Project	**IEEE 802.16 Broadband Wireless Access Working Group** <http://ieee802.org/16>
Title	**Non-orthogonal Superposition for UL MIMO**
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Re:	Call for Comments and Contributions (IEEE 802.16m-08/024) on Project 802.16m, System Description Document (SDD) Specific topic: Uplink MIMO schemes
Abstract	Non-orthogonal superposition in uplink for single and multiple antenna modes
Purpose	To be presented and discussed in TGm for adoption of the specific text in the SDD.
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Non-orthogonal Superposition for UL MIMO

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Introduction

According to the System Requirements Document (SRD) [1], IEEE 802.16m shall support multi-user MIMO techniques.
Superposition of signals (layers/streams) that are neither orthogonal in time or frequency nor in space and can only be separated by joint detection or successive interference cancellation is a multi-user technique for single and multiple antenna systems that can enhance the aggregate sector throughput significantly. It allows using more streams than the number of receive antennas at the BS. Comparable aggregate throughput cannot be achieved by orthogonal signaling under fairness constraints. Only long-term channel statistics are required at the transmitter.

Figure 1 shows the CCDF for the spectral efficiency per time-frequency radio resource of an OFDMA system with and without non-orthogonal superposition under the following assumptions:

- Single-antenna setup
- Non-orthogonal superposition of 2 layers
- Max. path loss difference in the cell: 60dB.
- Distributed physical allocation scheme (802.16e PUSC)
- Cell edge SNR: 0 dB
- Path loss exponent: 3.5.
- Most robust MCS: QPSK 1/2 with repetition coding 4.
- 30 active users in a sector
- QoS constraint: PER < 10^{-2}

The spectral efficiencies are:
- Cell spectral efficiency with SU access: 0.766 bps/Hz
- Cell spectral efficiency with MU access: 1.580 bps/Hz
- Cell spectral efficiency gain by non-orthogonal superposition: 106%

[1] The authors acknowledge the partial supported of this work by the European Commission in the framework of the FP7 project WiMAGIC

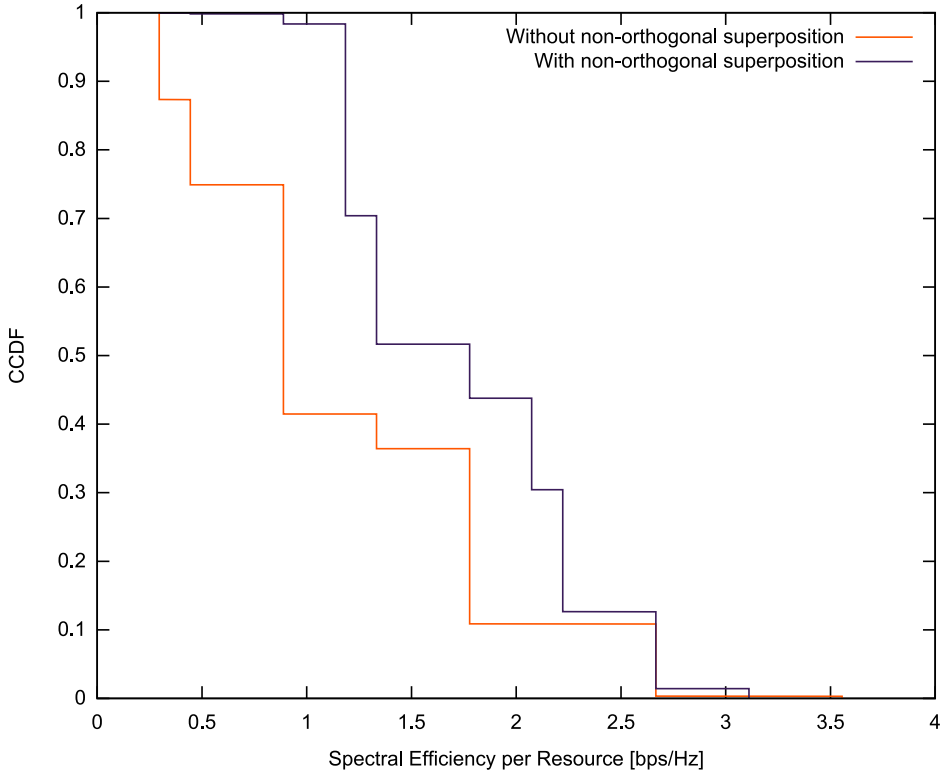

Figure 1: Spectral efficiency per time-frequency resource with and without non-orthogonal superposition

To support non-orthogonal signaling, IEEE 802.16m must be able to

- assign multiple terminals/basic CIDs (superposition layers) to a common time-frequency resource (the number of terminals may be higher than the number of receive antennas at the BS, e.g two times the number of receive antennas)
- signal in the UL control structure for each superposition layer in each time-frequency allocation:
  - the modulation and coding scheme (MCS) or burst profile
  - the terminal address/basic CID
  - the transmit power offsets relative to an uplink signal without superposition
- adjust different receive power per data tone at the BS for different layers
- cause a terminal to use different transmit power per data tone in the uplink for bursts with and without superposition even if the modulation and coding scheme (MCS) is the same.
- cause a terminal to adjust pilot boosting for the case that the same pilot patterns are used in different superposition layers.
- It may allow for hopping pattern assignment to the supported layers in conjunction with restrictions imposed by Fractional Frequency Reuse (FFR).

Proposed Text for the SDD:

----------Start of the Text----------

10 Medium Access Control Sub-Layer

10.x UL MIMO

IEEE 802.16m supports non-orthogonal superposition of uplink signals (superposition layers) from different terminals with the same or different receive power levels in the uplink, where the number of superposition layers may be higher than the number of receive antennas at the base station. It provides mechanisms to control the transmit power of a MS differently for different superposition layers and allows the transmit power per data tone of an uplink transmit burst using superposition to be different from other uplink bursts without superposition.

The IEEE 802.16m MAC allows the allocation of time frequency resources in uplink to be used for non-orthogonal superposition of signals from different MSs in single and multiple antenna modes.

It provides control structures for DL signaling of transmit power offsets to be used by the terminals for non-orthogonal superposition in UL.

10.x Power Control

10.x.x UL Power Control

IEEE 802.16m provides a mechanism and control structures for uplink power control on a per terminal basis to provide additional transmit power offsets required for adjusting the transmit powers for different layers in non-orthogonal superposition mode.

11 Physical Layer

11.6 DL Control Structure

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11.6.2.3.1.2 User-specific control information

The user specific control information includes additional user specific transmit power offsets to be used by the terminals only when transmitting in UL allocations reserved for non-orthogonal superposition. It may also include frequency hopping pattern configurations.

11.x UL MIMO

IEEE 802.16m MSs are able to adjust their transmit power on time-frequency resources reserved for non-orthogonal superposition in single and multiple antenna configurations according to transmit power offsets signaled by the BS specifically for that purpose.

----------End of the Text----------

References

[1] IEEE 802.16m System Requirements Document (SRD), IEEE 802.16m-07/002r4