Interference Mitigation for Uplink

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Re:
    IEEE 802.16m-08/024: Call for Contributions on Project 802.16m System Description Document (SDD) (2008-06-18), Interference Mitigation.

Abstract:
    Discussion on interference mitigation for uplink of IEEE 802.16m SDD

Purpose:
    Adoption of proposed text into SDD
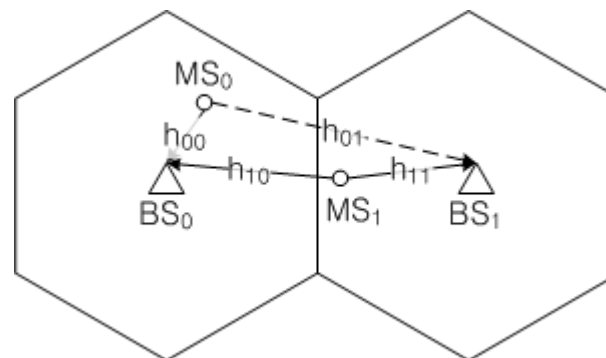
Interference Mitigation for Uplink

- ## Uplink Multi-cell Cooperation
    - Uplink (UL) Co-Channel Interference Cancellation (CCIC)
    - UL Virtual MIMO

- ## Uplink with Multiple Transmit Antennas
    - UL Beamforming

Uplink Multi-cell Cooperation

- h_{00}: channel from MS_0 to BS_0
- h_{10}: channel from MS_1 to BS_0
- h_{01}: channel from MS_0 to BS_1
- h_{11}: channel from MS_1 to BS_1

- UL Co-Channel Interference Cancellation (CCIC)
  - It has an interference cancellation gain.
  - MSs in the cell edge change their pilot pattern to estimate interfering channels in the affected BS.
  - The affected BS can remove the co-channel interference.

Uplink Multi-cell Cooperation (Cont'd)

- ## UL CCIC
  - For example, when only one user is dominant among users causing CCI, two pilot patterns exist.
    - Center users: pilot pattern A
    - Edge users: pilot pattern B

    - Patterns A and B are orthogonal.

    - It is possible to eliminate CCI for subcarriers using different pilot patterns.
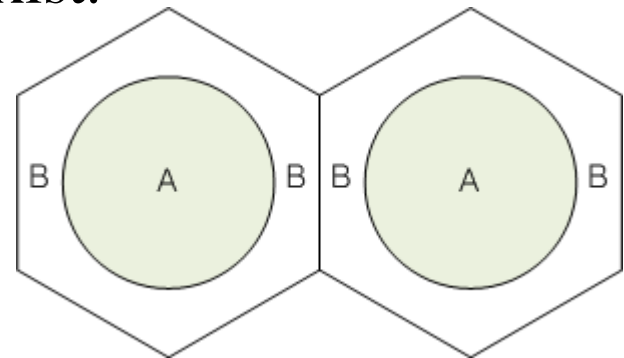
Uplink Multi-cell Cooperation (Cont'd)

- ## UL CCIC: Link Level Simulation Results
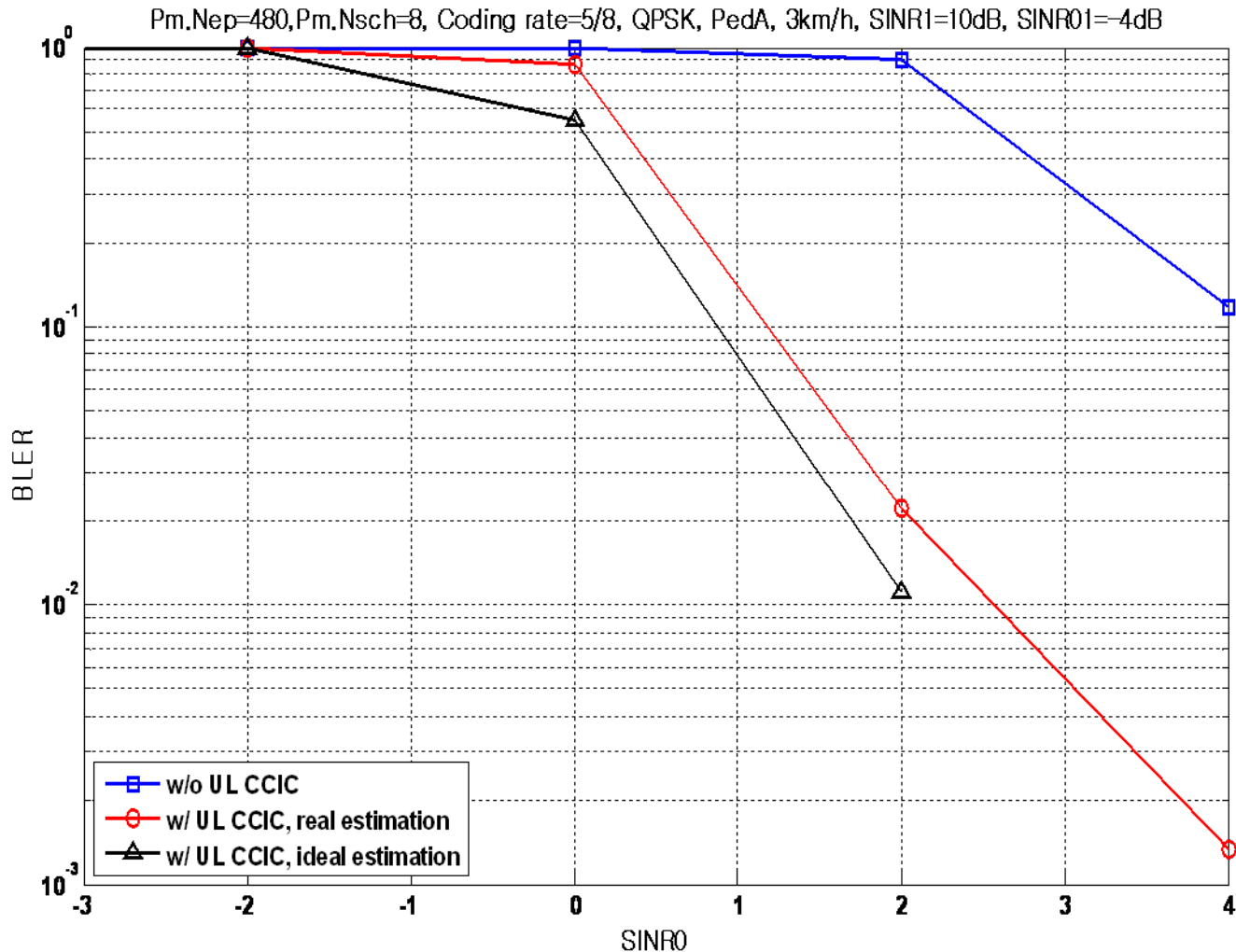

Pm.Nep=480,Pm.Nsch=8, Coding rate=5/8, QPSK, PedA, 3km/h, SINR1=10dB, SINR01=-4dB

$$y = h_{00}s_0 + h_{01}s_1 + NI_0 - \hat{h}_{01}\hat{s}_1$$

NI_0: co-channel interference with noise

$\hat{s}_1 : \text{SINR1},\quad \hat{h}_{01} : \text{SINR01}$

$\hat{s}_0, \hat{h}_{00} : \text{SINR0}$

ideal estimation: s_1, h_{01}

Legend:
- w/o UL CCIC
- w/ UL CCIC, real estimation
- w/ UL CCIC, ideal estimation

BLER vs SINR0

Uplink Multi-cell Cooperation (Cont'd)

- UL CCIC: System level Simulation Results
  - Open loop power control
  - Ideal channel and CCI estimation (one dominant user)
  - ACK: Nep=96, Game: Nep=480

SLS run time : 1000 frames					
	ACK: Game = 6:4		ACK: Game = 5:5		ACK: Game = 4:6	
	w/o CCIC	w/ CCIC	w/o CCIC	w/ CCIC	w/o CCIC	w/ CCIC
Throughput [Mbps]	1.132	1.425	1.613	2.030	1.951	2.305
Improvement	25.88%		25.85%		18.14%	

Uplink Multi-cell Cooperation (Cont'd)

- ## UL Virtual MIMO

  - UL virtual MIMO achieves diversity gain by incorporating CCI information from interfering cell.

  - Cooperation protocols can be in a centralized or decentralized fashion.

  - It requires both cell specific pilot patterns and multi-cell coordinated scheduling (For example, two users in the different cells have equal subcarrier index).

Uplink with Multiple Transmit Antennas

- h_{00}: channel from MS_0 to BS_0
- h_{10}: channel from MS_1 to BS_0
- h_{01}: channel from MS_0 to BS_1
- h_{11}: channel from MS_1 to BS_1
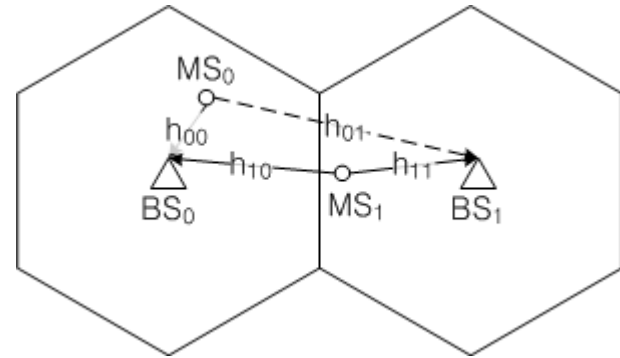
- UL Beamforming
  - For example, MS1 in the cell edge transmits
    - Beamformer
      - $$W = \alpha \cdot W_{ZF} + \beta \cdot W_{MRT}$$
        where W_{ZF} is zero-forcing beamformer for h_{10}, W_{MRT} is maximum ratio transmission beamformer for h_{11}, and α and β are constants.
      - W_{ZF} is used for interference mitigation, and W_{MRT} is used for maximizing the received power. They can be replaced by codeword.
      - Interfering channel, h_{10}, for calculating W_{ZF} can be obtained via downlink preamble (or midamble) in TDD or downlink signaling for transmitting codeword in FDD. For downlink codeword signaling in FDD, changing pilot patterns are required to estimate h_{10} as UL CCIC.

Proposed Texts into SDD

- **11.x. Interference Mitigation for Uplink**
  - 11.x.1. Uplink Multi-cell Cooperation
    - *Users in the cell edge can change their pilot pattern to estimate interfering channels in the affected BS.*

    - 11.x.1.1. Uplink Co-Channel Interference Cancellation
    - 11.x.1.2. Uplink Virtual MIMO

  - 11.x.2. Uplink Beamforming
    - *Users in the cell edge can use a beamforming scheme combining the selfish beamformer and the altruistic beamformer.*