

HARQ ACK Channels and Retransmission Dummy Pattern Performance Comparison

IEEE 802.16 Presentation Submission Template (Rev. 8.3)

Document Number:

IEEE C802.16j-07/290r3

Date Submitted: 2007-05-05

Source:

Hadi Baligh, Hosein Nikopour, Wen Tong, Hang Zhang, Peiying Zhu,
Mohan, Fong, Gamini Senarath, David Steer, Israfil Bahceci,
G.Q. Wang, Mark Naden, Derek Yu
Nortel
3500 Carling Avenue
Ottawa, Ontario
CANADA

Voice: 613-763-1315
Email: wentong@nortel.com

Venue:

IEEE 802.16 Session #49, Portland, USA

Base Document:

IEEE C802.16j-06/026r2 and URL <http://ieee802.org/16/.../C80216j-06_026r2.pdf>

Purpose:

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

Notice:

This document has been prepared to assist IEEE 802.16. It is offered as a basis for discussion and is not binding on the contributing individual(s) or organization(s). The material in this document is subject to change in form and content after further study. The contributor(s) reserve(s) the right to add, amend or withdraw material contained herein.

Release:

The contributor grants a free, irrevocable license to the IEEE to incorporate material contained in this contribution, and any modifications thereof, in the creation of an IEEE Standards publication; to copyright in the IEEE's name any IEEE Standards publication even though it may include portions of this contribution; and at the IEEE's sole discretion to permit others to reproduce in whole or in part the resulting IEEE Standards publication. The contributor also acknowledges and accepts that this contribution may be made public by IEEE 802.16.

IEEE 802.16 Patent Policy:

The contributor is familiar with the IEEE 802.16 Patent Policy and Procedures <<http://ieee802.org/16/ipr/patents/policy.html>>, including the statement "IEEE standards may include the known use of patent(s), including patent applications, provided the IEEE receives assurance from the patent holder or applicant with respect to patents essential for compliance with both mandatory and optional portions of the standard." Early disclosure to the Working Group of patent information that might be relevant to the standard is essential to reduce the possibility for delays in the development process and increase the likelihood that the draft publication will be approved for publication. Please notify the Chair <<mailto:chair@wirelessman.org>> as early as possible, in written or electronic form, if patented technology (or technology under patent application) might be incorporated into a draft standard being developed within the IEEE 802.16 Working Group. The Chair will disclose this notification via the IEEE 802.16 web site <<http://ieee802.org/16/ipr/patents/ntices>>.

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

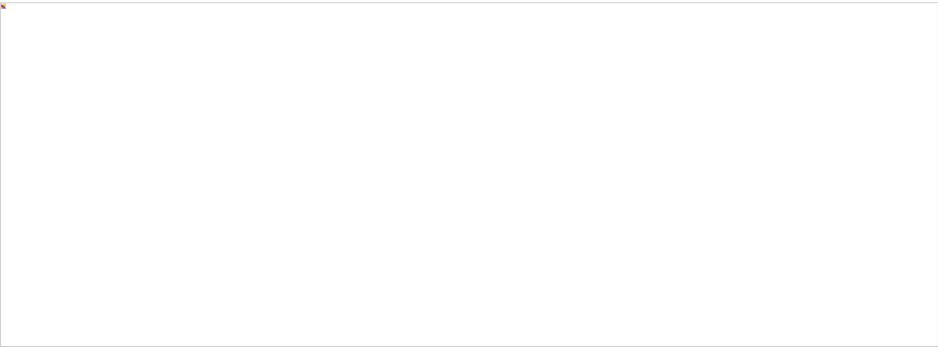
Table 298c

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

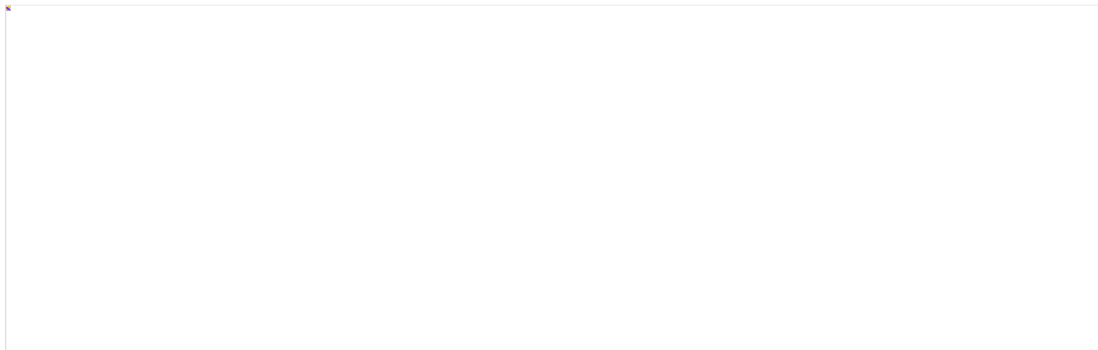


CQICH Coding for ACK/NAC

- Assume x_{ij} as the transmit symbol at data tone j of the tile i , where $i = 0, 1, \dots, 5$, and $j = 0, 1, \dots, 7$.
- $\mathbf{X}=[x_{ij}]$ is selected from 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 .

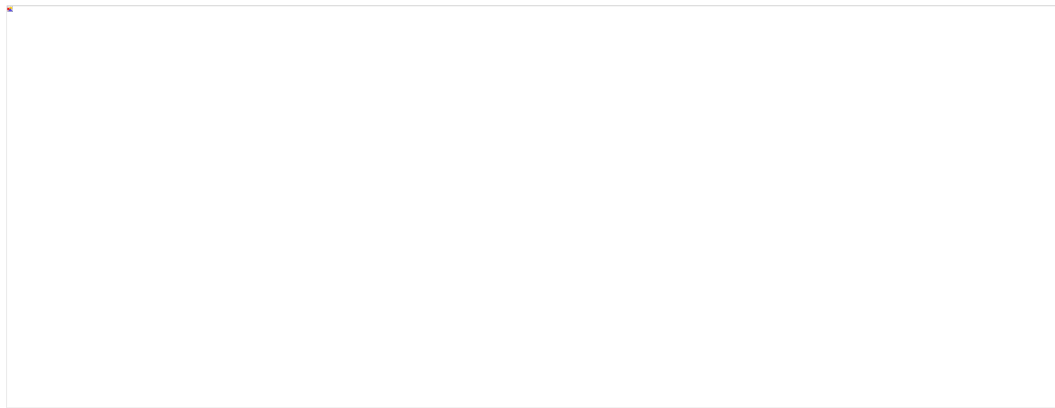
Coherent Detector

- \hat{h}_{ijk} represents estimated channel between transmit antenna and the k th 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

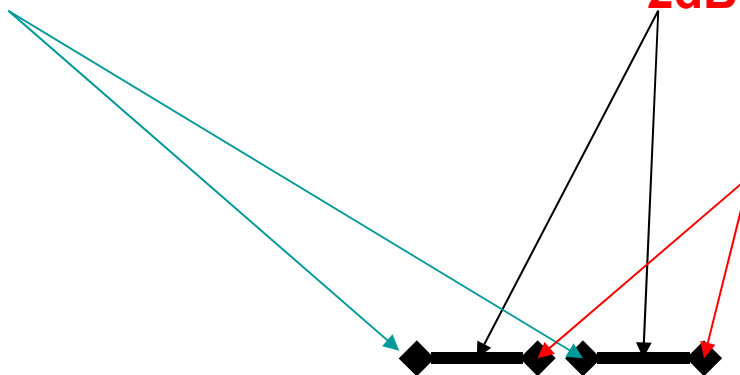
- Carrier Frequency = 2.5 GHz
- Channel assignment: Half of UL slot = 3 tiles
- Hypothesis = 8 (3bits)
- SIMO UL
- Channel Models
 - ITU-PB, 3km/h
 - ITU-VA 30km/h
 - ITU-VA 120km/h
- Receiver Model
 - Non-coherent, Non-coherent pilot assisted, Coherent-Perfect CSI

3-bit ACK/NACK Channel Comparison

C802.16j_07203

2dB loss

IEEE802.16e-2005

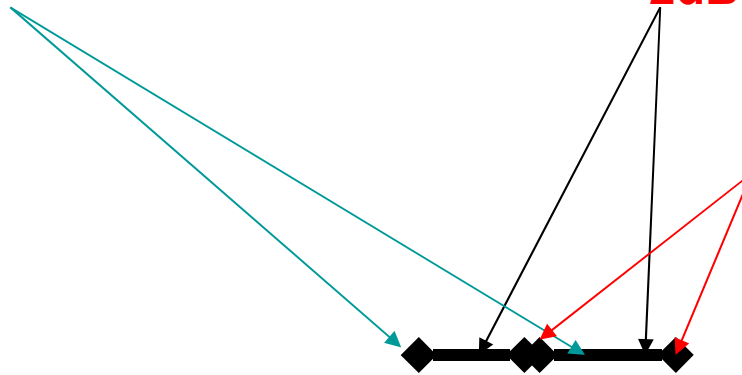


3-bit ACK/NACK Channel Comparison

C802.16j_07203

2dB loss

IEEE802.16e-2005

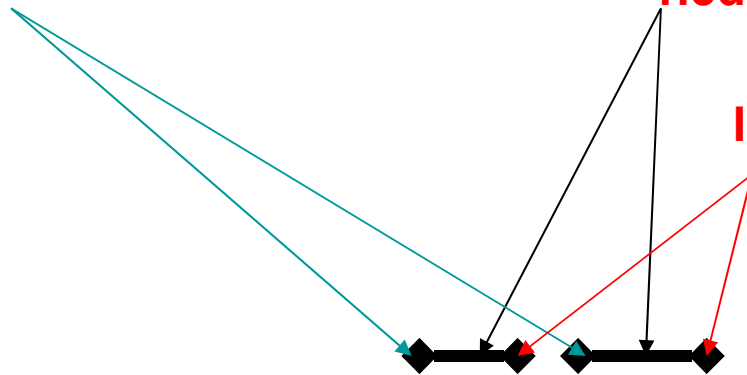


3-bit ACK/NACK Channel Comparison

C802.16j_07203

1.5dB loss

IEEE802.16e-2005



6-bit Compact ACK/NACK Channel

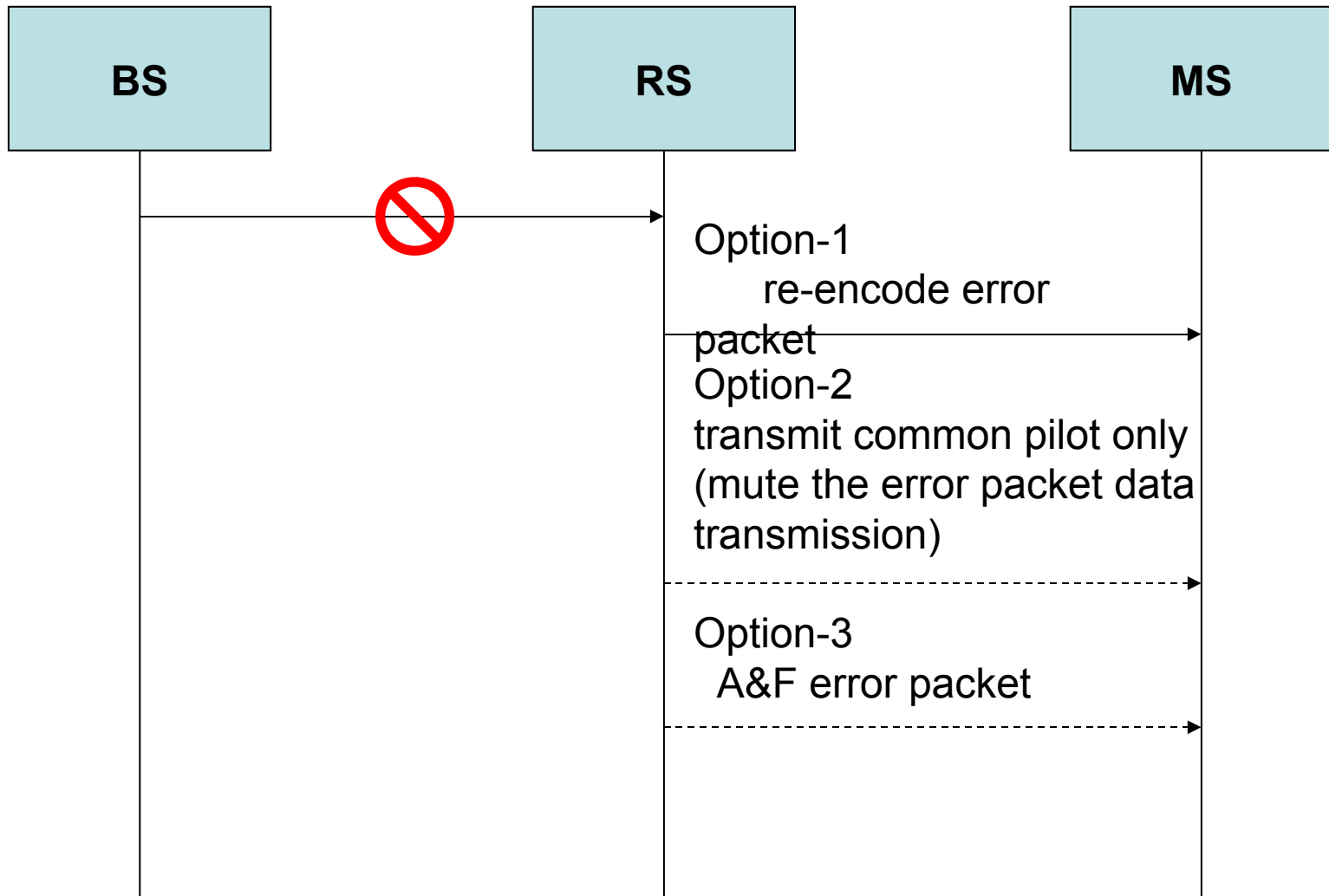
6-bit Compact ACK/NACK Channel

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

