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Re:	TGm, DL_MIMO RG – Call for comment of final draft : SDD Text on Downlink MIMO Schemes (IEEE 802.16m-08/657r2)
Abstract	This contribution provides the codebook structure for DL closed-loop MIMO
Purpose	For discussion and approval by TGm, DL MIMO RG
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Introduction of Multiple Codebooks to the 16m System

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1. Introduction

Codebook based precoding is the prominent technique in the closed-loop MIMO due to the reason of limited feedback overhead. While meeting the design considerations of codebook [1], two kinds of codebook types such as the power balanced codebook and power unbalanced codebook can be considered. DFT based codebook is the representative codebook for the power balanced codebook which shows better performance in the spatially correlated channel. Antenna selection is the representative codebook for the power unbalanced codebook which shows better performance in the uncorrelated channel.

In this contribution, we propose that DFT based codebook shall be supported with 16e codebook for the 16m closed-loop precoding MIMO.

2. Classification of Codebook Type

Two kinds of unitary codebook such as DFT based codebook (Type I) and 16e codebook (Type II) have been suggested to take into consideration for 16m codebook in the final draft of DL MIMO Rapporteur Group as shown in Table 1. Here, we added a modified DFT based codebook (Type III) whose structure is the combination of DFT codebook with an unbalanced codebook like antenna selection in order to have a robust performance regardless of channel type. We have already shown its performance in [1] with the combination of DFT + AS.

Table 1. Three types of codebooks

	Antenna power	Example
Type I	Balanced	DFT based codebook
Type II	Unbalanced	.16e codebook
Type III	Balanced + unbalanced	Modified DFT codebook

We can combine three kinds of codebook selection options from the above codebooks like Table 2. Largely, they are divided into two groups ; single codebook and multiple codebook.

Table 2. Options for selection of codebook for 16m

Codebook type	Type	Option
Single codebook	Type I	Option 1
	Type III	Option 2
Multiple codebooks	1) Type I, 2) Type II	Option 3

3. LGE's Preference

Based on performance results in Appendix, DFT based codebook shall be supported with 16e codebook for the 16m closed-loop precoding MIMO (Option 3). Currently, 16e codebook will be supported on both BS and MS side as a legacy codebook because it is expected to be incorporated into WiMAX 1.5 profile. However, its relative performance is not so good in spatially correlated channel, when compared with DFT based codebook as shown in Table 3. Therefore, we propose that DFT base codebook should be supported along with 16e codebook for 16m system in order to maintain a consistent performance regardless of channels condition.

Table 3. Performance comparison of three types [1]

Option	Scenario	
	Spatially correlated channel	Uncorrelated channel
Type I	Best	Good
Type II	Good	Best
Type III	Better	Better

4. Conclusion

In this contribution, we proposed that DFT based codebook shall be supported with 16e codebook for the 16m closed-loop precoding MIMO.

Text Proposal for the 802.16m SDDs

========== *Start of Proposed Text* ==========

Remedy 1. Line 2, page 9 and Line 22, page 9
Add the following text;

For codebook based precoding technique, multiple codebooks shall be supported. BS can determine and broadcast which codebook or subset of codebook to be used based on system conditions.

DFT based codebook shall be supported with IEEE 802.16e codebook for the closed-loop precoding MIMO.

========== *End of Text Proposal* ==========

Reference

[1] C80216m-08/431, LG Electronics, ”Codebook based pre-coding MIMO”

Appendix

Figure 1 and 2 is the system level simulation results proposed in C80216m-08/431. Only LTE simulation result has been updated with the final codebook of LTE specification. The LTE codebook shows better performance than the previous simulation result in the spatially correlated channel because it includes DFT codebook elements in its rank 1 codebook structure. But its performance has not been improved in the zero correlated channel as shown in Figure 2.

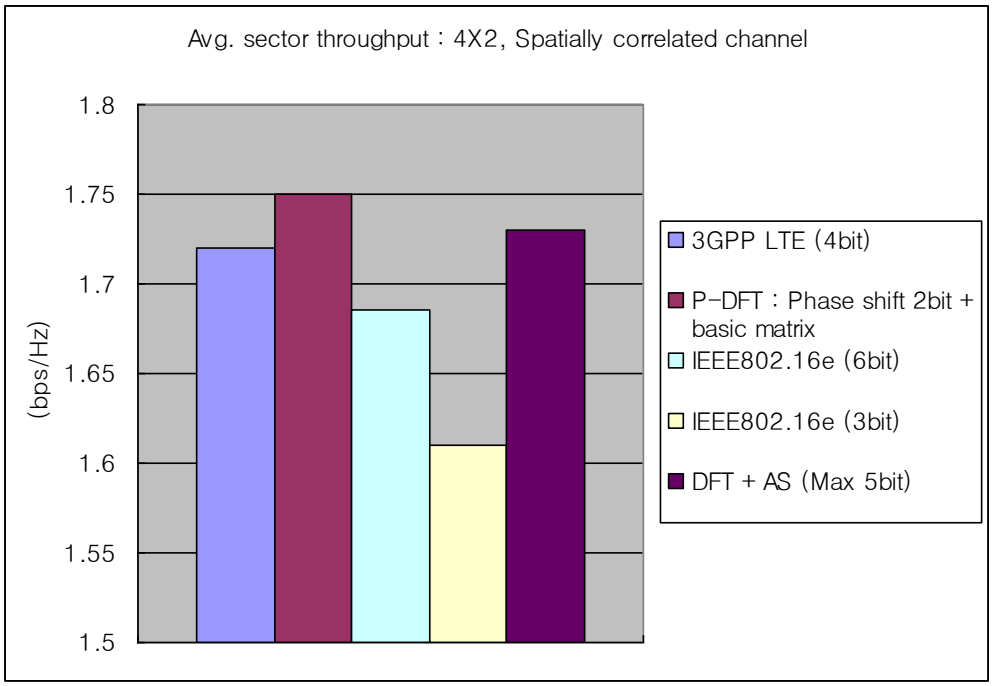

Figure 1. Comparison of avg. sector throughput

Table 3. Avg. sector throughput of each codebook scheme (bps/Hz)

(For spatially correlated channel)

Codebook type	IEEE802.16e (6bit)	Phase-adapted DFT (Max. 5bit : Phase shift 2 bit + basic matrix (4, 6))	3GPP LTE (4bit)	IEEE802.16e (3bit)	DFT + AS(Max.5bit(32,24))
Avg. sector throughput	1.685	1.75	1.72	1.61	1.73
Relative gain	0%	3.9%	2%	-4%	2.7%

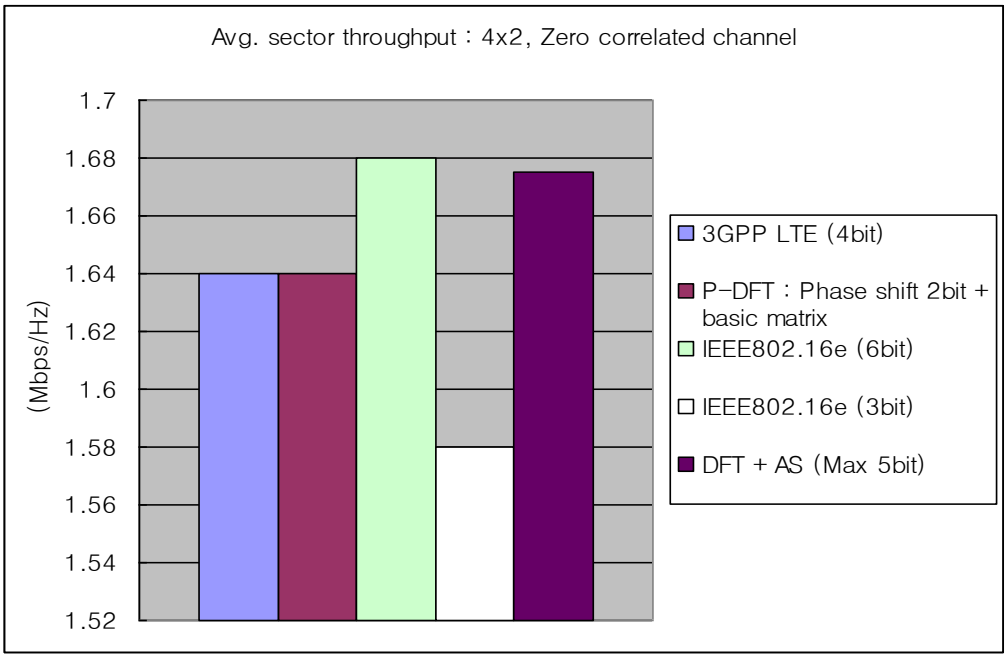

Figure 2. Comparison of avg. sector throughput

Table 4. Avg. sector throughput of each codebook scheme (bps/Hz)

(For zero correlated channel model)

Codebook type	IEEE802.16e (6bit)	Phase-adapted DFT (Max. 5bit : Phase shift 2 bit + basic matrix (4, 6))	3GPP LTE (4bit)	IEEE802.16e (3bit)	DFT + AS (Max.5bit(32,24))
Avg. sector throughput	1.68	1.64	1.64	1.58	1.675
Relative gain	0%	-2.4%	-2.4%	-6%	-0.3%