Importance of Distributed Allocations for Closed-Loop SU- and MU-MIMO

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Venue:
TGm – Comments on Project 802.16m System Description Document – Downlink MIMO Schemes
Abstract:
We propose that the SDD text on DL-MIMO includes the use of distributed allocations for CL-SU-MIMO and CL-MU-MIMO
Purpose:
Discussion and adoption of recommended text into 802.16m System Description Document for DL-MIMO

Problem in C802.16m-08/657r2

- The current SDD text submission for DL-MIMO allows CL-SU-MIMO and CL-MU-MIMO to operate only in localized allocations
- We propose allowing CL-MIMO and MU-MIMO to operate in both localized and distributed allocations
- Also want to ensure dedicated pilots continue to be supported in distributed allocations
  - Currently included in 16e / WiMAX R1 and 16m SDD draft
  - Enable vendor-specific precoding to work well in distributed allocations

Important Deployment Scenario: *Correlated Array in Suburban/Rural Environment*

- Characteristics:
  - BS above the clutter => Angular spread is low => Correlated array.
    - **Spatial channel characteristics are stable over time/frequency**
  - Moderate percentage of users experience a time-varying frequency-selective channel
    - **Frequency selectivity not static over time**
- Implications for velocity scenarios:
  - Beamforming / closed-loop transmission works with a wideband precoder
    - **Coherent processing gains can be achieved with wideband precoding**
    - Feedback of wideband PMI is also in the SDD
  - Difficulties with Band Selection:
    - Does not provide gains in velocity scenarios
      - **No gain from frequency selective scheduling**
    - Has high overhead
- Narrowband allocations cannot exploit frequency diversity!
- **CL-SU-MIMO & CL-MU-MIMO need to be able to operate with a distributed allocation**

Dedicated Pilots should be an option in Distributed Allocations

- Vendor-specific CL-SU-MIMO & CL-MU-MIMO require dedicated pilots
  - E.g., enabled by UL Sounding as in the SDD text
  - MS will not know the precoder vector/matrix
- CL-SU-MIMO & CL-MU-MIMO should be operable in distributed allocations
  - See previous slide
- Therefore need dedicated pilots in distributed allocations

Block-Based Distributed Allocations Needed for Closed-Loop Transmission

- Vendor-specific closed-loop transmission requires dedicated pilots ("beamformed" along with the data)
  - E.g., UL sounding, analog feedback, Codebooks for MU-MIMO
  - Pilots must be clearly tied to / associated with the user allocation
- Using dedicated pilots in single subcarrier-based distributed allocations (e.g., 16e-PUSC-style) imposes a restriction that all data in the resource block must be precoded / beamformed in the same way
  - Imposes large scheduling granularity when beamforming to a single user – Need to avoid this in 16m!
- Block-based distributed allocations avoids this restriction
  - Dedicated pilots within each block allow per-block precoding for tracking frequency selectivity
  - FEC across blocks exploits frequency diversity

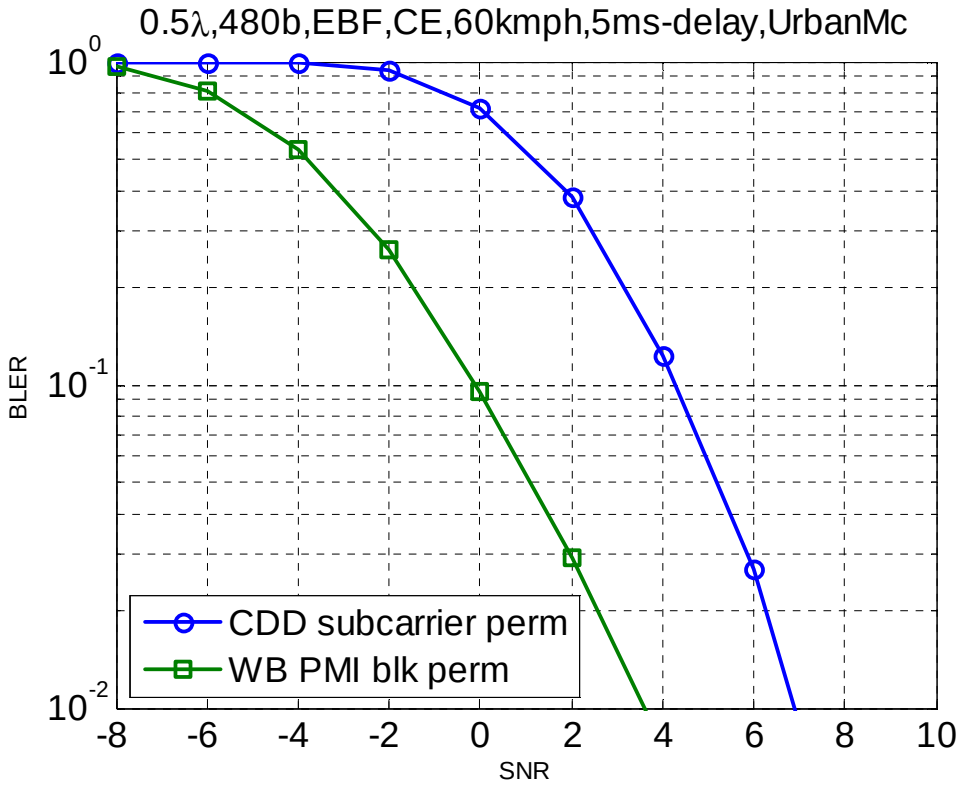
Response to various concerns

- Concern that distributed allocations means more overhead in the precoding feedback.
  - UL Sounding – enabled precoding
    - Distributed allocations has no impact on overhead – sounding can be matched to the DL allocation
  - Codebook – based precoding
    - Can have one PMI/PVI applied across the entire band – low overhead on UL & DL

SU-MIMO Simulations

Wideband Precoding based on Codebook feedback

- Urban Macro, 60kmph



Wideband precoding is effective at high velocity in *correlated* scenarios

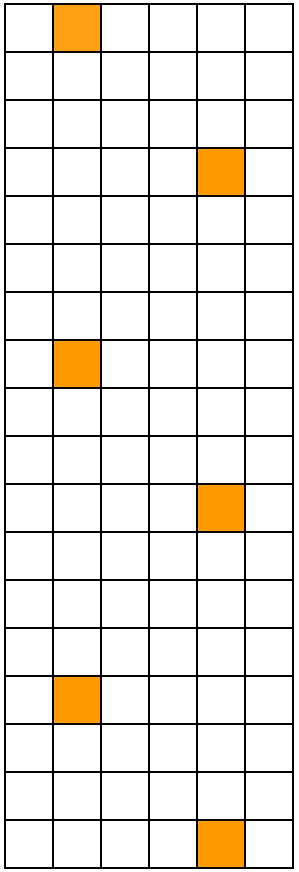
* Larger gains observed in suburban channels

SU-MIMO Simulation Parameters 1

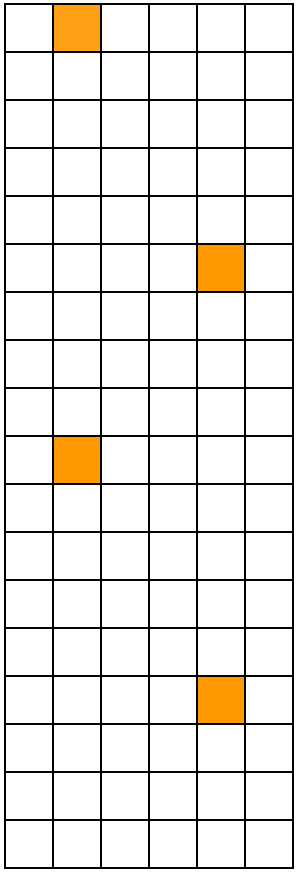
Parameter	Value
NFFT	1024
Carrier frequency	2.6 GHz
# Tx antennas	4
# Rx antennas	2
Antenna spacing	0.5 λ for Tx, 0.5 λ for Rx
MCS	1/2 QPSK
Channel model	SCM Urban Macro 15^0 (60kmph),
Feedback delay	5ms
Pilots	Dedicated for CL-MIMO and Broadcast for CDD, 2.5dB boost
Codebook Parameters	4-bit LTE codebook, no feedback error
Receiver	MRC
DL channel estimator	2D-MMSE based on 18x6 tile for CL-MIMO, 1-D MMSE for broadcast using WB pilots
Midamble channel estimator	Ideal
Packet size	480 info-bits (5PRU)
DL- Allocation	18x6 block distributed randomly (for CL-MIMO) or subcarrier permutation (for CDD)

SU-MIMO Simulation Parameters 2

- Pilot – dedicated - 5.56%



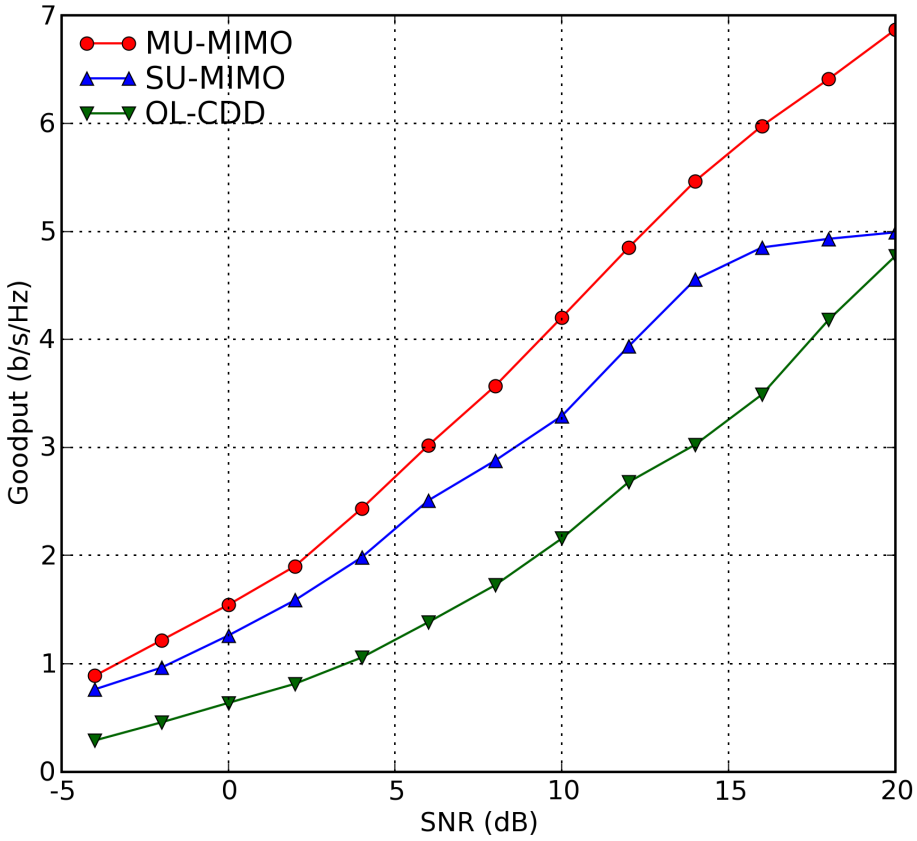
- Pilot – broadcast – 3.7%



MU-MIMO Simulations

Wideband Precoding based on Codebook feedback

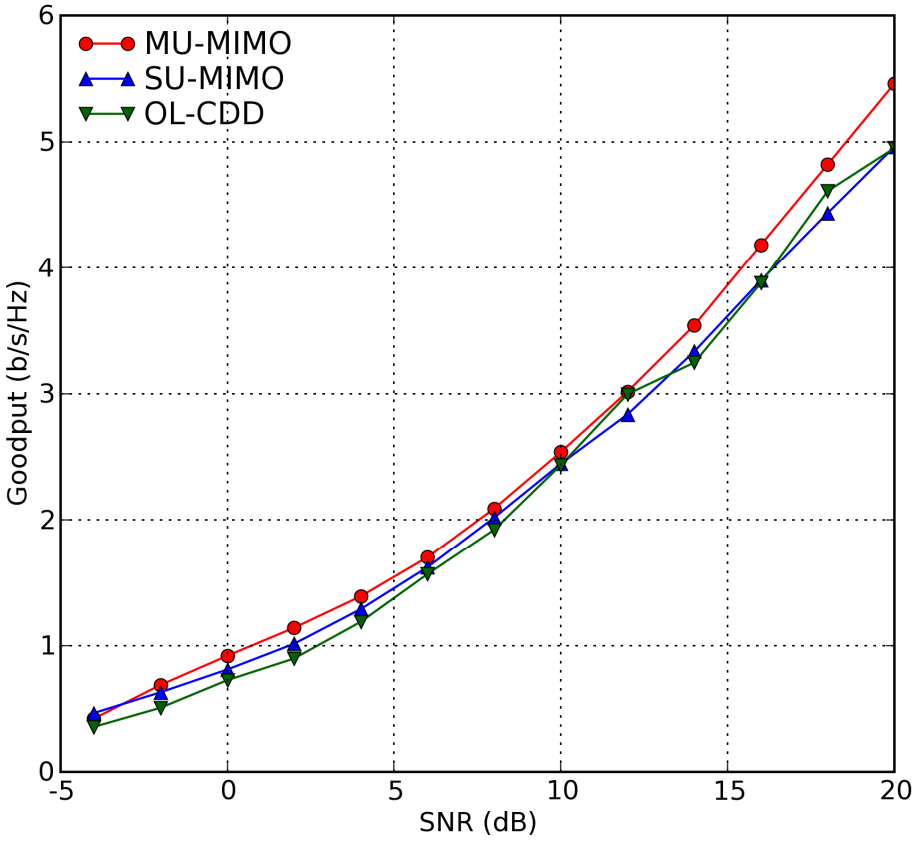
- Urban Macro, 60kmph, 0.5λ @ BS, 0.5 λ @ MS



Wideband precoding is effective at high velocity in *correlated* scenarios

Wideband Precoding based on Codebook feedback

- Urban Macro, 60kmph, 4λ @ BS, 0.5 λ @ MS



Wideband precoding performs similar to or slightly better than open-loop at high velocity in *uncorrelated* scenarios

MU-MIMO Simulation Parameters

Parameter	Value
NFFT	1024
Carrier frequency	2.5 GHz
# Tx antennas	4
# Rx antennas	2
Antenna spacing	4λ or 0.5λ @ BS, 0.5 λ for Rx
Channel model	SCM Urban Macro (Table 10, Sec. 3.2.5.1 of IEEE802.16m-08/004r2)
MS velocity	60 kmph
Feedback delay	5ms
Codebook Parameters	3-bit LTE codebook, no feedback error
Receiver	MMSE for MU-MIMO, MRC for CDD
DL channel estimation	Perfect
Packet size	480 info-bits
DL- Allocation	Spread over entire bandwidth
Number of users	6 for MU-MIMO, 1 for OL-CDD