Way Forward on Precoding Codebook for SU-MIMO

IEEE 802.16 Presentation Submission Template (Rev. 9)

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Re: TGm SDD: In response to the TGm Call for contributions and Comments on 802.16m-08/003r5 for session 58 (support for comment)

Base Contribution:
IEEE C802.16m-08/1249

Purpose:
To discuss and adopt the proposed text in the next revision of the 802.16m SDD.

Introduction

- This contribution addresses the key properties for SU-MIMO precoding codebook
- It is suggested that we first agree on the properties of the codebook, and then propose and select a particular codebook
- The codebook in IEEE802.16e does not support 8 TX antennas
- The performance of DFT codebook and IEEE802.16e codebooks depends on different simulation scenarios depending on the antenna type and correlation model
  - The simulation scenarios have to be decided first
- It is also necessary to decide if a single codebook which overall best performance in all scenarios is selected or multiple codebooks will be adopted
- In this contribution, we propose the key properties of the codebook for SU-MIMO

Discussion

- Due to the constraint on the power amplifier, it is proposed to adopt codebooks of precoders with constant modulus (CM) property
  - CM property means that the transmitted symbols from all antennas have equal gain

- The complexity of precoder selection is a limiting factor for MS. It is suggested to reduce the complexity by two means:
  - The algorithmic complexity may be reduced by imposing appropriate structure to the codebook without sacrificing much of the performance, e.g., using house-holder transformation
  - The computational complexity can be further reduced, by minimizing the number of multiplication required to select the precoder

- After the users are selected, the precoders has to be reconfirmed by the BS. Such reconfirmation is required in both SU- and MU-MIMO scheme to allow accurate demodulation. For example, the error in feedback link might have changed the precoder index that is fed back by a MS.

Key Properties

- Precoding performance: The most essential property of the selected codebook is to have the overall best performance
- Computational complexity: Since the precoder selection is performed by MS, the complexity of the precoder selection has to be taken into account
  - It is proposed to use the codebook that can avoid or minimize the number of multiplications for example by using the elements in the form of ±1, ±j, ±1±j, ±2 ±j,…
    (Please note that multiplication by $\pm 2^{a} \pm 2^{b} j$ can be done only by shifting and summation)
  - It is proposed to use a codebook structure which allows for precoder selection with lower computational complexity
- Constant modulus property: Due to the limitation of power amplifiers (PA), e.g., one PA per antenna, the codebook should have CM property. Otherwise, the codebook with high PAPR will considerably lose in performance.
- Nested codebook: It is desirable to have nested codebooks for lower ranks. This allows for simple allocation of MCS if BS requires to override the requested precoding rank by a MS

Summary

- We propose consideration of two steps in precoding codebook selection
- First, to agree on the possible scenarios in terms of the channel model, antenna configuration/type, and correlation model in order to evaluate the performance of the codebooks.
- Second, to include the following key properties for the precoding codebook
  - Performance
  - Complexity
  - Constant modulus property
  - Nested property
- The selected precoder for the transmission has to be signalled from BS to the users because of several reasons:
  - Error in feedback link
  - Possible rank override by BS

Proposed Text (1)

Remove the following text from 11.8.2.1.2.1 Precoding technique section of the (IEEE 802.16m 08/003r5), page 83, line 2:

---------- Text Start ----------

“For codebook based precoding, the codebook will be a .16e based and/or DFT-based codebook”

---------- Text End ----------

Proposed Text (2)

Insert the following text into 11.8.2.1.2.1 Precoding technique section of the (IEEE 802.16m 08/003r5):

---------- Text Start ----------

"For codebook based precoding, the codebook will be selected with overall best performance, and with the lowest complexity. The codebook should have constant modulus property and the nested structure. Constant modulus refers to equal gain transmission from each antennas and nested structure means that any precoder in the codebook of a lower rank are obtained by eliminating the columns of a precoder in the codebook of higher rank."

---------- Text End ----------

Proposed Text (3)

Insert a new section 11.8.2.1.4 in page 83 of the (IEEE 802.16m 08/003r5):

---------- Text Start ----------

“11.8.2.1.4 Feedforward for SU-MIMO

The selected precoders that is used for the transmission will be signalled by BS to MS.”

---------- Text End ----------

Proposed Text (4)

Insert a new section 11.8.2.2.4 in page 85 of the (IEEE 802.16m 08/003r5):

---------- Text Start ----------

“11.8.2.2.4 Feedforward for MU-MIMO

The selected precoders that is used for the transmission to plurality of users will be signalled by BS to all users in the plurality.”

---------- Text End ----------