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Re:	MIMO DL Rapporteur Group Discussions
Abstract	Contribution to the TGm SDD on MIMO DL.
Purpose	Discuss and accept the proposal into the Draft of MIMO DL SDD document
Notice	
Release	
Patent Policy	

A two-stream Alamouti scheme for MIMO DL in 802.16m

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Introduction

The mapping of the transmission layers to the different antennas is an important part of the DL-MIMO specifications currently under development in the 16m group. In this contribution, we concentrate in particular on the case of 4 transmit and 2 receive antennas. This case is relevant for practical deployment because many BSs are anticipated to use 4 antenna elements, since this can provide high diversity while keeping dimensions of the array (and thus windload) reasonably small. Furthermore, we are concentrating on the case of two data streams that are to be transmitted to the receiver.

The current Draft 3 of the DL-MIMO rapporteur group suggests the following specifications for the 4 TX, 2 RX, 2 stream case: the input to the MIMO encoder is represented as a 2 × 1 vector

$$\mathbf{x} = \begin{bmatrix} s_1 \\ s_2 \end{bmatrix}.$$

The output of the MIMO encoder is a 2 × 1 vector

$$\mathbf{z} = \mathbf{x}.$$

The output of the precoder is a 4 × 1 vector

$$\mathbf{y} = \mathbf{D} \times \mathbf{W} \times \mathbf{z},$$

where **W** is a 4 × 2 unitary precoder and **D** is a 4 × 4 diagonal delay matrix. Note that **W** and **D** may be frequency dependant as described in section 11.x.2.1.1.

In this contribution we suggest an alternative scheme that is simpler to implement and gives better results. Namely, we suggest the use of a two-stream Alamouti scheme. The MCSs (modulation and coding schemes) for the two streams can be adjusted individually (based on the CQI fed back from the receiver). Such schemes, also known as DSTTD, have been proposed and analyzed in the scientific literature (see, e.g., [1-3]) and are also implemented in the IEEE 802.11n standard.

Proposed transmitter structure

Figure 1 shows the structure of the proposed transmitter. The 2 data streams (layers) are independently encoded by two standard Alamouti encoders, resulting in 4 outputs. These outputs are then mapped onto the TX antennas in such a way that outputs from Alamouti encoder A are mapped onto antenna elements 1 and 3, while outputs from Alamouti encoder B are mapped onto antenna elements 2 and 4, giving good decorrelation.

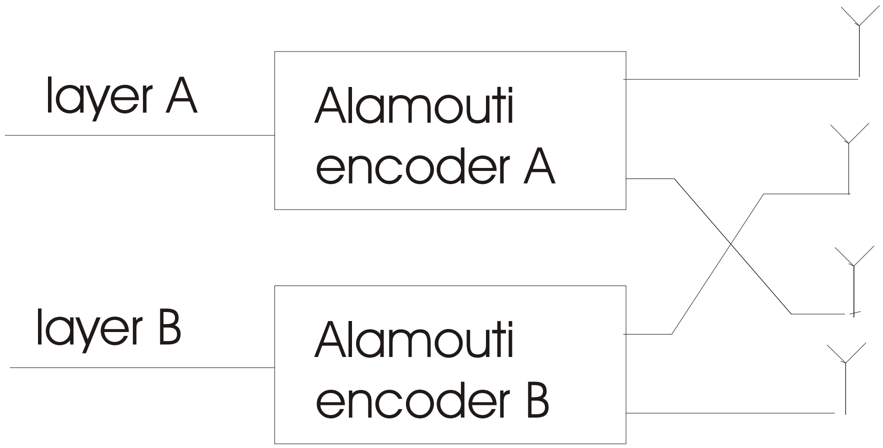

Figure 1: Description of the proposed system transmitter.

Simulation results

In Figures 2-4, the average symbol error rate performance of three schemes are compared for QPSK, 16-QAM and 64-QAM constellations, respectively. The following are the schemes under comparison:

a) Proposed two-stream Alamouti scheme with 4-transmit anteannas and two-receive antenna MMSE receiver
b) Proposed scheme with an additional per-tone cyclic delay diversity
c) Two-stream spatial multiplexing scheme with unitary precoding followed by cyclic delay diversity.

An IEEE Veh-A channel is assumed with 60 Hz Doppler, and perfect channel estimation at the receiver. As shown in Figs. 2-4, the proposed system performs significantly better than the two-stream spatial multiplexing without Alamouti enoding (i.e., scheme c). On the other hand, with an additional per-tone cyclic delay diversity over the proposed scheme marginally improves the performance at higher signal-to-noise ratios.

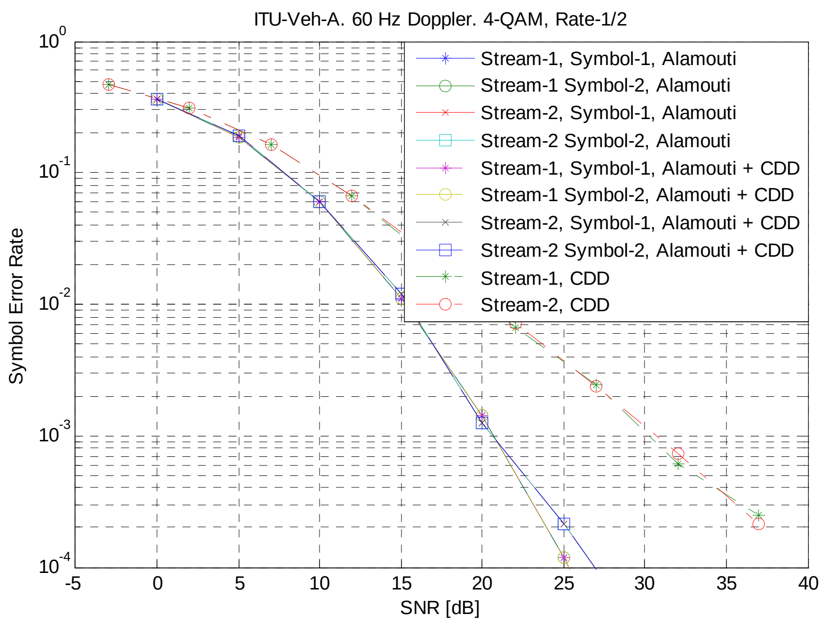

Figure 2: Symbol error rate performance for QPSK modulation.

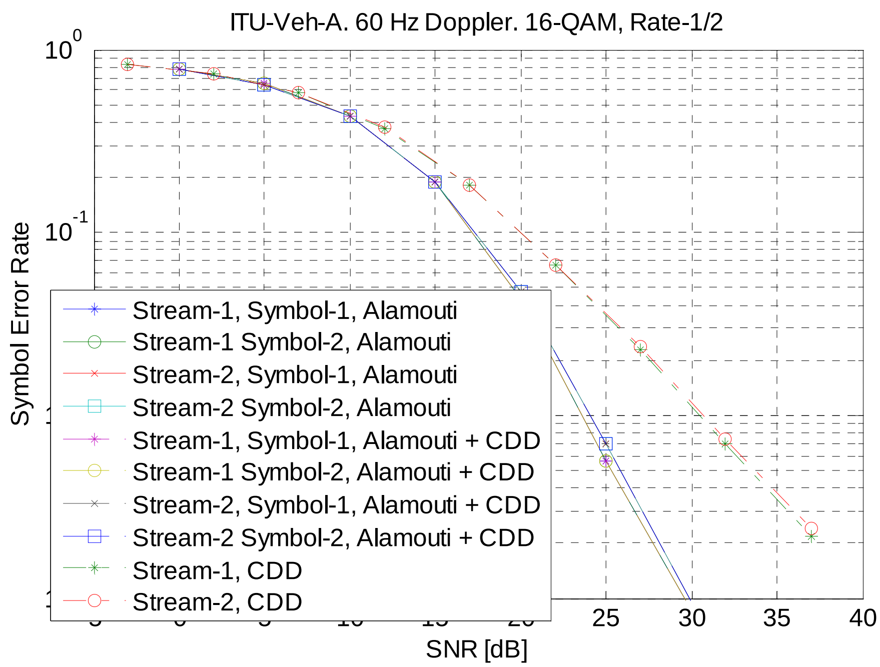

Figure 3: Symbol error rate performance for 16-QAM modulation.

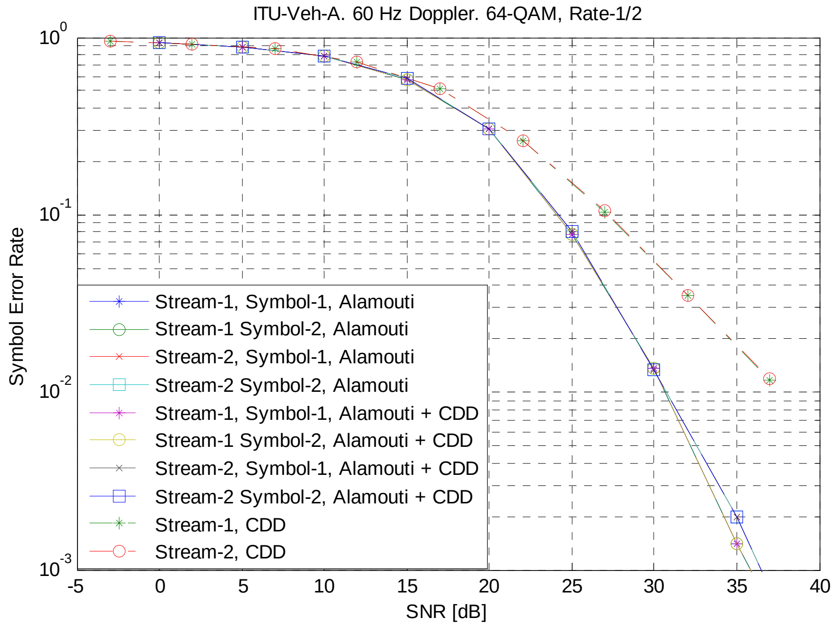

Figure 4: Symbol error rate performance for 64-QAM modulation.

Text proposal

for the 4 TX, 2 RX, 2 stream case: the input to the MIMO encoder is represented as a 2 × 2 vector

$$\mathbf{x} = \begin{bmatrix} s_1 & s_2 \\ s_3 & s_4 \end{bmatrix}$$

where the two rows represent the two layers, and the columns two (subsequent) time instants.
The output of the Alamouti encoders is a 4 × 2 matrix

$$\mathbf{z} = \begin{bmatrix} s_1 & s_2 \\ -s_2^* & s_1^* \\ s_3 & s_4 \\ -s_4^* & s_3^* \end{bmatrix}$$

The output of the encoder is mapped onto the antennas after multiplication by multiplication

$$\mathbf{y} = \mathbf{W}\mathbf{z},$$

where **W** is a 4 × 4 permutation matrix

$$\mathbf{W} = \begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

The MCSs of the two layers can be adapted independently, based on CQI feedback from the receiver.

References

[1] Onggosanusi E.N.; Dabak A.G.; Schmidl T.A., High rate space-time block coded scheme: performance and improvement in correlated fading channels, Wireless Communications and Networking Conference, 2002, 194-199

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[3] Giulii Capponi; Yahong R. Zheng; Gumaste, A.; Chengshan Xiao, Error Performance of Double Space Time Transmit Diversity System, 2006 IEEE International Conference on Communications, 4859-4864.