Project	**IEEE 802.16 Broadband Wireless Access Working Group <http://ieee802.org/16>**
Title	**Enhancement to 3 Tx Open-loop STC Transmission**
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Source(s)	Chan-Byoung Chae, Wonil Roh, Sung-Ryul Yun, Hongsil Jeong, JeongTae Oh, Kyunbyoung Ko, Seungjoo Maeng, Panyuh Joo, Jaeho Jeon, Jaeyeol Kim, Soonyoung Yoon cb.chae@samsung.com Voice: +82-31-279-4828 **Samsung Electronics Co., Ltd.** Young-Ho Jung, Seung Hoon Nam, Jaehak Chung, Yungsoo Kim **Samsung Advanced Institute of Technology** Jianzhong (Charlie) Zhang, Tony Reid, Kiran Kuchi **Nokia**
Re:	
Abstract	Enhancement to 3 Tx Open-loop STC Transmission
Purpose	Adoption of proposed changes into P802.16e ~~Crossed-out indicates deleted text,~~ underlined blue indicates new text change to the Standard
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Enhancement to 3 Tx Open-loop STC Transmission

Chan-Byoung Chae, Wonil Roh, Sung-Ryul Yun, Hongsil Jeong, JeongTae Oh,
Kyunbyoung Ko, Seungjoo Maeng, Panyuh Joo, Jaeho Jeon, Jaeyeol Kim, Soonyoung Yoon
Samsung Electronics

Young-Ho Jung, Seung Hoon Nam, Jaehak Chung, Yungsoo Kim
Samsung Advanced Institute of Technology

Jianzhong (Charlie) Zhang, Tony Reid, Kiran Kuchi
Nokia

1. Introduction

A modified performance criterion that can be used for improving the performance of existing space-time codes for 3 Tx BS is presented. Using parameter comparison and simulation results, the proposed criterion results in a different encoding parameter than the current standard which uses conventional determinant criterion in predicting the performance of 3 Tx antenna STC. Based on our design criterion, we propose a modified STC for three transmit antennas.

2. Design Criteria

We can enhance the performance by changing the phase rotator value. This value is found based on full search form $\theta = 0$ to $\theta = 90$.

Proposed phase rotator : $\theta =$ atan(1/3)

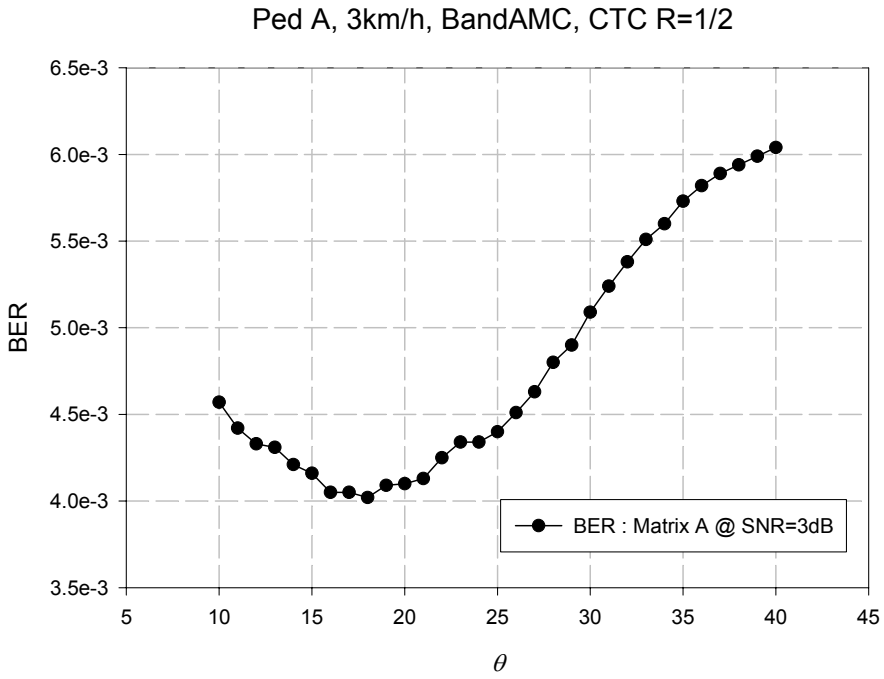
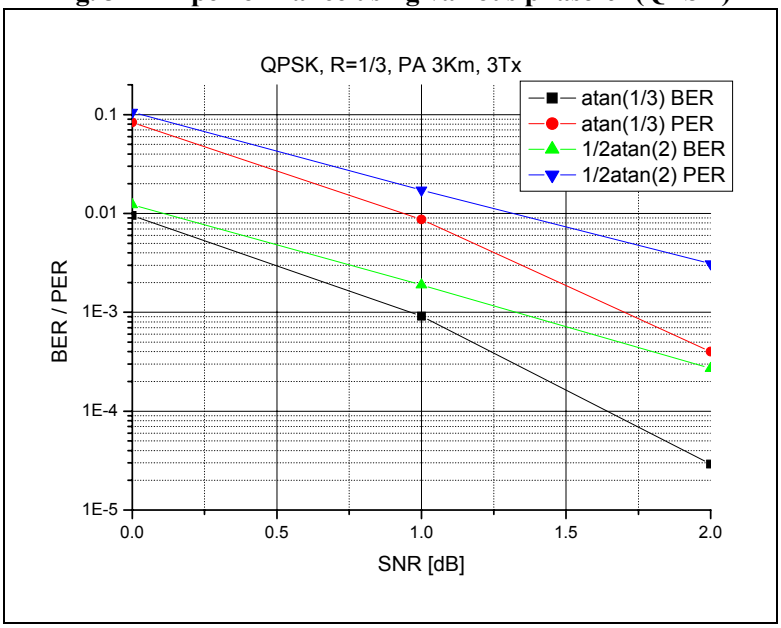
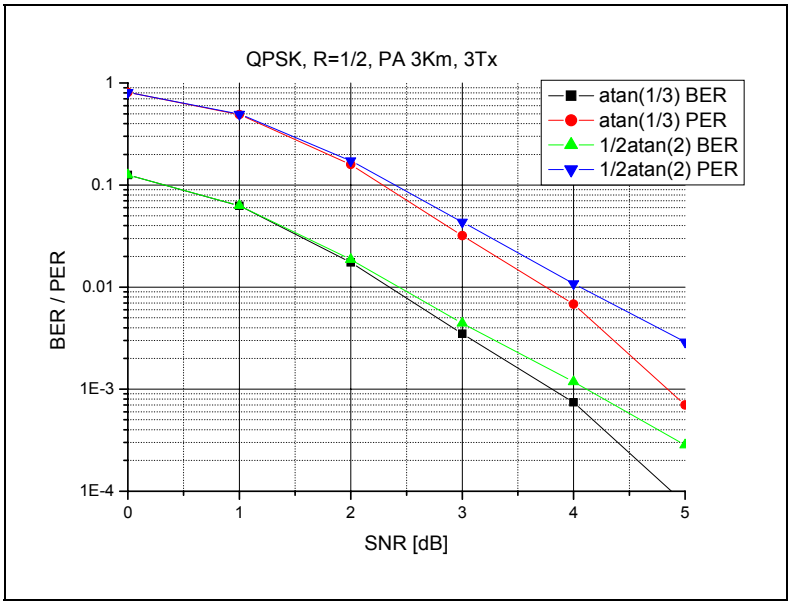


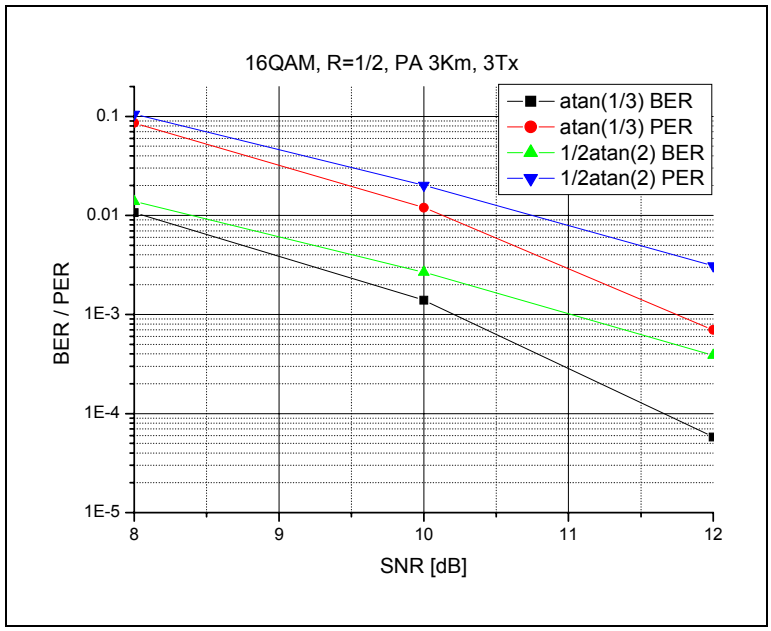
Fig. 3 BER performance using various phase θ (QPSK)



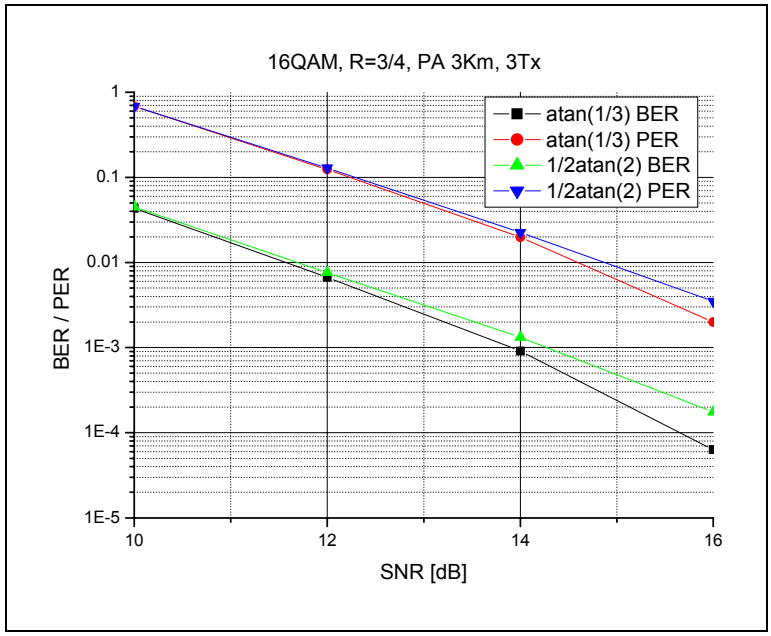
(a) QPSK CTC R=1/3, PedA 3km/h



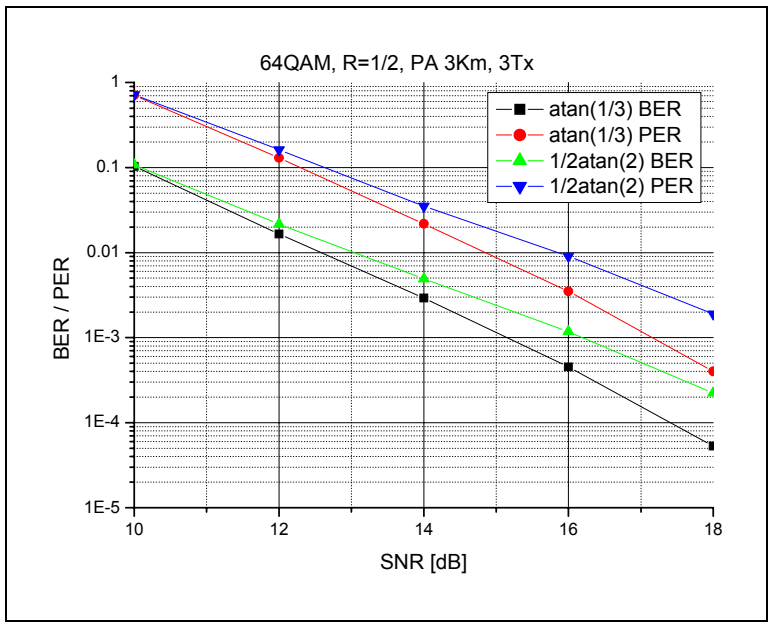
(b) QPSK CTC R=1/2, PedA 3km/h



(c) 16QAM CTC R=1/2, PedA 3km/h



(d) 16QAM CTC R=3/4, PedA 3km/h



(e) 64QAM CTC R=1/2, PedA 3km/h

Fig. 4 BER/FER performance

3. Specific Text Changes

[Modify the 8.4.8.3.4 Transmission schemes for 3 antenna BS]

8.4.8.3.4 Transmission Schemes for 3 Antenna BS

STC for 3Tx-Rate 1, 2, and 3:

For three antenna BS, one of the three transmission matrices A, B or C, shall be used.
Let the complex symbols to be transmitted be x1, x2, x3, x4 which take values from a square QAM constellation. Let $s_i = x_i e^{j\theta}$ for i=1,2,…,5, where ~~$\theta = \frac{1}{2}\tan^{-1} 2$~~ $\theta = \tan^{-1}\left(\frac{1}{3}\right)$ and let

$\tilde{s}_1 = s_{1I} + js_{3Q}$; $\tilde{s}_2 = s_{2I} + js_{4Q}$; $\tilde{s}_3 = s_{3I} + js_{1Q}$; $\tilde{s}_4 = s_{4I} + js_{2Q}$; $\tilde{s}_5 = s_{5I} + js_{7Q}$ where $s_i = s_{iI} + js_{iQ}$.

The proposed Space-Time-Frequency code (over two OFDMA symbols and two sub-carriers) for 3Tx-Rate 1 configuration with diversity order 3 is given in three permuted versions:

$$A_1 = \begin{bmatrix} \tilde{s}_1 & -\tilde{s}_2^* & 0 & 0 \\ \tilde{s}_2 & \tilde{s}_1^* & \tilde{s}_3 & -\tilde{s}_4^* \\ 0 & 0 & \tilde{s}_4 & \tilde{s}_s^* \end{bmatrix}$$

$$A_2 = \begin{bmatrix} \tilde{s}_1 & -\tilde{s}_2^* & \tilde{s}_3 & -\tilde{s}_4^* \\ \tilde{s}_2 & \tilde{s}_1^* & 0 & 0 \\ 0 & 0 & \tilde{s}_4 & \tilde{s}_s^* \end{bmatrix}$$

$$A_3 = \begin{bmatrix} \tilde{s}_1 & -\tilde{s}_2^* & 0 & 0 \\ 0 & 0 & \tilde{s}_3 & -\tilde{s}_4^* \\ \tilde{s}_2 & \tilde{s}_1^* & \tilde{s}_4 & \tilde{s}_s^* \end{bmatrix}$$

where the ML decoding can be achieved by symbol-by-symbol decoding.

The matrix B is

$$B_1 = \begin{bmatrix} \sqrt{\frac{3}{4}} & 0 & 0 \\ 0 & \sqrt{\frac{3}{4}} & 0 \\ 0 & 0 & \sqrt{\frac{3}{2}} \end{bmatrix} \begin{bmatrix} \tilde{s}_1 & -\tilde{s}_2^* & \tilde{s}_5 & -\tilde{s}_6^* \\ \tilde{s}_2 & \tilde{s}_1^* & \tilde{s}_6 & \tilde{s}_5^* \\ \tilde{s}_7 & -\tilde{s}_8^* & \tilde{s}_3 & -\tilde{s}_4^* \end{bmatrix}$$

$$B_2 = \begin{bmatrix} 0 & 1 & 0 \\ 0 & 0 & 1 \\ 1 & 0 & 0 \end{bmatrix} B_1$$

$$B_3 = \begin{bmatrix} 0 & 0 & 1 \\ 1 & 0 & 0 \\ 0 & 1 & 0 \end{bmatrix} B_1$$

where the definition for the remaining variables are as follows:

$\tilde{s}_6 = s_{6I} + js_{8Q}$; $\tilde{s}_7 = s_{7I} + js_{5Q}$; $\tilde{s}_8 = s_{8I} + js_{6Q}$

The matrix C is used for spatial multiplexing.

$$C = \begin{bmatrix} s_1 \\ s_2 \\ s_3 \end{bmatrix}$$

References:

[1] IEEE P802.16-REVd/D5-2004 Draft IEEE Standards for local and metropolitan area networks part 16: Air interface for fixed broadband wireless access systems

[2] Tarokh et al, "Space-time codes for high data rate wireless communication: performance criteria and code construction," *IEEE Trans. Inf. Theory*, 1998