Pre-coding for DL Unicast Service CCH

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Venue:

SDD Session 56 Cleanup, Call for PHY Details

Purpose:

This contribution provides simulation results for two detailed PHY USCCH proposals

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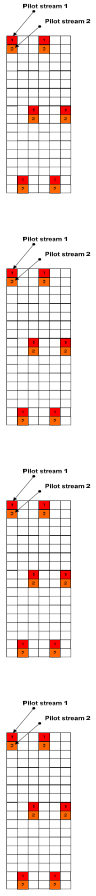
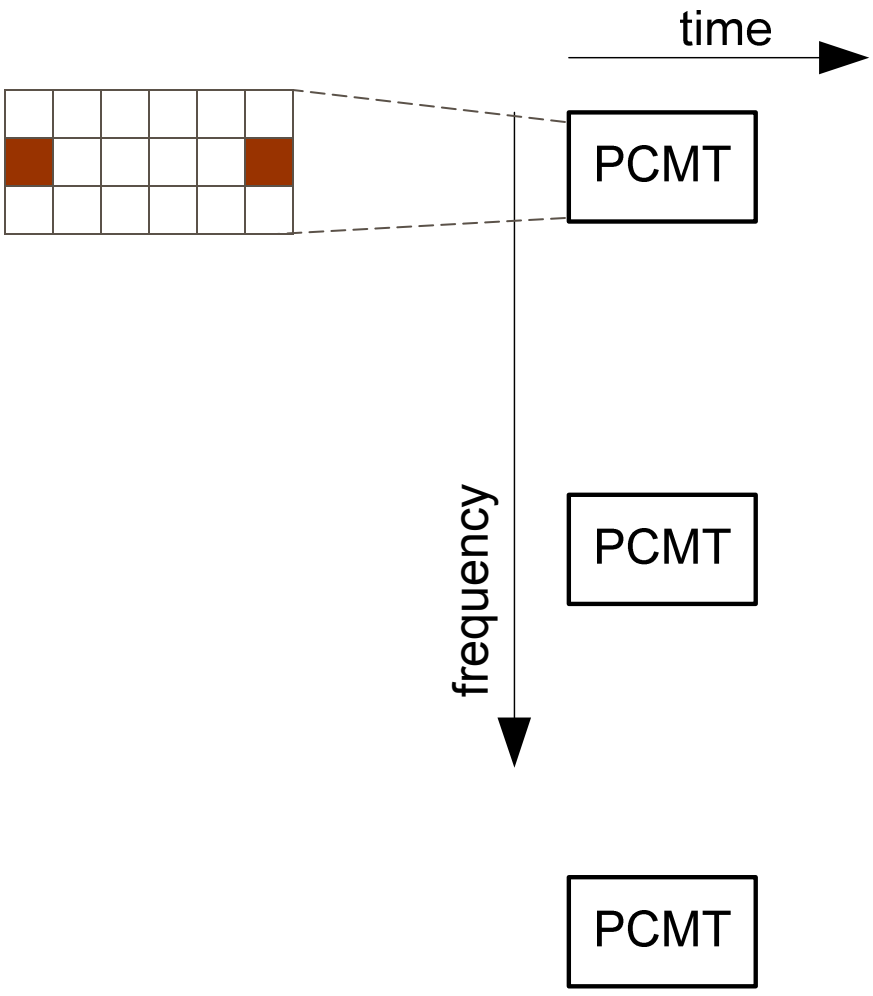
- This contribution examines the performance improvement provided by precoding the Unicast Service Control Channel (USCCH) for both downlink and uplink allocations
  - Precoding can provide significant cell-edge performance improvement by reducing control overhead by half or more
- Per 11.7.2.3 the SDD consensus
  - Separate coding of USCCH is assumed.
    - "*For user-specific control information intended for a single user, multiple information elements are coded separately*."
  - FDM multiplexing of the USCCH is assumed
- Further assumptions:
  - Pre-coding is based on the PMI feedback sent during an active state data transmission
  - PMI is based on a MIMO midamble transmission
  - USCCH carries dedicated pilots precoded with the data

Reference Configuration: DRU Based Allocation (open-loop)



- Control Message
  - Payload = 48 bits
  - QPSK (16 QAM is TBD)
  - Coding R=1/2, ¼, 1/8, 1/6
- DRU based control
  - 4 or more (TBD) DRUs are reserved for control depending on capacity
  - Payload
    - 96 symbols per DRU (if SBFC is assumed)
    - 384 in a 4 DRU control channel zone
  - Control message
    - Multiple of 48 symbols
    - 48 symbols are selected based on the subcarrier permutation.
    - Separately coded
  - Pilots are common to control messages
    - Pilot pattern is based on SDD 2-TX PRU format

Pre-coded Configuration: Distributed Tile-Based Allocation (closed-loop)



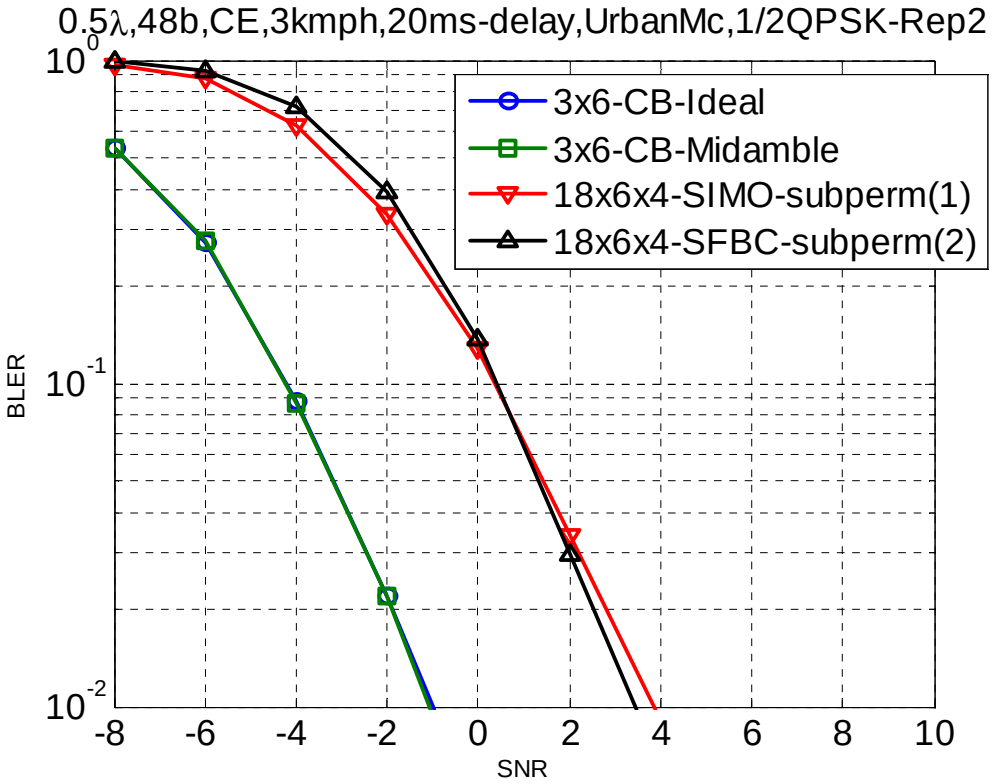
- Control Message
  - Payload = 48 bits
  - QPSK (16 QAM is TBD)
  - Coding R=1/2, ¼, 1/8, 1/6
- Tile based control
  - 3, 6 or 12 PRUs are reserved for downlink control depending on capacity
  - The PRUs are distributed in frequency
  - Each 6x18 PRU is subdivided into six 6x3 Control Tiles (CT)
  - Three CT from different PRUs are grouped together to forma separately coded control channel with a payload of 48 bits

Simulation Parameters 1

Parameter	Value
NFFT	1024
Carrier frequency	2.6 GHz
# Tx antennas	4 or 1 (power fair)
# Rx antennas	2
Antenna spacing	4 λ or 0.5 λ for Tx, 0.5 λ for Rx
MCS	1/2 QPSK, 1/2 QPSK Rep-2
Channel model	Urban Macro, Suburban Macro
Mobile speed	3kmph
UL delay	20ms delay
Pilots	2.5dB pilot boost, 1 stream for SIMO or BF, 4 streams for SFBC+FSTD
Codebook parameters	4-bit LTE codebook, 1 codebook index feedback for wideband, ideal feedback
Receiver	MRC
DL channel estimator	2D MMSE PRU based
Packet size	48 info-bits
DL- CCH PHY Structure	Distributed allocation, tiles randomly distributed
Midamble	1 symbol 16e midamble, ideal channel estimation or linear channel estimation
Subcarrier permutation	1-subcarrier permutation x 4 PRU for SIMO, 2 (pair) subcarrier permutation x 4 PRU for SFBC-FSTD
SFBC	4Tx SFBC + FSTD scheme with 4Tx pilots similar to LTE

Urban Macro 0.5 λ

- BLER

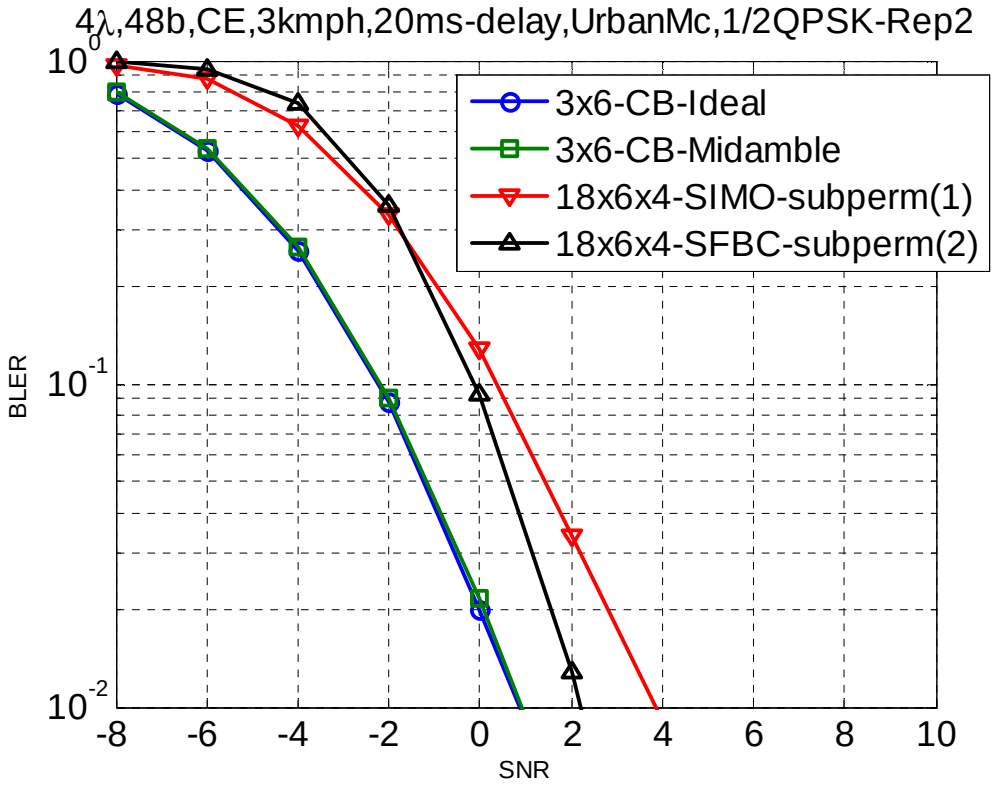


Note 1: 18x6x4-SIMO-subperm(1)= 18x6 tiles with 1-subcarrier permutation across 4 tiles, CE done within 1 tile (6 pilots), pilot format according to 16m-SDD

Note 2: 18x6x4-SFBC-subperm(2)= 18x6 tiles with 2-subcarrier permutation across 4 tiles, CE done within 1 tile (16 pilots for 4 streams), pilot format according to 16m-SDD

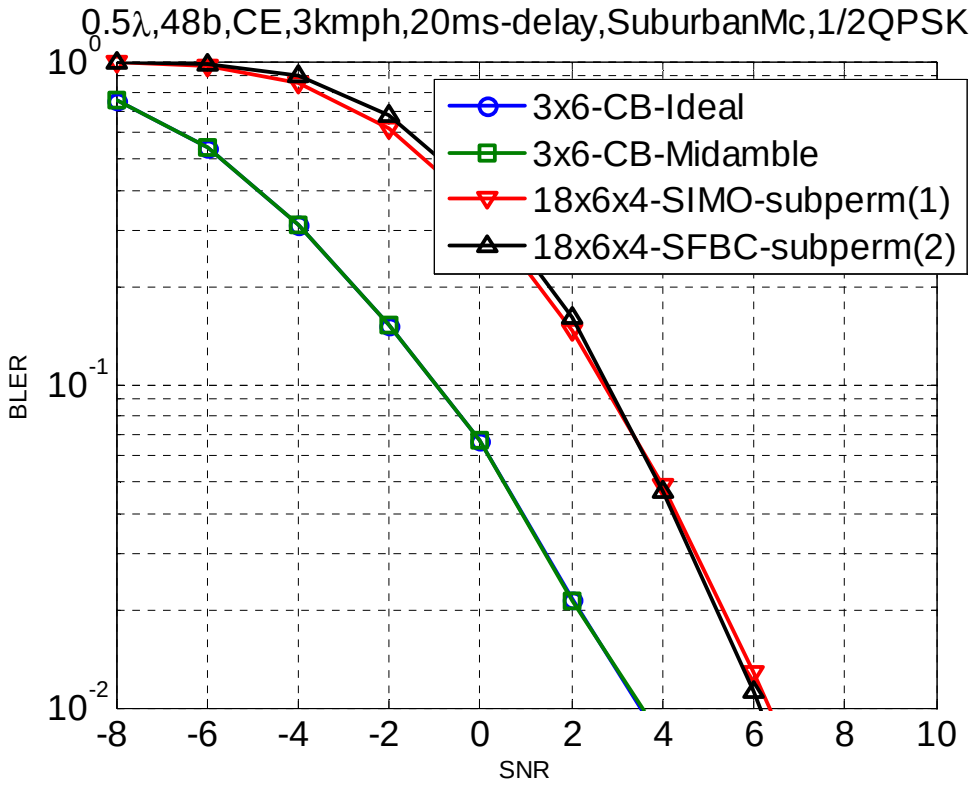
Urban Macro 4 λ

- BLER



Suburban Macro 0.5 λ

- BLER



Observations

- Pre-coded control provides anywhere from 3 to 5 dB improvement depending on antenna spacing and spatial channel model
  - Represents a reduction in control overhead by 50% to 75%
- Pre-coded control is better in all environments and antenna spacings when 4 Tx antennas are employed
  - Pre-coding is the clear choice for correlated antenna arrays with 0.5 λ spacing
  - Pre-coding provides a 1.5 dB performance advantage even for uncorrelated antenna arrays with 4 λ spacing
- It is acknowledged that 2 Tx BS configurations may continue to use a non pre-coded configuration
- Recommendation:
  - Adopt 2 USCCH formats one for open-loop and one closed-loop
    - Open-loop: DRU based and separately coded
    - Closed-loop: 3x6 Tile based, pre-coded with dedicated pilots
  - PBCH may signal the USCCH format to allow roaming between different BS configurations