Parametric Compression of Rank-1 Analog Feedback

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Ron Porat, Phil Orlik — poratron@yahoo.com, porlik@merlcom
Mitsubishi Electric Research Laboratories
Toshiyuki Kuze — Kuze.Toshiyuki@ah.MitsubishiElectric.co.jp
Mitsubishi Electric Corporation

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Purpose: Discussed and Approval

Background

- We propose to use rank-1 analog and compressed analog feedback for MU-MIMO (for homogeneous and heterogeneous deployments)
- Details and text proposal are in C80216m-09_1341r1

- Analog feedback provides 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.
- Compressed analog enables very low UL overhead by parameterizing the rank-1 feedback and feeding back the parameters in an analog fashion. As an example, a correlated 8 antenna array requires only one real parameter (phase) which can be fed back over one subcarrier.
- Another good property is that the feedback is self-contained and its accuracy can be made progressively more accurate with enough repetition. On the other hand side, differential codebooks require dependency on previous feedback, low mobility or high feedback frequency and the constraining of the scheduler to allocate an MS in the same band for a long time.

- With unknown and varying UL SNR, analog is more resilient than digital which suffers from a cliff effect.

Rank-1 Computation

The optimal solution per subcarrier is given by a closed form formula

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

where h_i i=1,2 is the i'th row of H - the 2x(MN) global DL channel between the MS and all M collaborating BS (each with N antennas).

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

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 cross-polarized closely spaced 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

Analog Feedback

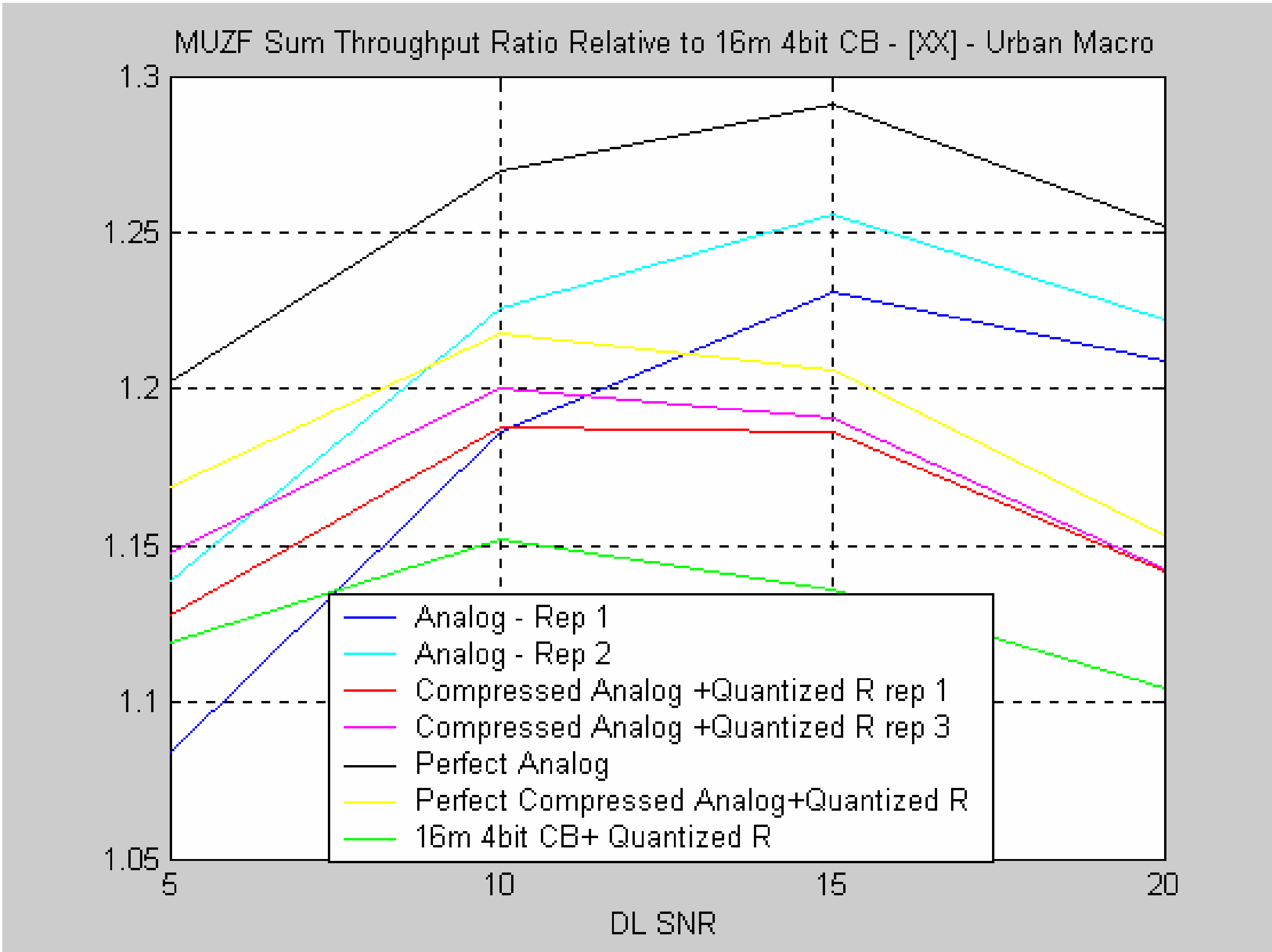
1. We map the N complex numbers to NxL subcarriers using AM and repetition-L coding

2. Compressed Form – we map the real (phase) values to subcarriers using PM and the complex weights using AM. Repetition-L coding is used as well

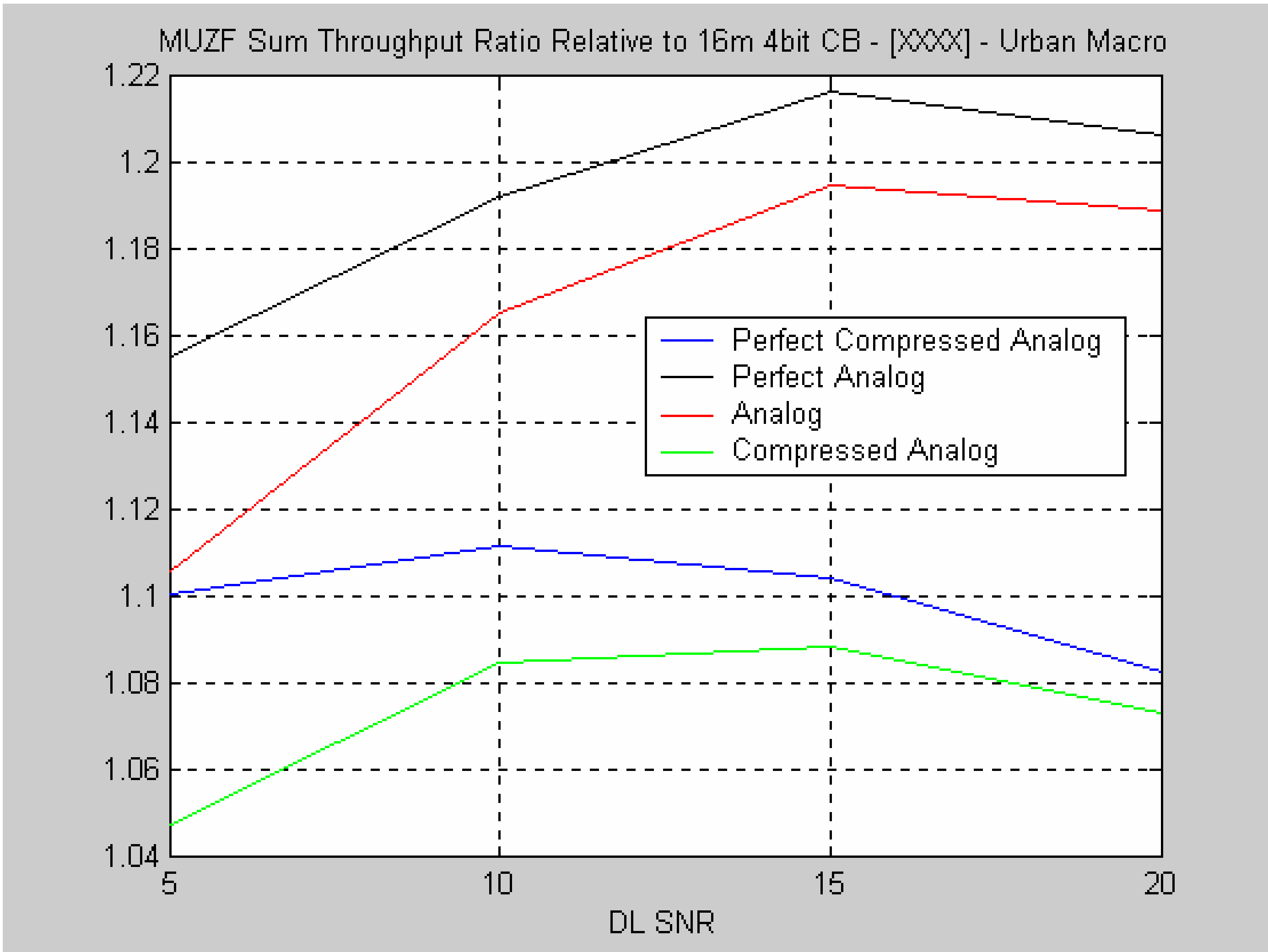
MU-MIMO Simulation

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

4-Antenna XX Results



8-Antenna XXXX Results



8-Antenna XX XX Results