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Title	**Per-tone SINR Computation for MIMO STBC with MRC**
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Re:	TGmEVAL Change Request for 16m EMD (C802.16m-08/004r4).
Abstract	In this document, the expressions for MIMO 2x2 MRC receiver of the Per Tone SINR Computation section of the 16m EMD have been reviewed with the view to identify and explain error in the current expressions.
Purpose	For consideration and adoption into the 16m EMD document (C802.16m-08/004r4).
Notice	
Release	
Patent Policy	

Per-tone Post Processing SINR for MIMO STBC with MRC

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Introduction

The Per-tone Post Processing SINR expression for MIMO STBC with MRC as described in section 4.4.3 of 16m EMD requires correction for the term 'P_S' in equation 73. The following provides an explanation with a brief derivation:

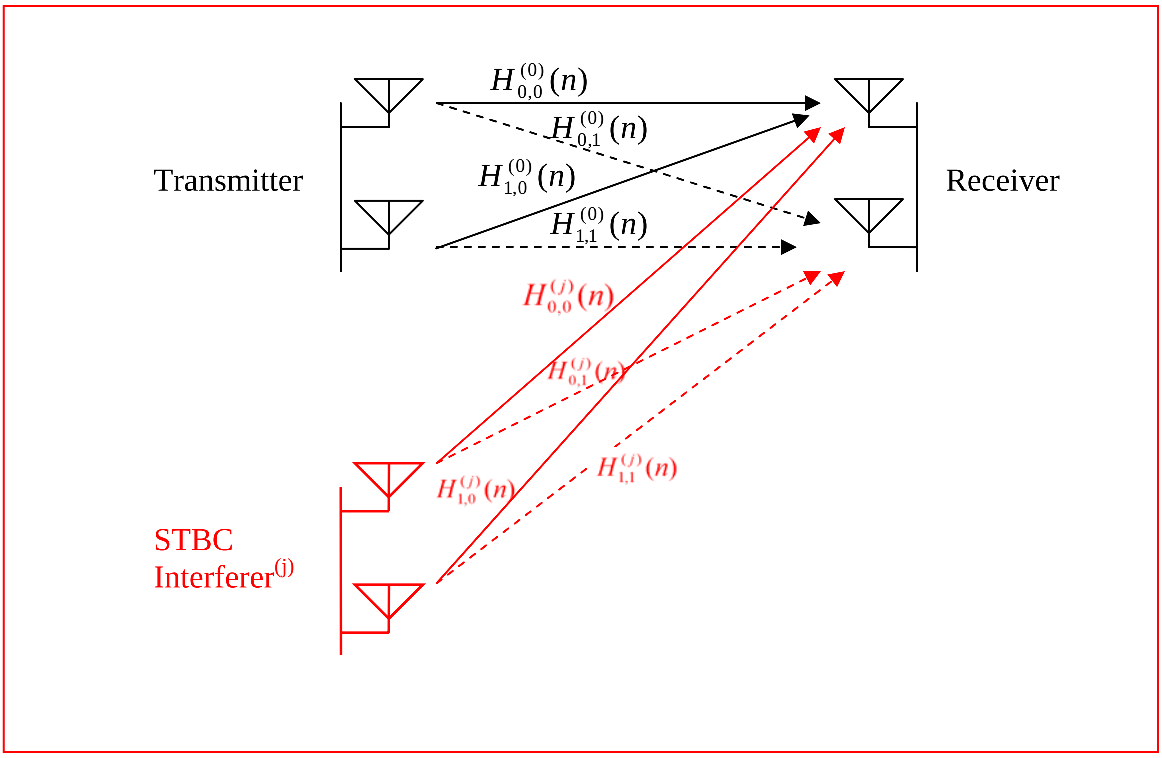

Figure 1 MIMO 2x2 STBC system with interferer 'j'

Assuming the same notations as followed in the 16m EMD, STBC Matrix can be defined as:

$$\begin{array}{c} \\ Ant0 \\ Ant1 \end{array} \begin{array}{c} \begin{array}{cc} odd & even \end{array} \\ \begin{bmatrix} X_0 & -X_1^* \\ X_1 & X_0^* \end{bmatrix} \end{array}$$

The received signal at n[th] sub-carrier in the 1[st] (odd) and 2[nd] (even) STBC symbol interval are then expressed as:

(i) 1[st] Symbol

$$Y_r^{(0)}(n,0) = \left[\sqrt{\frac{P_{tx}^{(0)} P_{loss}^{(0)}}{2}} \left(H_{0,r}^{(0)}(n) X_0^{(0)}(n) + H_{1,r}^{(0)}(n) X_1^{(0)}(n) \right) \right]$$
$$+ \sum_{j \in STBCset} \left[\sqrt{\frac{P_{tx}^{(j)} P_{loss}^{(j)}}{2}} \left(H_{0,r}^{(j)}(n) X_0^{(j)}(n) + H_{1,r}^{(j)}(n) X_1^{(j)}(n) \right) \right] + U_r^{(0)}(n,0)$$

(ii) 2[nd] Symbol

$$Y_r^{(0)}(n,1) = \left[\sqrt{\frac{P_{tx}^{(0)}P_{loss}^{(0)}}{2}}\left(H_{1,r}^{(0)}(n)X_0^{(0)}(n)^* - H_{0,r}^{(0)}(n)X_1^{(0)}(n)^*\right)\right]$$
$$+ \sum_{j\in STBCset}\left[\sqrt{\frac{P_{tx}^{(j)}P_{loss}^{(j)}}{2}}\left(H_{1,r}^{(j)}(n)X_0^{(j)}(n)^* - H_{0,r}^{(j)}(n)X_1^{(j)}(n)^*\right)\right] + U_r^{(0)}(n,1)$$

Performing $H_{0,r}^{(0)}(n)^* * (i) + H_{1,r}^{(0)}(n) * (ii)^*$ for each of the receive antennas gives:

(iii) For Receive Antenna 0:

$$H_{0,0}^{(0)}(n)^* Y_0^{(0)}(n,0) + H_{1,0}^{(0)}(n) Y_0^{(0)}(n,1)^* =$$
$$\left[\sqrt{\frac{P_{tx}^{(0)}P_{loss}^{(0)}}{2}}\left(\left|H_{0,0}^{(0)}(n)\right|^2 + \left|H_{1,0}^{(0)}(n)\right|^2\right)X_0^{(0)}(n)\right]$$
$$+ \sum_{\substack{j\neq 0\\ j\in STBCset}} \sqrt{\frac{P_{tx}^{(j)}P_{loss}^{(j)}}{2}}\begin{bmatrix}\left(H_{0,0}^{(0)}(n)^* H_{0,0}^{(j)}(n) + H_{1,0}^{(0)}(n)H_{1,0}^{(j)}(n)^*\right)X_0^{(j)}(n) \\ + \left(H_{0,0}^{(0)}(n)^* H_{1,0}^{(j)}(n) - H_{1,0}^{(0)}(n)H_{0,0}^{(j)}(n)^*\right)X_1^{(j)}(n)\end{bmatrix}$$
$$+ H_{0,0}^{(0)}(n)^* U_0^{(0)}(n,0) + H_{1,0}^{(0)}(n) U_0^{(0)}(n,1)^*$$

(iv) For Receive Antenna 1:

$$H_{0,1}^{(0)}(n)^* Y_1^{(0)}(n,0) + H_{1,1}^{(0)}(n) Y_1^{(0)}(n,1)^* =$$
$$\left[\sqrt{\frac{P_{tx}^{(0)}P_{loss}^{(0)}}{2}}\left(\left|H_{0,1}^{(0)}(n)\right|^2 + \left|H_{1,1}^{(0)}(n)\right|^2\right)X_0^{(0)}(n)\right]$$
$$+ \sum_{\substack{j\neq 0\\ j\in STBCset}} \sqrt{\frac{P_{tx}^{(j)}P_{loss}^{(j)}}{2}}\begin{bmatrix}\left(H_{0,1}^{(0)}(n)^* H_{0,1}^{(j)}(n) + H_{1,1}^{(0)}(n)H_{1,1}^{(j)}(n)^*\right)X_0^{(j)}(n) \\ + \left(H_{0,1}^{(0)}(n)^* H_{1,1}^{(j)}(n) - H_{1,1}^{(0)}(n)H_{0,1}^{(j)}(n)^*\right)X_1^{(j)}(n)\end{bmatrix}$$
$$+ H_{0,1}^{(0)}(n)^* U_0^{(0)}(n,0) + H_{1,1}^{(0)}(n) U_0^{(0)}(n,1)^*$$

In expressions (iii) & (iv) above, the 1^{st}, 2^{nd} & 3^{rd} terms on RHS represent signal strength, Interference from STBC users and Noise. When expressions (iii) & (iv) are combined, per-tone post processing SINR may be defined by:

$$SINR^{(0)}(n) = \frac{P_S}{P_N + P_{I\_NonSTBC} + P_{I\_STBC}}$$

where,

$$P_S = P_{tx}^{(0)}P_{loss}^{(0)}\sigma_0^2\left(\sum_{t=0}^{1}\sum_{r=0}^{N_R-1}\left|H_{t,r}^{(0)}(n)\right|^2\right)^2,$$

$$P_N = \left(\sum_{t=0}^{1}\sum_{r=0}^{N_R-1}\left|H_{t,r}^{(0)}(n)\right|^2\right)\sigma^2,$$

$$P_{I\_STBC} = \sum_{\substack{j\neq 0,\\ j\in STBCset}} P_{tx}^{(j)}P_{loss}^{(j)}\sigma_j^2\left(\begin{array}{l}\sum_{r=0}^{N_R-1}\left|H_{0,r}^{(0)}(n)^* H_{0,r}^{(j)}(n) + H_{1,r}^{(0)}(n)H_{1,r}^{(j)}(n)^*\right|^2 + \\ \sum_{r=0}^{N_R-1}\left|H_{0,r}^{(0)}(n)^* H_{1,r}^{(j)}(n) - H_{1,r}^{(0)}(n)H_{0,r}^{(j)}(n)^*\right|^2\end{array}\right)$$

Text Proposal

[Modify equation 73 of section 4.4.3 of the 16m EMD document by replacing the expression for 'P_S' by that shown in the blue box:]

$$SINR^{(0)}(n) = \frac{P_S}{P_N + P_{I\_NonSTBC} + P_{I\_STBC}}$$

where,

~~$$P_S = P_{tx}^{(0)} P_{loss}^{(0)} \sigma_0^2 \left(\sum_{t=0}^{1} \sum_{r=0}^{N_R-1} \left| H_{t,r}^{(0)}(n) \right|^2 \right)$$~~

$$P_S = P_{tx}^{(0)} P_{loss}^{(0)} \sigma_0^2 \left(\sum_{t=0}^{1} \sum_{r=0}^{N_R-1} \left| H_{t,r}^{(0)}(n) \right|^2 \right)^2 ,$$

$$P_N = \left(\sum_{t=0}^{1} \sum_{r=0}^{N_R-1} \left| H_{t,r}^{(0)}(n) \right|^2 \right) \sigma^2 ,$$

$$P_{I\_NonSTBC} = \sum_{\substack{j \neq 0, \\ j \notin STBCset}} P_{tx}^{(j)} P_{loss}^{(j)} \sigma_j^2 \left(\sum_{t=0}^{N_T^{(j)}-1} \sum_{r=0}^{N_R-1} \left| H_{0,r}^{(0)}(n)^* H_{t,r}^{(j)}(n) \right|^2 + \sum_{t=0}^{N_T^{(j)}-1} \sum_{r=0}^{N_R-1} \left| H_{1,r}^{(0)}(n)\ H_{t,r}^{(j)}(n)^* \right|^2 \right) ,$$

and

$$P_{I\_STBC} = \sum_{\substack{j \neq 0, \\ j \in STBCset}} P_{tx}^{(j)} P_{loss}^{(j)} \sigma_j^2 \left(\begin{array}{l} \sum_{r=0}^{N_R-1} \left| H_{0,r}^{(0)}(n)^* H_{0,r}^{(j)}(n) + H_{1,r}^{(0)}(n) H_{1,r}^{(j)}(n)^* \right|^2 + \\ \sum_{r=0}^{N_R-1} \left| H_{1,r}^{(0)}(n) H_{0,r}^{(j)}(n)^* - H_{0,r}^{(0)}(n)^* H_{1,r}^{(j)}(n) \right|^2 \end{array} \right)$$