Parametric Compression of Rank-1 Analog Feedback

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Notice:

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Patent Policy:

Background

- We propose to use rank-1 analog and compressed analog feedback for MU-MIMO
- Details and text proposal are in C80216m-09_1341r2
- General analog rank-1 feedback requires feeding back N complex numbers for N antennas independent of the antenna configuration
- However, for correlated antennas the proposed new compressed mode enables lower UL overhead by parameterizing the rank-1 feedback and feeding back the parameters in an analog fashion.
- The proposed compressed analog also works in the (codebook) transformation mode

- Some general good properties:
  - Analog feedback has an inherent advantage over codebook for MU-MIMO because its accuracy naturally grows with SNR - a property that is required for enabling accurate processing (ZF) at the BS. This property enables accurate feedback in high SNR cases involving heterogeneous deployments (femto/relay)
  - The feedback is self-contained (no 'memory' required as in differential codebook)
  - If the MS is scheduled on the same band in successive frames the BS can average the feedback also across time (less need for frequency repetition)

Rank-1 Computation

A closed form formula for the strongest singular vector per subcarrier was given in C802.16m-08/522r1

$$v = h_1^* \cos\theta + h_2^* \sin\theta \; e^{j\phi}$$

where h_i i=1,2 is the i'th row of H - the 2xN DL channel

$$e^{j\phi} = \frac{h_2^* h_1}{| h_2^* h_1 |} \qquad \tan 2\theta = \frac{2 | h_2^* h_1 |}{| h_1 |^2 - | h_2 |^2}$$

Mobiles with 4 antennas can use the formula given in C80216m-09_1344

The formula is general and works for any antenna configuration

Compressed Form for (Semi-)Correlated Antennas

When the BS antennas are correlated or semi-correlated it's possible to reduce feedback overhead by parameterizing the feedback.
For example, if the BS uses a 4 closely spaced cross-polarized antennas the rank-1 feedback can be represented by two steering arrays with one complex (gain/phase) offset.

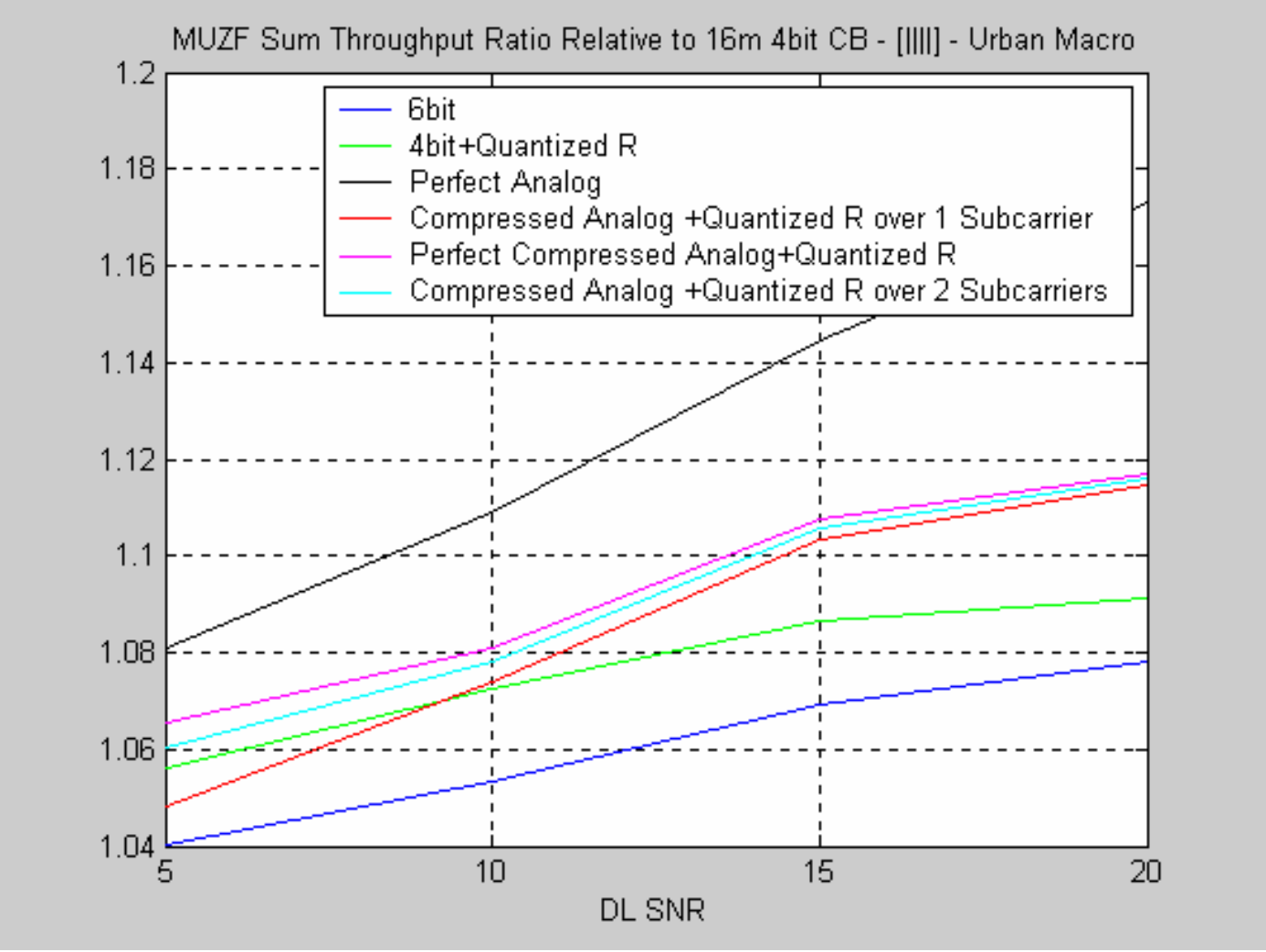
$$[\exp(j*(0:N-1)*\Phi_1) \quad \alpha \exp(j*(0:N-1)*\Phi_2)]$$

The feedback overhead is 2 real parameters Φ_i , the steering array phases, and one complex number which can be mapped onto 3 subcarriers

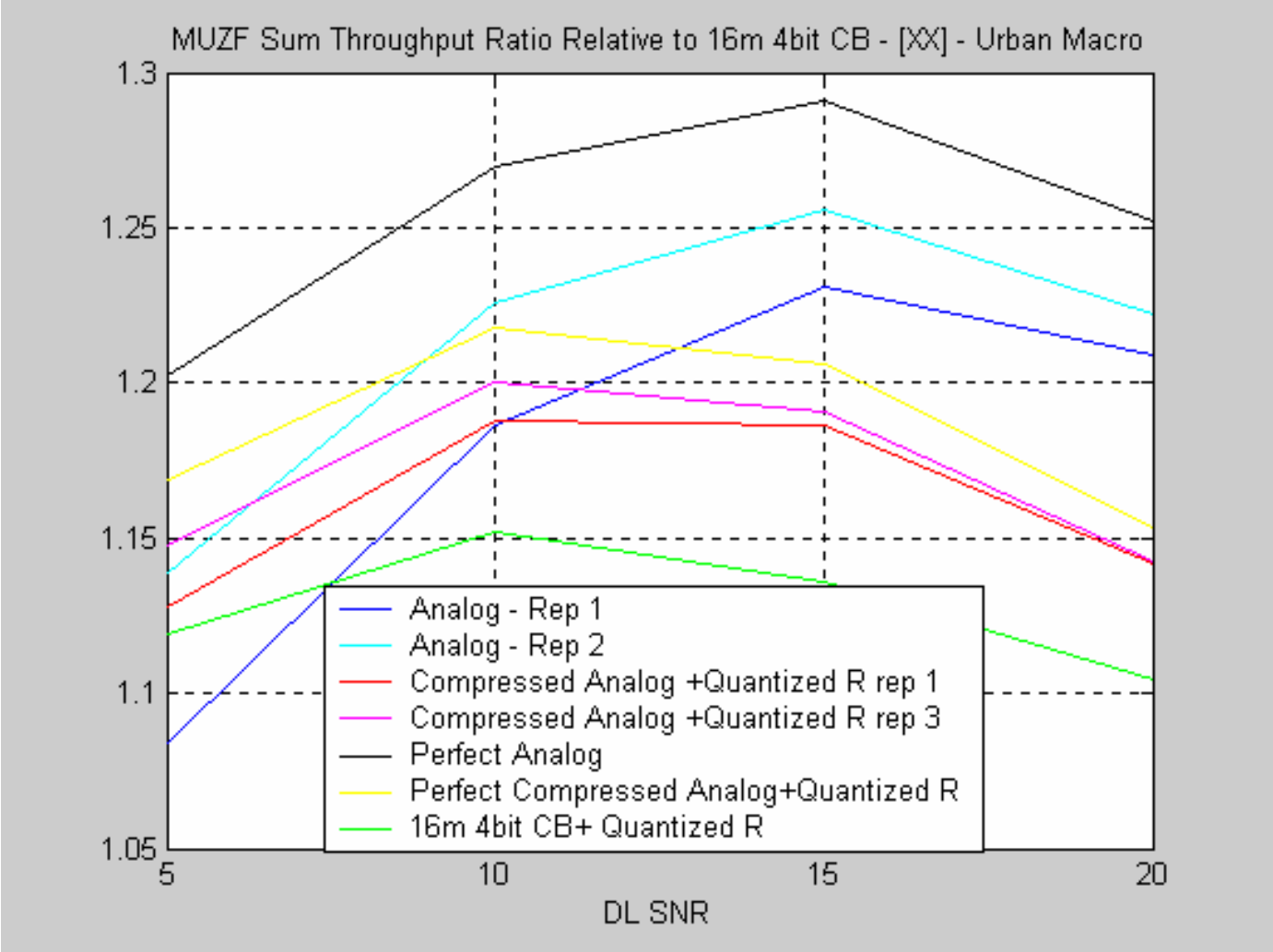
MU-MIMO Simulation

- Explicit DL and UL channel modeling using SCM Urban Macro
- Real channel estimation
- Equal DL and UL SNR per subcarrier
- MUZF with 4 users per band with exhaustive search
- Band size 4 PRB
- UL overhead:
  - 8 subcarriers for 4bit PMI (current 16m uses 10 subcarriers)
  - N subcarriers for Analog (for N-antenna BS)
  - 1,2,3 or 5 subcarriers for compressed analog

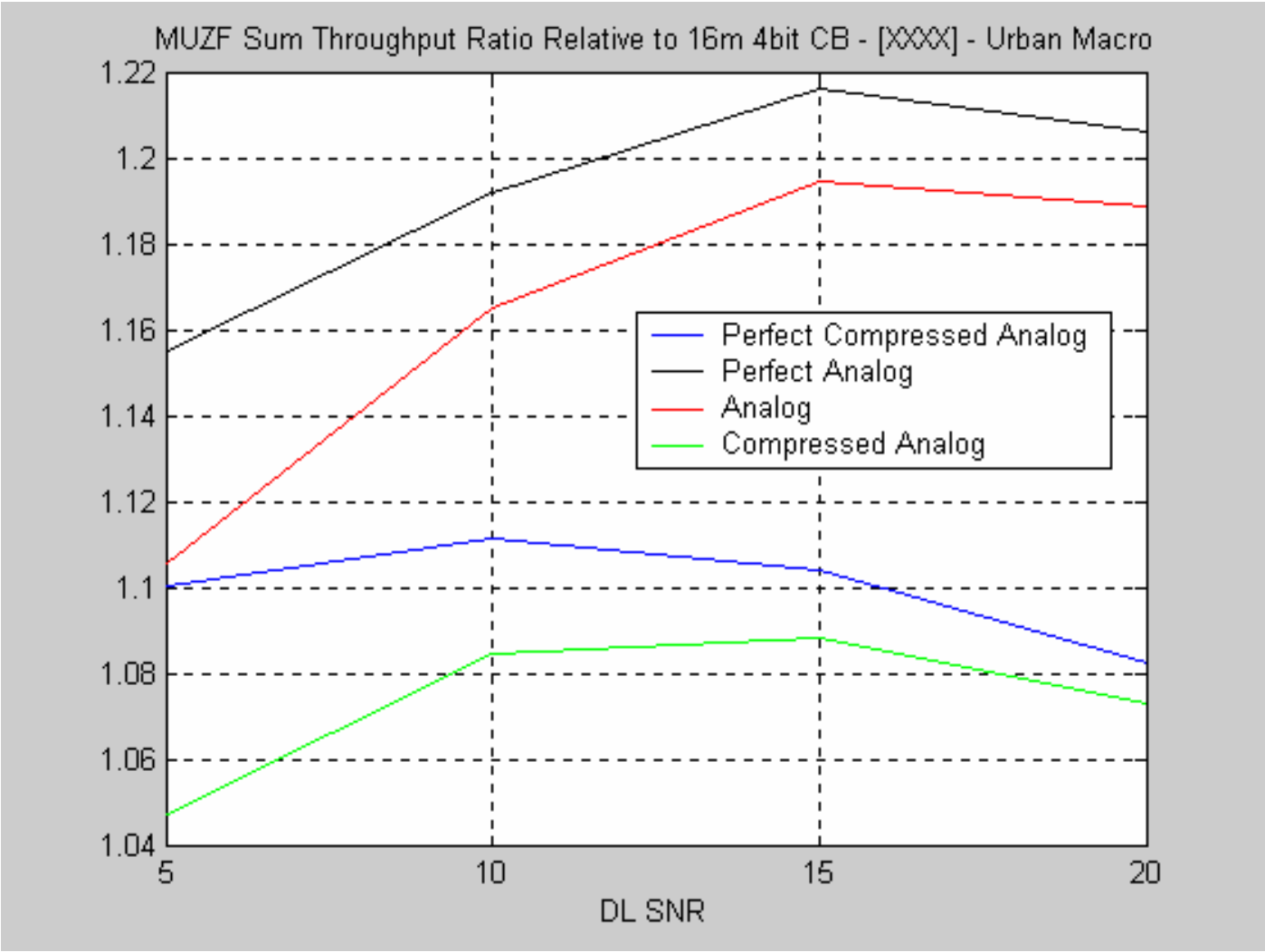
4-Antenna |||| Results



4-Antenna XX Results



8-Antenna XXXX Results



8-Antenna XX XX Results