HARQ ACK Channels and Retransmission Dummy Pattern Performance Comparison

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Purpose:
Performance comparison of HARQ ACK/NAK channels and re-transmission dummy pattern

Background

- Several ACK/NAK channels schemes are proposed for MR system.
  - Performance and overhead tradeoff should be compared
- Several re-transmission dummy patterns are proposed for MR system
  - Performance should be compared and optimized
- This contribution reports the simulation results for performance comparisons and propose our recommendations

Schemes Compared

ACK/NAK	Re-transmit Dummy Pattern
ACK/NAK (1bit) (Table 301)	Skip Error Packet (with Common Pilot)
ACK/NAK (3bit) (Table in 07-203)	Send Re-encode Error Packet (with Common Pilot)
CQICH (3bit) (Table 298c)	Send Null packet (with Common Pilot)
CQICH (6bit) (Table 298d)	Send AF Error Packet (with Dedicated Pilot)

ACK/NAK

Table 301

ACK 1-bit symbol	**Vector Indices per Tile Tile(0), Tile(1), Tile(2)**
0	**0, 0, 0**
1	**4, 7, 2**

Baseline ACK/NAK

07-203

Link Distance/Depth	**Vector Indices per Tile Tile(0), Tile(1), Tile(2)**
Any Distance	0, 0, 0
1	4, 7, 2
2	3, 5, 1
3	7, 2, 4
4	5, 1, 3
5	6, 2, 3
6	5, 1, 7
7	2, 6, 5

New Physical Channel

Table 298c

Link Distance/Depth	**Fast Feedback vector indices per Tile Even = {Tile(0), Tile(2),Tile(4)} or Odd = {Tile(1), Tile(3),Tile(5)}**
0	0, 0, 0
1	1,1,1
2	2,2,2
3	3,3,3
4	4,4,4
5	5,5,5
6	6,6,6
7	7,7,7

Sub-set of CQICH channel

Proposed ACK/NAK

6-bit Payload (binary)	Fast-feedback vector indices per Tile Tile(0), Tile(1), ... Tile(5)	6-bit Payload (binary)	Fast-feedback vector indices per Tile Tile(0), Tile(1), ... Tile(5)
000000	0,0,0,0,0,0	100000	6,7,5,1,2,4
000001	1,1,1,1,1,1	100001	7,6,4,0,3,5
000010	2,2,2,2,2,2	100010	4,5,7,3,0,6
000011	3,3,3,3,3,3	100011	5,4,6,2,1,7
000100	4,4,4,4,4,4	100100	2,3,1,5,6,0
000101	5,5,5,5,5,5	100101	3,2,0,4,7,1
000110	6,6,6,6,6,6	100110	0,1,3,7,4,2
000111	7,7,7,7,7,7	100111	1,0,2,6,5,3
001000	2,4,3,6,7,5	101000	7,5,1,2,4,3
001001	3,5,2,7,6,4	101001	6,4,0,3,5,2
001010	0,6,1,4,5,7	101010	5,7,3,0,6,1
001011	1,7,0,5,4,6	101011	4,6,2,1,7,0
001100	6,0,7,2,3,1	101100	3,1,5,6,0,7
001101	7,1,6,3,2,0	101101	2,0,4,7,1,6
001110	4,2,5,0,1,3	101110	1,3,7,4,2,5
001111	5,3,4,1,0,2	101111	0,2,6,5,3,4
010000	4,3,6,7,5,1	110000	5,1,2,4,3,6
010001	5,2,7,6,4,0	110001	4,0,3,5,2,7
010010	6,1,4,5,7,3	110010	7,3,0,6,1,4
010011	7,0,5,4,6,2	110011	6,2,1,7,0,5
010100	0,7,2,3,1,5	110100	1,5,6,0,7,2
010101	1,6,3,2,0,4	110101	0,4,7,1,6,3
010110	2,5,0,1,3,7	110110	3,7,4,2,5,0
010111	3,4,1,0,2,6	110111	2,6,5,3,4,1
011000	3,6,7,5,1,2	111000	1,2,4,3,6,7
011001	2,7,6,4,0,3	111001	0,3,5,2,7,6
011010	1,4,5,7,3,0	111010	3,0,6,1,4,5

CQICH Coding for ACK/NAC

- Assume x_{ij} as the transmit symbol at data tone j of the tile i, where $i = 0, 1, \ldots, 5$, and $j = 0, 1, \ldots, 7$.
- $X=[x_{ij}]$ is selected form the codebook P.
  - $\mathbf{p}=[p_{ij}]$ is a codeword of the codebook P containing 64 different codewords.
  - p_{ij} is selected from a QPSK constellation.
  - Each codeword represents a 6-bit binary number.
- Assume y_{ijk} as the received symbol at the receive antenna number k.

Coherent Detector

- $h^{\wedge}_{ijk}$ represents estimated channel between transmit antenna and the kth receive antenna for the data tone j and tile i.
  - Channel is estimated based on the received pilots per each tile.
  - The best channel estimation method is to average the 4 pilots over a uplink tile.
- Coherent detection is defined as follows:

Non-coherent Detector

- No channel estimation
- Non-coherent detection is defined as follows:

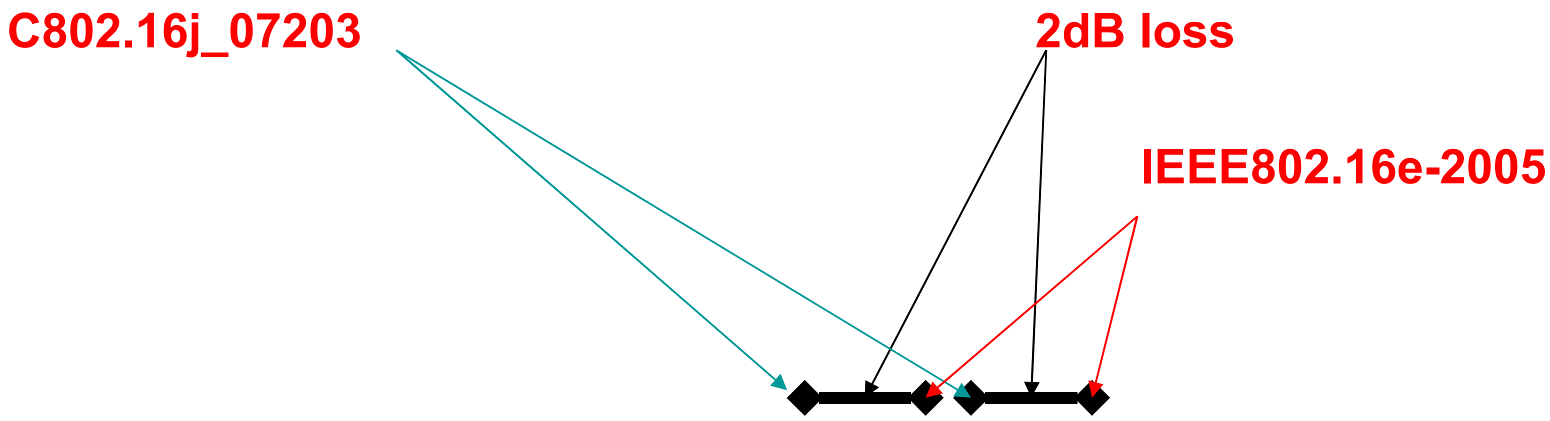
Pilot Overhead

- Coherent detection needs pilot for channel estimation.
- Pilot overhead for uplink tile is $10\log_{10}(12/8) \sim 1.7$ dB assuming no pilot power boost.
- Benefit of non-coherent detection is that there is no need to transmit pilots.
  – Null pilot tones
  – 1.7 dB power saving in comparison to coherent detection

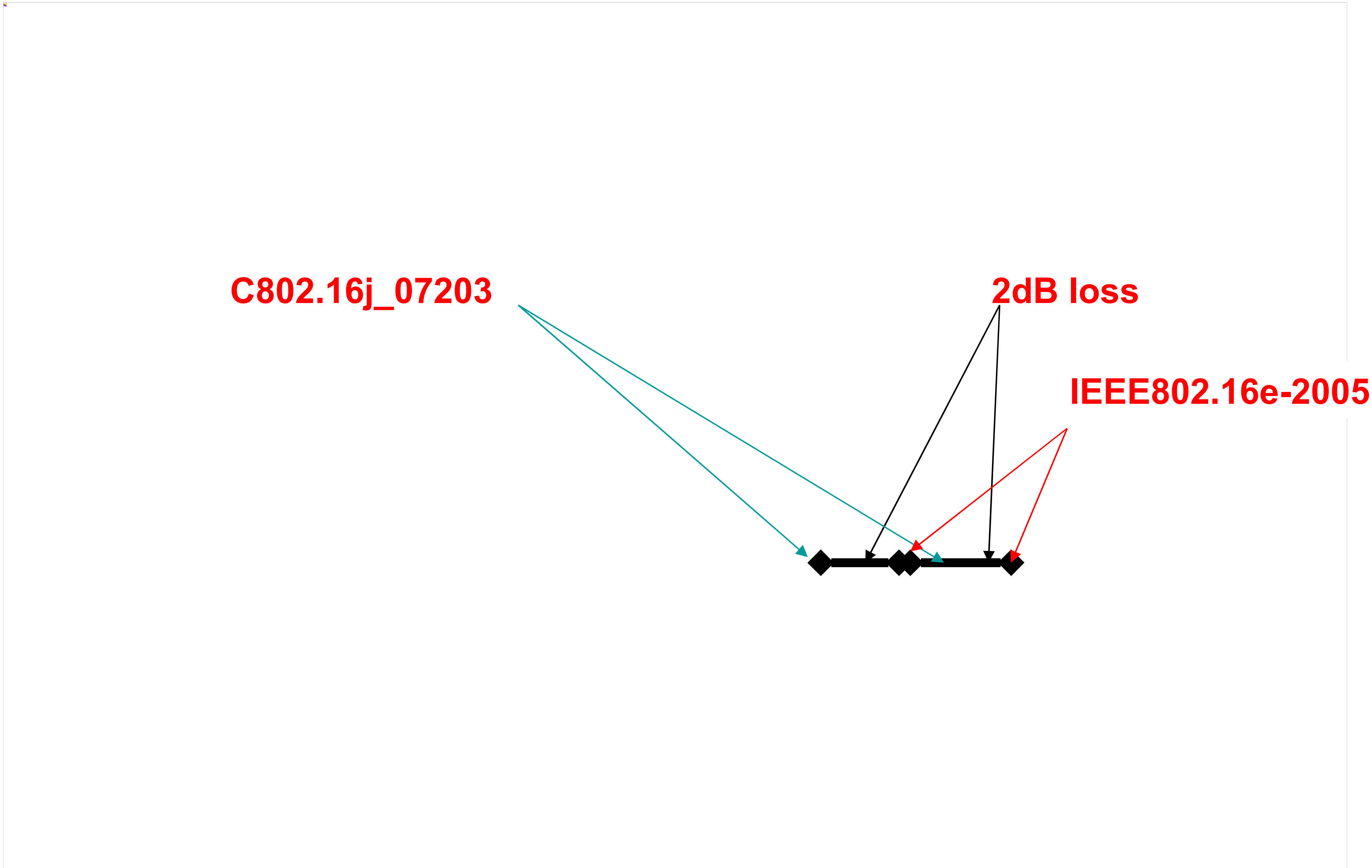
Simulation Conditions

- Carrier Frequency = 2.5 GHz
- Channel assignment: Half of UL slot = 3 tiles
- Hypothesis = 8 (3bits)
- SIMO UL
- Channel Models
  - ITU-PB, 3km/h
  - ITU-VA 30km/h
  - ITU-VA 120km/h
- Receiver Model
  - Non-coherent, Non-coherent pilot assisted, Coherent-Perfect CSI

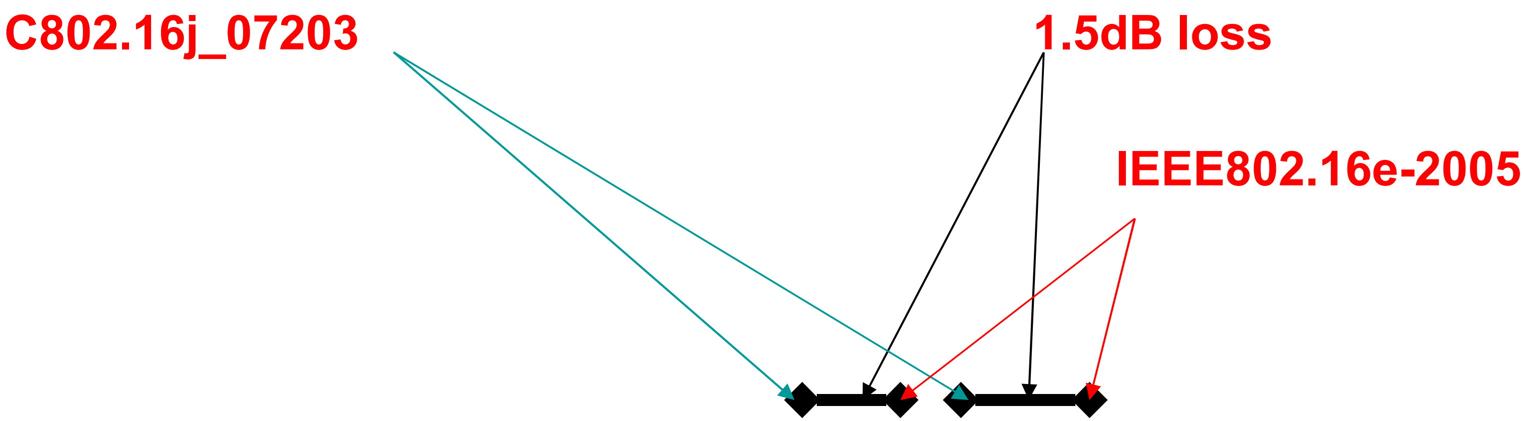
3-bit ACK/NACK Channel Comparison



3-bit ACK/NACK Channel Comparison



3-bit ACK/NACK Channel Comparison



6-bit Compact ACK/NACK Channel

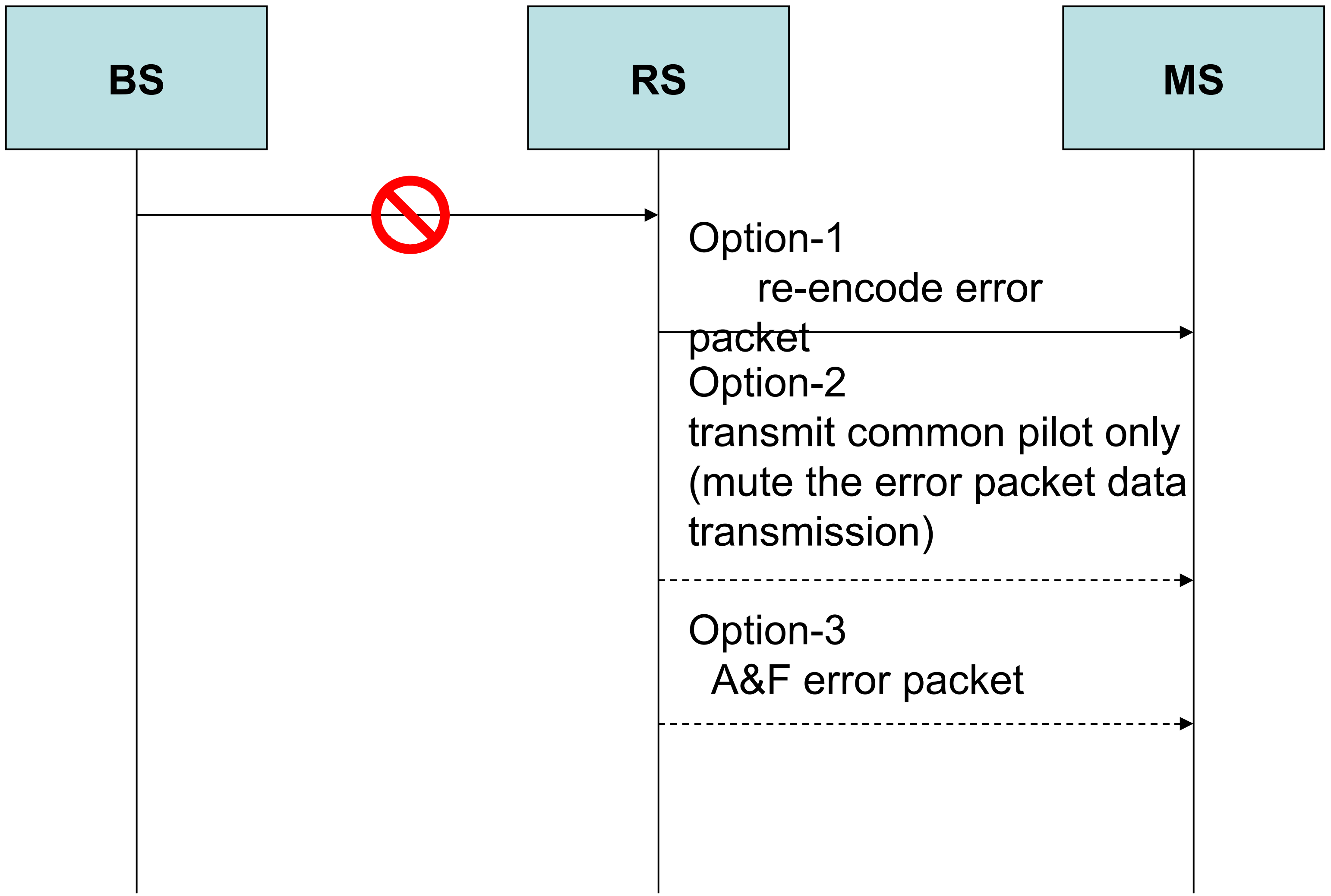
6-bit Compact ACK/NACK Channel

6-bit Compact ACK/NACK Channel

Summary of ACK/NACK Channel Performance

- The performance of IEEE802.16e-2005 3-bit CQICH channel as defined in Table 298c is outperform the 3-bit ACK/NACK channel proposed in 802.16j-07/203
  - The 3-bit ACK/NACK channel proposed in 802.16j-07/203 is optimized for AWGN channel not fading channel
- Reuse of IEEE802.16e-2005 6-bit CQICH channel as defined in Table 298d can be used as compact ACK/NACK channel without performance lose
- Recommendations →
  - Reuse IEEE802.16e-2005 3-bit CQICH channel as defined in Table 298c as 3-bit ACK/NACK channel
  - Reuse IEEE802.16e-2005 6-bit CQICH channel as defined in Table 298d as 6-bit compact ACK/NACK channel

Re-transmit Dummy Pattern



Simulation Conditions

- Carrier Frequency = 2.5 GHz, SISO
- Channel model ITU-PB 3km/h
- Coding modulation: QPSK 1/3.
- It is assumed that the first hop fails to decode with probability of 10% to 30% @ SNR is -2dB, 0dB , 2dB.
- It is assumed that it is decoded in the 1st hop after 2nd transmission
  - ie. BLER of 1st hop after 2nd transmission is 0
- Scenario 1 → Option-2
- Scenario 2 → Option-3

Simulation Results for Transmit Dummy Pattern

Simulation Results for Transmit Dummy Pattern

Simulation Results for Transmit Dummy Pattern

Simulation Results for Transmit Dummy Pattern

Summary for Transmit Dummy Pattern

- 3 Options are considered
- Option-1: Re-encode error packet
- Option-2: Transmit common pilot only
  - mute the error packet data transmission
- Option-3: A&F error packet
- We recommend Option-1 & 2 for RS

Backup

1-bit ACK/NAK

1-bit ACK/NAK

1-bit ACK/NAK