoding by parent is not correct, it broadcast NAK message to member RSs. Member RS(s) with correctly decoded HARQ packet forwards burst to the parent. Upon successful decoding, the parent transmits ACK message to its serving station and subordinate node (using DL HARQ_ACK_IE). If decoding is not successful at the parent and all reports from the member RSs are NAK, the parent transmits a NAK message to the subordinate terminal so that it re-transmits the HARQ packet. Meanwhile, it sends a NAK 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 NAK message from the parent, can amplify and forward the received signal to the parent. The parent soft combines its own packet and the signals from member RSs. Through superposition effect, the parent is likely to perform correct decoding. If the parent 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. If the parent can not decode correctly, the parent transmits a NAK message to the subordinate terminal so that it re-transmits the HARQ packet, it sends a NAK message to serving station along with a pilot or null data burst.

## 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 data burst forwarding modes: (i) it forwards traffic burst only for some specified terminals or connections, (ii) it may forward all traffic data it receives from the parent.

The parent is aware of all member RS-subordinate terminal associations. The group parent may use this info along with the ACK/NAK responses during the HARQ burst flow.

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 parent received HARQ data packets.

### 4.2 Insert subclause 6.3.17.x.y.z

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

Once the parent of the RS group receives a correctly decoded HARQ packet, it forwards HARQ packet to the member RSs. The member RSs decode the data and respond to the parent 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 terminal. If the subordinate terminal 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 parent retransmits the HARQ packet.

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

If a subordinate terminal 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 terminal 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 terminal. Through RF/macro-diversity combining or superposition of received data, the subordinate terminal is more likely to decode the HARQ packet correctly. In this mode, upon reception of the NAK messages from all group members, the parent has the group members perform amplify-and-forward transmission for the HARQ packet. Then, the parent waits for a ACK/NAK message that will be initiated by the subordinate terminal. Depending on the decoding result, the subordinate node transmits an ACK/NAK message which is forwarded to the parent. If the parent receives a NAK message, it retransmits the HARQ packet (along with suitable AI_SN, SPID/ACID if the subordinate terminal 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 terminal 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 parent. If the parent 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 parent is not correct, it broadcast NAK message to member RSs. Next, member RSs with correctly decoded HARQ packet forwards burst to the parent. Upon successful decoding, the parent transmits ACK message to its serving station and subordinate node (using DL HARQ_ACK_IE). If decoding is not successful at the parent and all reports from the member RSs are NAK, the parent transmits a NAK message to the subordinate terminal so that it re-transmits the HARQ packet, it sends a NAK message to serving station along with a pilot or null data burst.

**Amplify-and-Forward UL HARQ:**

If none of the member RSs and the parent could decode the HARQ packet correctly, the member RSs, upon reception of NAK message from the parent, can amplify and forward the received signal to the parent. The parent soft combines its own packet and the signals from member RS(s). If the parent 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. If the parent can not decode correctly, the parent transmits a NAK message to the subordinate terminal so that it re-transmits the HARQ packet, it sends a NAK message to serving station along with a pilot or null data burst.

### 4.4 Insert new field in Table 91

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

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