

HARQ Mechanisms in Multi-hop Relay

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HARQ Mechanism in IEEE 802.16j

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Overview

Hybrid-ARQ (HARQ) is a mechanism to compensate for degradation of the received BER which results from fast fading and shadow fading

- Improving BER/PER performance due to the fast re-transmission and time diversity via HARQ combining
- HARQ over multiple hops potentially has fewer re-transmission due to better propagation environments

Issues of HARQ mechanism in multi-hop networks

- Varying propagation conditions and different hops may result in the different HARQ performances from hop to hop
- Drainage of radio resource and large delay introduced by multiple re-transmissions over multiple hops
- Two types of multi-hop HARQ mechanisms
 - Per-link multi-hop HARQ
 - Multi-link multi-hop HARQ

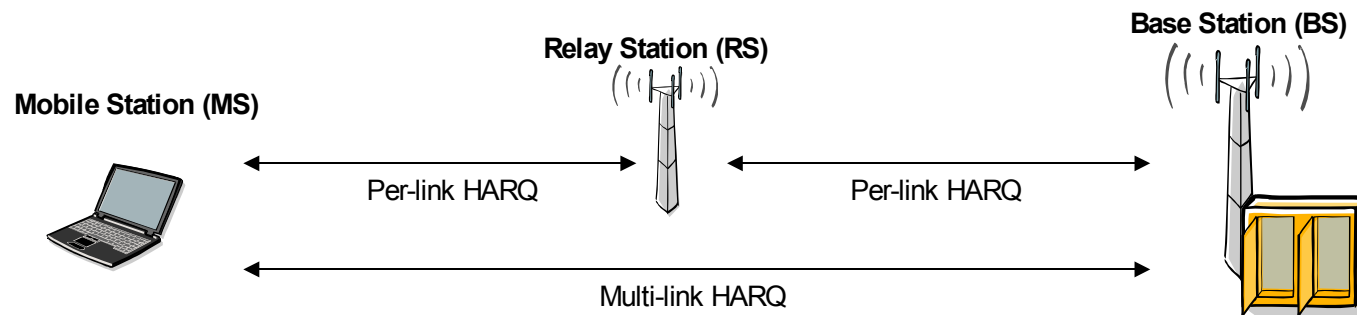


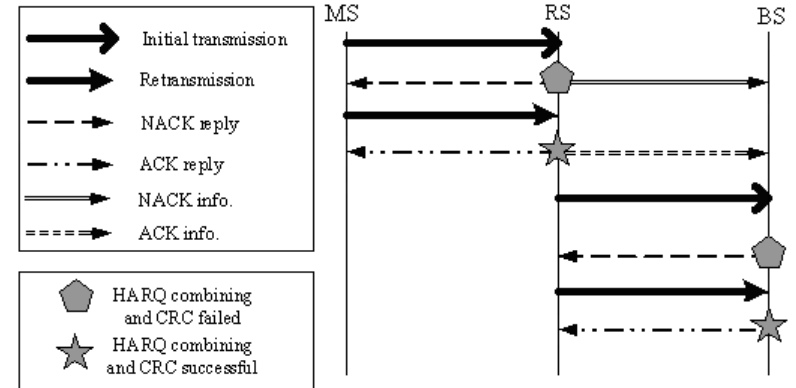
Fig. 1 Per-link HARQ and Multi-link HARQ in multi-hop relay networks

Proposed Scheme

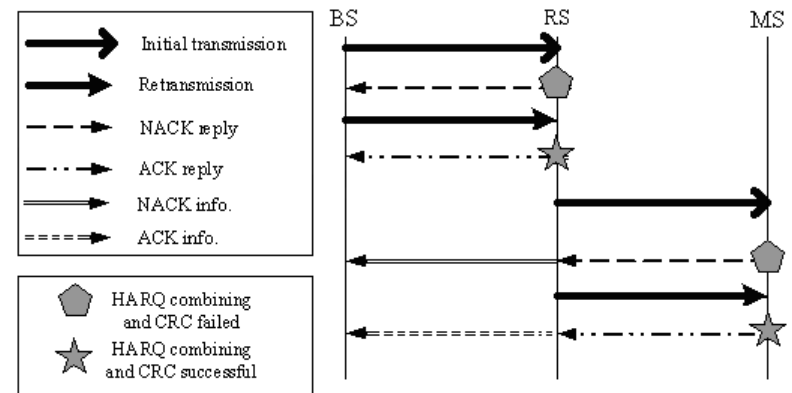
- Active Multi-hop Relay (MR) HARQ mechanism
 - It is a per-link HARQ mechanism, potentially for fast changing propagation environments, i.e., Mobile RS (MRS) and the functions such as traffic congregation
 - Supports CID update at RS
- Passive Multi-hop Relay (MR) HARQ mechanism
 - It is a multi-link HARQ mechanism for simplicity and low latency
 - RS forwards ACK/NACK
 - No additional messages required
- MMR HARQ mechanism and its related resource allocation are mainly concerned
 - Both Chase combining HARQ and Incremental Redundancy HARQ are supported
 - Active/passive MR HARQ mechanisms are complementary to each other for different application scenarios and functions.
 - Can be applied to both DL and UL.

Active MR HARQ Mechanism

- CRC verification results at RS are reported to the BS
- Central HARQ retransmission control
 - HARQ retransmission attempts are triggered by BS, MS or RS
 - Resources for HARQ retransmission including relay links are allocated by BS
- Distributed HARQ combining performed hop by hop
 - At RS, HARQ retransmissions are combined till the frame succeeds in CRC verification or the maximum retransmission number is reached before forwarding
 - Code rate or modulation scheme can change from hop to hop for same data
 - Active MR HARQ allows for implementation of RS in high mobility or fast change wireless environment
- Per-link HARQ mechanism
 - Allows for some special functions at RS, such as traffic congregation and CID update
 - Less radio resource needed for relay including spectrum and time slot



(a) The principle and procedure in uplink



(b) The principle and procedure in downlink

Fig. 2: The principle and procedure in the active MR HARQ mechanism

Passive HARQ Mechanism

- HARQ retransmissions are triggered by BS or MS with the aid of RS
- HARQ combining is performed at each RS
 - In CC case, RS combines HARQ retransmission with previously received copy and then forwards the combined packet to the next link.
 - In IR case, RS combines HARQ retransmission with previously received copy, and then verify CRC. If CRC check passes, the combined packet is forwarded. Otherwise, the combined or the latest retransmission is forwarded to the next link.
- If a correct packet is available after HARQ combining at RS, the RS initializes HARQ retransmission as a source node.
- Allows for some features and functions such as cooperative relay, transparent relay

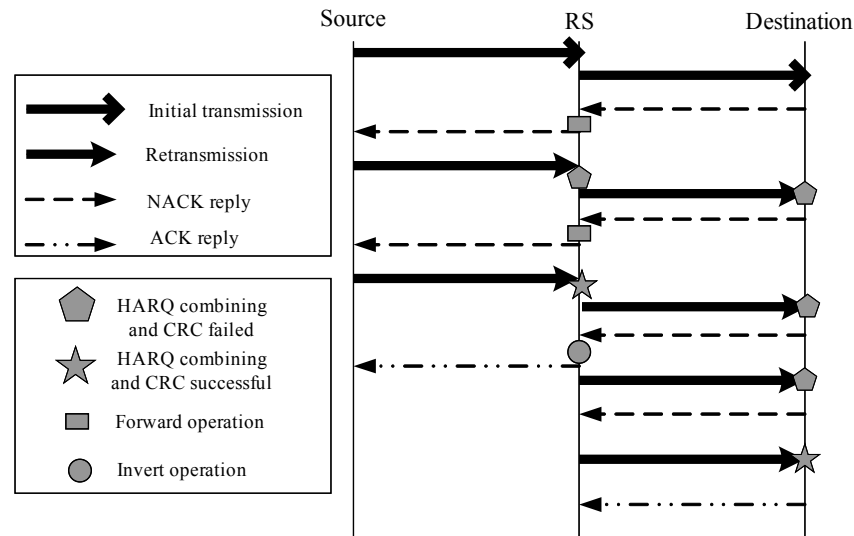


Fig.3: The passive MR HARQ mechanism in uplink

Summary

Two multi-hop HARQ mechanisms proposed for different scenarios and environments

- Active MR HARQ
 - A per-link HARQ mechanism in multi-hop relay network
 - Allowing for high mobility of the RS and special functions, i.e., CID update and traffic congregation
 - Less retransmission resource

- Passive MR HARQ
 - A multi-link mechanism with limited intelligence
 - Cooperative relay can be implemented with this mechanism
 - Fast convergence

Thanks!