An ARQ scheme for IEEE 802.16j multihop relay networks

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None.

Purpose:
Propose a cooperative ARQ scheme to be considered for Section 6.3.4.6 ARQ Operation.

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Cooperative Retransmission

- BS transmit to SS1 in two hops via RS1. In the first hop, transmission from BS to RS1 is overheard by RS2 and RS3.
- Traditionally, a failed transmission is retransmitted by the original transmitter (BS in this case).
- Not effective: (1) the original link could suffer from extended fading, (2) other overhearing nodes have better links.
- We propose that a failed transmission to be retransmitted from overhearing nodes to SS1, or to RS1.
• To be implemented where there is at least one non-SS hop, so that there is not change required at SS.
• Non-SS hop = a hop with no SS node at both its end points
• ARQ transmit block states

• 5 possible states: Not-sent, Outstanding, Waiting-for-retransmission, Discard, Delegate.

• Mode 2 = Retransmission Delegated. Mode 1 = Retransmission Not Delegated.

• “Pseudo Retransmit” = following the original ARQ process which includes starting the ARQ_RETRY_TIMEOUT timer but not actually transmitting the packet.
Decision algorithm for cooperative retransmission

//Decision on performing actual or pseudo retransmission by the original transmitter node.  
//Link quality is calculated as the ratio of total number of packets positively acknowledged  
//over total number of packets transmitted. If the ratio is not more than 0.5, the link quality  
//is consider bad.  
if (link quality between original transmitter and intended receiver is bad)  
    mode = 2;  
else  
    mode = 1;  

//Decision on selecting cooperative node and receiver node.  
//S₁ is the set of nodes with good link quality, and are within the range of the original  
//transmitter node, the intended receiver node and the downstream node of intended  
//receiver.  
//S₂ is the set of nodes with good link quality, and are within the range of the original  
//transmitter node and the intended receiver node.  
//Q₁,i is the link quality between i-th node in S₁ and the downstream node of intended  
//receiver.  
//Q₂,i is the link quality between i-th node in S₂ and the intended receiver node.  
//Wₖ,i is the willingness to cooperate as declared by the i-th node in Sₖ.  
if (S₁ is not empty) {  
    cooperative node = arg max i ∈ S₁ {W₁,i × Q₁,i};  
    receiver node = downstream node of the intended receiver;  
}  
else if (S₂ is not empty) {  
    cooperative node = arg max i ∈ S₂ {W₂,i × Q₂,i};  
    receiver node = intended receiver;  
}  
else  
    original ARQ procedure;
Scheduling algorithm for cooperative retransmission

generate a random number $x$ within the range and inclusive of 0 and 1
if ($x \leq P_1$ and own packet queue is not empty)
   transmit own packet;
else if ($x \leq P_1 + P_2$ and retransmission queue is not empty)
   retransmit own failed packet;
else if ($x \leq P_1 + P_2 + P_3$ and identified as cooperative node and the failed packet is buffered)
   retransmit overheard failed packet;

// $P_1 + P_2 + P_3 = 1$
// $P_1 \geq P_2 + P_3$.
// Suggestion: $P_1 = 2 \times (P_2 + P_3)$ and $P_2 = P_3$
<table>
<thead>
<tr>
<th>Syntax</th>
<th>Size</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>C-ARQ_IE(LAST) {</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Syntax</td>
<td>Size</td>
<td>Notes</td>
</tr>
<tr>
<td>COOPERATIVE NODE</td>
<td>16 bits</td>
<td>The identified Cooperative Node</td>
</tr>
<tr>
<td>LAST</td>
<td>1 bit</td>
<td>0 = More C-ARQ IE in the list</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1 = Last C-ARQ IE in the list</td>
</tr>
<tr>
<td>TYPE</td>
<td>2 bits</td>
<td>0x0 = C-ARQ Feedback (C-NACK)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0x1 = C-ARQ Command</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0x2 = reserved</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0x3 = reserved</td>
</tr>
<tr>
<td>CID</td>
<td>16 bits</td>
<td>The ID of the connection being referenced</td>
</tr>
<tr>
<td>BSN</td>
<td>11 bits</td>
<td>Block Sequence Number</td>
</tr>
<tr>
<td>MODE</td>
<td>2 bits</td>
<td>0x0 = reserved</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0x1 = Not Pseudo Retransmission</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0x2 = Pseudo Retransmission</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0x3 = reserved</td>
</tr>
<tr>
<td>RECEIVER NODE</td>
<td>16 bits</td>
<td>The identified Receiver node</td>
</tr>
<tr>
<td>}</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**C-ARQ IE**