Project	**IEEE 802.16 Broadband Wireless Access Working Group <http://ieee802.org/16>**
Title	**Proposed Cleanup Text for Differential codebook (16.3.7.2.5.6.2) for the IEEE 802.16m/D3**
Date Submitted	**2009-12-29**
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Re:	Proposed text changes to P802.16m/D3 16.3.7.2.5.6.2
Abstract	
Purpose	To be discussed and adopted by TGm for the 802.16m D4 Draft
Notice	
Release	
Patent Policy	

Proposed Cleanup Text for Differential codebook (16.3.7.2.5.6.2) for the IEEE 802.16m/D3

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I. Introduction

This contribution proposes some cleanup text in differential codebook section (section 16.3.7.2.5.6.2) of P802.16m/D3 [1].

References

[1] Draft Amendment, P802.16m/D3, December 2009.

-- Text Change starts--

Replace the text in page 479 from line 1 to line 51 with the following text.

16.3.7.2.5.6.2 Differential codebook-based feedback mode

The differential feedbacks exploit the correlation between precoding matrixes adjacent in time or frequencies. The feedback shall start initially and restart periodically by sending a one-shot feedback that fully depicts the precoder by itself. At least one differential feedback shall follow the start and restart feedback. The start and restart feedback employs the codebook defined for the base mode and is sent through long term report defined in Feedback Allocation A-MAP IE for MFM 3 and 6. The differential feedback is sent through short term report defined in Feedback Allocation A-MAP IE for MFM 3 and 6.

Denote the feedback index, the corresponding feedback matrix, and the corresponding precoder by t, $\boldsymbol{D}(t)$, and $\boldsymbol{V}(t)$, respectively. The sequential index is reset to 0 at $\boldsymbol{T}_{\max}+1$. The index for the start and restart feedbacks are 0. Let $\boldsymbol{A}$ be a vector or a matrix and $\boldsymbol{Q}_{\boldsymbol{A}}$ be the rotation matrix determined by $\boldsymbol{A}$. The indexes of the subsequent differential feedbacks are 1, 2, ..., $\boldsymbol{T}_{\max}$ and the corresponding precoders are:

$$\boldsymbol{V}(t)=\boldsymbol{Q}_{\boldsymbol{V}(t-1)}\boldsymbol{D}(t)\text{, for } t=0,1,2,...,\boldsymbol{T}_{\max}\text{,}$$

where the rotation matrix $\boldsymbol{Q}_{\boldsymbol{V}(t-1)}$ is a unitary $\boldsymbol{N}_t \times \boldsymbol{N}_t$ matrix computed from the previous precoder $\boldsymbol{V}(t-1)$; $\boldsymbol{N}_t$ is the number of transmit antennas. The dimension of the fed back matrix $\boldsymbol{D}(t)$ is $\boldsymbol{N}_t \times \boldsymbol{M}_t$, where $\boldsymbol{M}_t$ is the number of spatial streams.

The $\boldsymbol{Q}_{\boldsymbol{V}(t-1)}$ has the form $\boldsymbol{Q}_{\boldsymbol{V}(t-1)} = \left[\boldsymbol{V}(t-1) \quad \boldsymbol{V}^{\perp}(t-1)\right]$, where $\boldsymbol{V}^{\perp}(t-1)$ consists of columns each of which has a unit norm and is orthogonal to the other columns of $\boldsymbol{Q}_{\boldsymbol{V}(t-1)}$. For $\boldsymbol{M}_t = 1$, where $\boldsymbol{V}(t-1)$ is a vector,

$$\boldsymbol{Q}_{\boldsymbol{V}(t-1)} = \begin{cases} \boldsymbol{I} - \dfrac{2}{\|\boldsymbol{\omega}\|^2}\boldsymbol{\omega}\boldsymbol{\omega}^H, \|\boldsymbol{\omega}\| > 0 \\ \boldsymbol{I}, otherwise \end{cases},$$

where $\|\boldsymbol{V}(t-1)\| = 1$ and $\boldsymbol{\omega} = e^{-j\theta}\boldsymbol{V}(t-1) - \boldsymbol{e}_1$; θ is the phase of the first entry of $\boldsymbol{V}(t-1)$; $\boldsymbol{e}_1 = [1 \quad 0 \quad \ldots \quad 0]^T$. For $\boldsymbol{M}_t > 1$, let $\boldsymbol{L} = \boldsymbol{N}_t - \boldsymbol{M}_t$. For computing $\boldsymbol{Q}_{\boldsymbol{V}(t-1)}$, $\boldsymbol{L}$ columns are appended to $\boldsymbol{V}(t-1)$ forming a square matrix $\boldsymbol{M} = \left[\boldsymbol{V}(t-1) \quad \boldsymbol{E}\right]$ and the appended columns are

$$\boldsymbol{E} = [\boldsymbol{e}_{\tau_1} \quad \ldots \quad \boldsymbol{e}_{\tau_L}]$$

where $\boldsymbol{e}_{\tau_j}$ is the $\boldsymbol{N}_t \times 1$ vector whose entry on the τ_j-th row is one and whose other entries are zeros. $\boldsymbol{Q}_{\boldsymbol{V}(t-1)}$ is computed by orthogonalizing and normalizing the columns of $\boldsymbol{M}$. The indexes τ_j for $j = 1, \ldots, \boldsymbol{L}$ are selected for the numerical stability of the orthogonalization and normalization process. Let

$$\boldsymbol{g} = \left(\left|\mathrm{Re}\left(\boldsymbol{V}(t-1)\right)\right| + \left|\mathrm{Im}\left(\boldsymbol{V}(t-1)\right)\right|\right)\boldsymbol{a},$$

where $\boldsymbol{a}$ is the $1 \times \boldsymbol{M}_t$ vector with all entries equal to one; $\mathrm{Re}(\ )$ and $\mathrm{Im}(\ )$ take the real and imaginary parts of the input matrix, respectively; $|\ |$ takes the absolute values of the input matrix entry by entry. The i-th row of the vector $\boldsymbol{g}$ has the sum of the absolute values of all the real and imaginary parts of $\boldsymbol{V}(t-1)$ on the same row. The entries of $\boldsymbol{g}$ are sorted in an increasing order. If $g_i = g_j$ and $i < j$, then $g_i < g_j$ is used in the order list. The order list is

$$g_{k_1} < \ldots < g_{k_{N_t}},$$

where k_i for $i=1,...,\boldsymbol{N}_t$ are row indexes of $\boldsymbol{g}$. The first $\boldsymbol{L}$ indexes in the list are assigned to the indexes τ_j in $\boldsymbol{E}$ as

$$\tau_j = k_j \text{ , for } j=1,...,\boldsymbol{L}.$$

The Gram-Schmidt orthogonalization and a normalization process are applied on the last $\boldsymbol{L}$ columns of $\boldsymbol{M}$ column by column and result in $\boldsymbol{Q}_{\boldsymbol{V}(t-1)}$ as

For $j=1:\boldsymbol{L}$

For $k=1:j+\boldsymbol{M}_t-1$

$$\boldsymbol{m}_{j+\boldsymbol{M}_t} = \boldsymbol{m}_{j+\boldsymbol{M}_t} - m^*_{\tau_j,k}\boldsymbol{m}_k$$

End

$$\boldsymbol{m}_{j+\boldsymbol{M}_t} = \frac{\boldsymbol{m}_{j+\boldsymbol{M}_t}}{\left\|\boldsymbol{m}_{j+\boldsymbol{M}_t}\right\|}$$

End

$$\boldsymbol{Q}_{\boldsymbol{V}(t-1)} = \boldsymbol{M}$$

where $m^*_{\tau_j,k}$ is the conjugate of $\boldsymbol{M}$'s entry on the τ_j-th row and k-th column.

--- Text Change ends---