Project	IEEE 802.16 Broadband Wireless Access Working Group <http://ieee802.org/16>
Title	STC sub-packet combining with antenna grouping for 3 and 4 transmit antennas in OFDMA
Date Submitted	2004-11-16

Source(s)	Bin-Chul Ihm, Yongseok Jin, Jinyoung Chun, Kyuhyuk Chung LG Electronics, Inc. 533,Hogye-1dong, Dongan-gu, Anyang-shi, Kyongki-do, Korea	Voice: 82-31-450-7187 Fax: 82-31-450-7912 [mailto: {bcihm, jayjay, jychun03, kyuhyuk}@lge.com]
	Ran Yaniv, Tal Kaitz Alvarion Ltd.	[mailto:{ran.yaniv, tal.kaitz@alvarion.com}

Re:	This is a response to a Call for Comments on IEEE P802.16e-D5
Abstract	STC sub-packet combining scheme can be applied with antenna grouping in OFDMA
Purpose	This document is submitted for review by 802.16e Working Group members
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.
Patent Policy and Procedures	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/notices>.

STC sub-packet combining with antenna grouping for 3 and 4 transmit antennas in OFDMA

Bin-chul Ihm, Jinyoung Chun, Yongseok Jin, and Kyuhyuk Chung
LG Electronics

Ran Yaniv, Tal Kaitz
Alvarion Ltd.

1. Introduction

In OFDMA of the current 802.16 standard, STC sub-packet retransmission schemes for 2 and 4-antenna are provisioned in section '8.4.8.9 STC sub-packet combining'. This scheme gives the efficient retransmission because the pairs of transmit antennas consist of STTD structure.

Received signal with the initial and retransmission packets are written as follows:

$$x_{init} = H_{init}\, s + v_1$$

$$x_{retx} = H_{retx}\, s_{retx} + v_2$$

where $[s \quad s_{retx}] = \begin{bmatrix} s_1 & -s_2^* \\ s_2 & s_1^* \end{bmatrix}$ for 2 tx antenna and $[s \quad s_{retx}] = \begin{bmatrix} s_1 & -s_2^* \\ s_2 & s_1^* \\ s_3 & -s_4^* \\ s_4 & s_3^* \end{bmatrix}$ for 4 tx antennas as shown in table 314l and 314m. In the current specification, the retransmission subpacket has a fixed form as above, however, adaptive antenna grouping according to channel condition can improve the system performance. There can be three alternative retransmission formats in 3 and 4 transmit antennas system as follows:

For 3 transmit antenna system, option 1: $\begin{bmatrix} -s_{i+2}^* \\ s_{i+1}^* \\ s_{i+3}^* \end{bmatrix}$, option 2: $\begin{bmatrix} -s_{i+3}^* \\ s_{i+2}^* \\ s_{i+1}^* \end{bmatrix}$, option 3: $\begin{bmatrix} s_{i+1}^* \\ -s_{i+3}^* \\ s_{i+2}^* \end{bmatrix}$

For 4 transmit antenna system, option 1: $\begin{bmatrix} -s_{i+2}^* \\ s_{i+1}^* \\ -s_{i+4}^* \\ s_{i+3}^* \end{bmatrix}$, option 2: $\begin{bmatrix} -s_{i+3}^* \\ -s_{i+4}^* \\ s_{i+1}^* \\ s_{i+2}^* \end{bmatrix}$, option 3: $\begin{bmatrix} -s_{i+4}^* \\ -s_{i+3}^* \\ s_{i+2}^* \\ s_{i+1}^* \end{bmatrix}$

Receiver can select one of the three options and then feedback its index to the transmitter for retransmission scheme adaptation through the fast feedback channel or mode selection feedback header.

2. Simulation results

In the simulation, we used convolutional code 1/2, QPSK symbols, 3 transmit and 3 receive antennas in band-AMC mode.

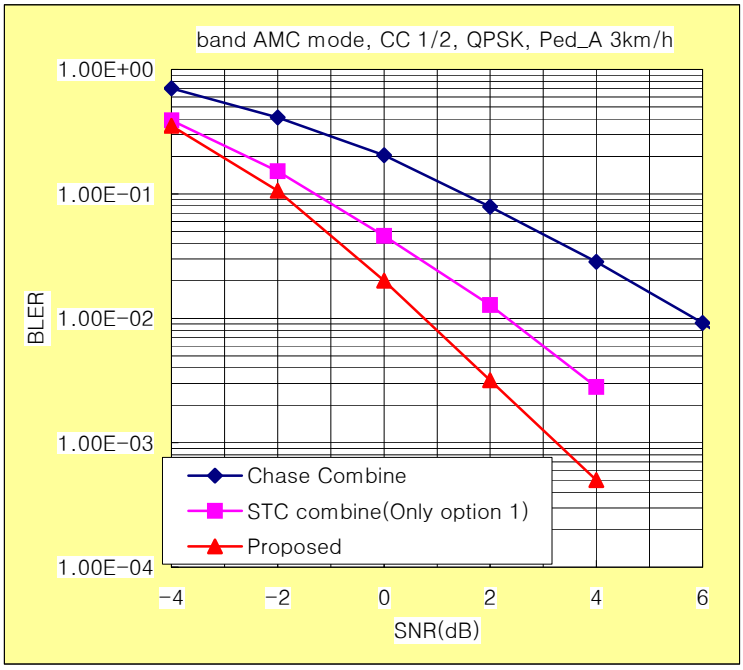

Figure 1. Performance comparison in Ped_A(3km/h)

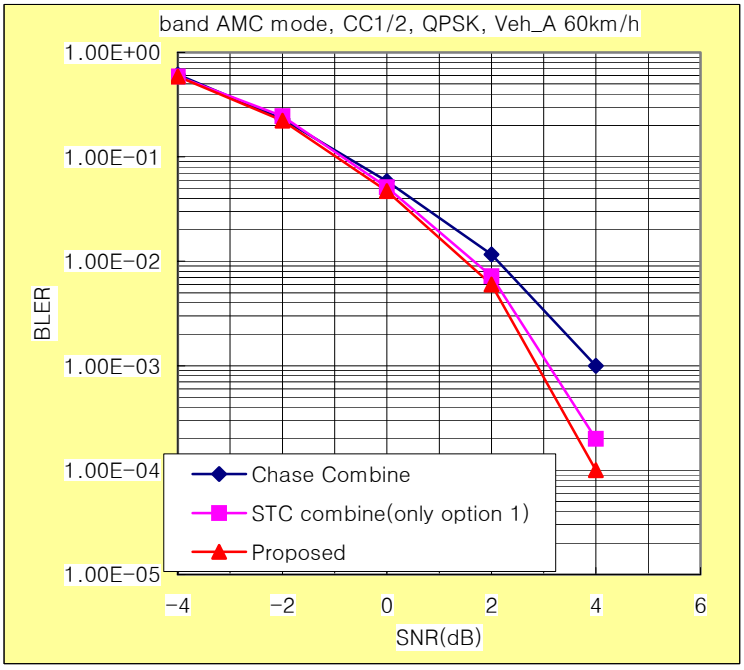

Figure 2. Performance comparison in Veh_A(60km/h)

3. Proposed Text Change

[Modify Table 314l , Table 314m and add a new Table 314m in section 8.4.8.9 STC sub-packet combing]

Table 314l – STC subpacket combining (2-transmit antenna case)

	Initial transmission	odd re-transmission	Even re-transmission
Space time code incremental redundancy for matrix ~~A~~ B	$S^{(0)} = \begin{bmatrix} s_1 \\ s_2 \end{bmatrix}$	$S^{(odd)} = \begin{bmatrix} -s_2^* \\ s_1^* \end{bmatrix}$	$S^{(even)} = \begin{bmatrix} s_1 \\ s_2 \end{bmatrix}$

Table 314m – STC subpacket combining (3–transmit antenna case)

	Initial transmission	Odd re-transmission	Even re-transmission
Space time code incremental redundancy for matrix C	$S^{(0)} = \begin{bmatrix} s_1 \\ s_2 \\ s_3 \end{bmatrix}$	$S^{(odd)} = \begin{bmatrix} -s_2^* \\ s_1^* \\ s_3^* \end{bmatrix}$ (Option 1) $S^{(odd)} = \begin{bmatrix} -s_3^* \\ s_2^* \\ s_1^* \end{bmatrix}$ (Option 2) $S^{(odd)} = \begin{bmatrix} s_1^* \\ -s_3^* \\ s_2^* \end{bmatrix}$ (Option 3)	$S^{(even)} = \begin{bmatrix} s_1 \\ s_2 \\ s_3 \end{bmatrix}$

Table 314~~m~~n – STC subpacket combining (4 –transmit antenna case)

	Initial transmission	Odd re-transmission	Even re-transmission
Space time code incremental redundancy for matrix ~~A~~ C	$S^{(0)} = \begin{bmatrix} s_1 \\ s_2 \\ s_3 \\ s_4 \end{bmatrix}$	$S^{(odd)} = \begin{bmatrix} -s_2^* \\ s_1^* \\ -s_4^* \\ s_3^* \end{bmatrix}$ (Option 1) $S^{(odd)} = \begin{bmatrix} -s_3^* \\ -s_4^* \\ s_1^* \\ s_2^* \end{bmatrix}$ (Option 2)	$S^{(even)} = \begin{bmatrix} s_1 \\ s_2 \\ s_3 \\ s_4 \end{bmatrix}$

		$S^{(odd)} = \begin{bmatrix} -s_4^* \\ -s_3^* \\ s_2^* \\ s_1^* \end{bmatrix}$ (Option 3)	

[Apply the changes into Table 296d in section 8.4.5.4.10.7, page 186]

Table 296d—Encoding of payload bits for Fast-feedback slot

Value	Description
0b00000	STTD and PUSC/FUSC permutation
0b00001	STTD and adjacent-subcarrier permutation
0b00010	SM and PUSC/FUSC permutation
0b00011	SM and adjacent-subcarrier permutation
0b00100	Hybrid and PUSC/FUSC permutation
0b00101	Hybrid and adjacent-subcarrier permutation
0b00110	Beamforming and adjacent-subcarrier permutation
0b01111	Closed-loop SM and PUSC/FUSC permutation
0b10000	Closed-loop SM and adjacent-subcarrier permutation
~~0b10001~0b11111~~	~~Reserved~~
0b10001	Retransmission Option 1
0b10010	Retransmission Option 2
0b10011	Retransmission Option 3
0b10100~0b11111	Reserved

[Apply the changes into Table 297 in section 8.4.5.4.10.8, page 186]

Table 297—Encoding of payload bits for MIMO feedback with 6 bit payload

Value	Description
0b101000	STC and PUSC/FUSC permutation
0b101001	STC and adjacent-subcarrier permutation
0b101010	SM and PUSC/FUSC permutation
0b101011	SM and adjacent-subcarrier permutation
0b101100	Closed-loop SM and PUSC/FUSC permutation
0b101101	Closed-loop SM and adjacent-subcarrier permutation
0b101110	Hybrid and PUSC/FUSC permutation
0b101111	Hybrid and adjacent-subcarrier permutation

0b110000	Beamforming and adjacent-subcarrier permutation
~~0b110001~~	~~Antenna Group A For 3-antenna BS, 00 = Antenna group 0,1 & 0,2 For 4-antenna BS, 00 = Antenna group 0,1 & 2,3~~
~~0b110010~~	~~Antenna Group B For 3-antenna BS, 00 = Antenna group 0,1 & 1,2 For 4-antenna BS, 00 = Antenna group 0,2 & 1,3~~
~~0b110011~~	~~Antenna Group C For 3-antenna BS, 00 = Antenna group 0,2 & 1,2 For 4-antenna BS, 00 = Antenna group 0,3 & 1,2~~
~~0b110100~0b111111~~	~~Reserved~~
0b110001	Retransmission Option 1
0b110010	Retransmission Option 2
0b110011	Retransmission Option 3
0b111000~0b111111	Reserved