HARQ for Multi-hop Relaying System

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    David Comstock, John Lee,

    Zheng Shang, Jingling Zhu   Voice   +1 858 735 9382

    Huawei Technologies   E-mail: dcomstock@huawei.com

    No. 98, Lane 91, Eshan Road, Shanghai, PRC

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Base Document:

    IEEE C802.16j-06/XXX http://dot16.org/CSUpload//upload/Relay_db/C80216j-06_XXX.pdf

Purpose:

    The purpose of this slide set is to introduce contribution C802.16j-06_XXX. This contribution describes the HARQ procedure for multi-hop relaying system. Changes in the standard are partially described in contribution C802.16j-06_XXX.pdf.

Outline

- Introduction
- Problem Statement
- End-to-End Transparent HARQ
- Hop-by-Hop Non-Transparent HARQ
- Summary

Introduction

- **From MS's point of view:**
  - Transparent RS
    - Doesn't transmit preamble and MAP signal, or just transmit the same preamble and MAP signal with its superior anchor station;
    - MS can not sense the existence of transparent RS at all;
    - Transparent RS is a low capability RS, which is controlled by its anchor station;
  - Non-Transparent RS
    - Generate and send its own preamble and MAP signal;
    - Non-transparent RS act as a BS to MS;
    - Non-transparent is a high capability RS, and has the ability of resource scheduling, it can be the anchor station of a transparent RS;

- **In HARQ procedure**
  - Transmission and retransmission resource should be allocated for the corresponding MS and RS;
  - The HARQ procedure of the transparent RS is different from that of the non-transparent RS;

Problem Statement

- For non-transparent RS
  - Hop-by-Hop HARQ is preferred for the simplicity and efficiency;
    - Access Link: legacy 16e HARQ remains unchanged;
    - Relay Link: legacy 16e mechanism can be reused with some optimization;
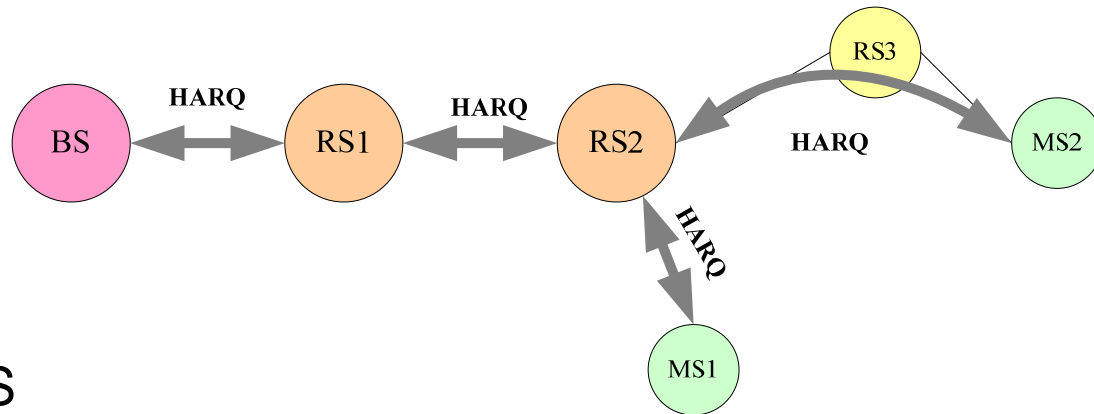
- For transparent RS
  - End-to-End HARQ is more suitable for the lacking of resource scheduling capability;
    - New HARQ procedure should be defined;
    - When a MS accesses to a transparent RS, the MS adjusts its uplink power to this RS via ranging procedure. Therefore, the anchor station can not be guaranteed to receive the uplink signal directly from MS;

End-to-End Transparent HARQ
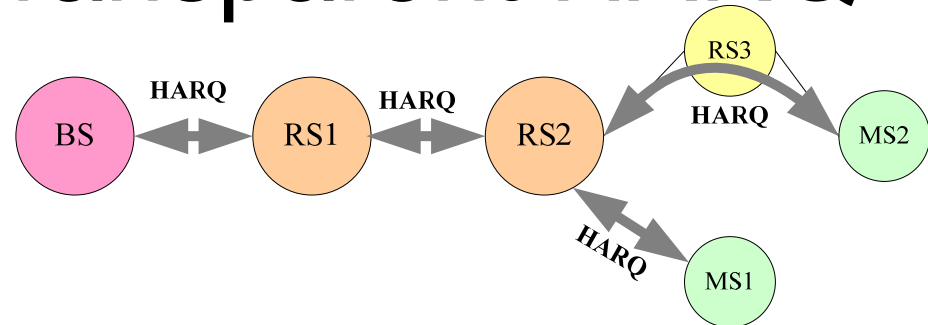
- Downlink HARQ:
  - When RS2 relays downlink HARQ burst to MS2, RS2 first send the burst to RS3;
  - Then the burst transmission will be indicated to MS2 via DL-MAP, this MAP information may be transmitted by RS3 at the same time;
  - If RS3 received burst correctly, it will relay the burst as DL-MAP indicated, otherwise, no data will be send by RS3 in order to reduce interference;
  - MS2 will receive the burst as the indication of DL-MAP, and send the feedback information following the method defined in legacy 16e;
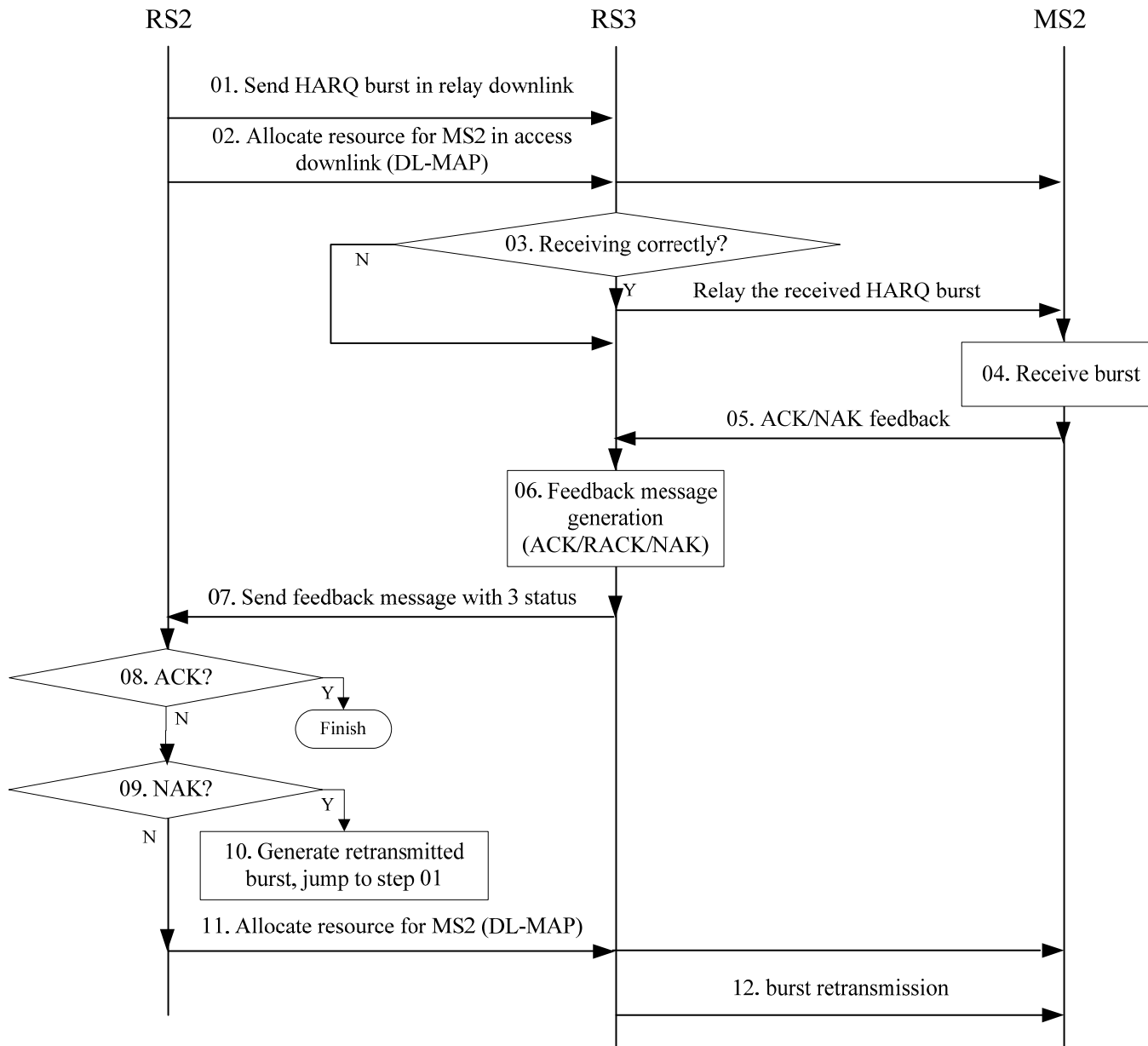 - When RS3 receives the feedback information from MS2, it will generate and send feedback message with three statuses to RS2:
    - ACK means MS2 receives burst correctly;
    - NAK means neither MS2 nor RS3 receives burst correctly.
    - RACK means RS3 receives burst correctly, but MS2 fails to receive the burst;
  - When RS2 get the feedback message, it can tell whether the burst is received correctly by MS2 and RS3, and turn to relevant processing;
  - When feedback is RACK, retransmission from RS3 is performed.

Message Type	Length of Bitmap1	Bitmap1	Bitmap2

Feedback message with three status

RS2   RS3   MS2

01. Send HARQ burst in relay downlink

02. Allocate resource for MS2 in access downlink (DL-MAP)

03. Receiving correctly?

N

Y   Relay the received HARQ burst

04. Receive burst

05. ACK/NAK feedback

06. Feedback message generation (ACK/RACK/NAK)

07. Send feedback message with 3 status

08. ACK?

Y

Finish

N

09. NAK?

Y

10. Generate retransmitted burst, jump to step 01

N

11. Allocate resource for MS2 (DL-MAP)

12. burst retransmission

Procedure of downlink HARQ

HARQ burst Number	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Receiving status of RS3	1	1	1	1	1	1	1	0	1	1	1	1	1	1	1	0

HARQ burst Number	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Feedback status of MS2	1	1	1	0	1	1	1	0	1	1	0	0	1	1	1	0
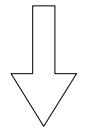
Bitmap sequence number	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Bitmap1	1	1	1	0	1	1	1	0	1	1	0	0	1	1	1	0

Bitmap2	1	0	1	1	0
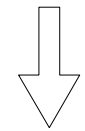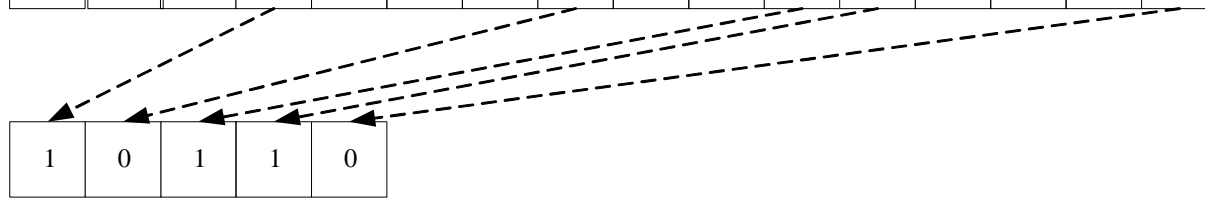
HARQ burst Number	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Feedback information derived by RS2	ACK	ACK	ACK	RACK	ACK	ACK	ACK	NAK	ACK	ACK	RACK	RACK	ACK	ACK	ACK	NAK

Detailed explanation of three status feedback message

End-to-End Transparent HARQ

- Uplink HARQ
  - Before MS2 sends HARQ burst to RS2, RS2 allocates uplink resource to MS2 via UL-MAP (RS3 may transmit the same UL-MAP at the same time);
  - RS3 receives the burst transmitted by MS2, and sends the receiving status to RS2;
  - If RS3 receives the burst correctly, it will relay the burst to RS2. Otherwise, no data will be transmitted;
  - RS2 will generate the feedback message to MS2 according to the receiving status of RS3;
  - When the burst is correctly received by RS3, ACK is generated and sent to MS2 by RS2, otherwise, NAK is sent;
  - The processing thereafter is determined according to the receiving status of RS2 and RS3;
  - When the burst is correctly received by RS3, but RS2 is failed, retransmission from RS3 is performed, other than from MS2;
  - The retransmission from RS3 is controlled by RS2;
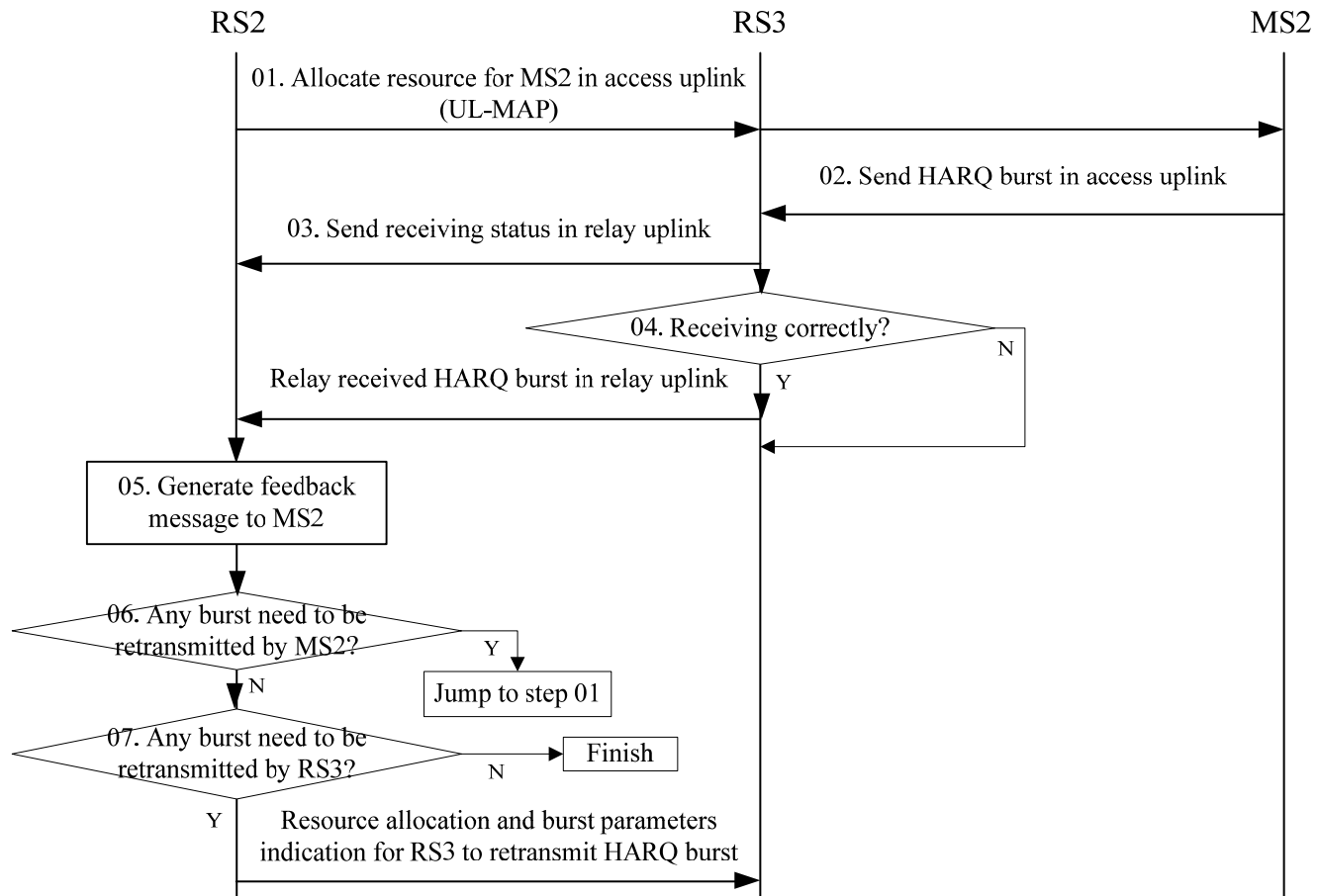
Procedure of uplink HARQ

Hop-by-Hop Non-Transparent HARQ

- For hop-by-hop non-transparent HARQ
  - Legacy 16e HARQ remains unchanged for access link;
  - As to relay link, legacy 16e mechanism can be reused with some optimization;

Summary

- End-to-End Transparent HARQ
  - For either uplink or downlink HARQ, as long as the transparent RS between the source station and the destination station receives the packets from the source station correctly, but the destination station is failed at receiving. The burst is retransmitted by the transparent RS at the control of anchor station, other than from the source station.