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Title: Evaluation Results for DL MU-MIMO Enhancement Schemes
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1 Introduction

In this contribution, we present evaluation results for a simple enhanced CSI reporting scheme targeting DL MU-MIMO performance improvement, presented in [1]. System level simulations, conforming to the recently agreed simulation methodology and assumptions, reveal that even a wideband enhanced feedback can yield good system throughput improvements that are not dependent on an effective OLLA implementation.

2 Simulation Results

We now evaluate the DL MU-MIMO performance obtained using the enhanced CSI reporting over different scenarios.

We consider a network for which the simulation parameters are summarized in Table 1. Each user computes and reports a wideband PMI, wideband RI along with per-subband CQI(s).¹ For enhanced feedback each user reports one additional wideband normalized residual error norm which is computed using the reported wideband PMI. The cell average and the 5% cell edge spectral efficiencies of the baseline scheme with SU-MIMO CSI user reports are provided in Table 2 considering the Scenario-A. The ZF transmit precoding is employed for all MU-MIMO transmissions. In the case of enhanced feedback, each user first determines and reports its SU-MIMO CSI (for the rank it considers best) followed by the wideband normalized residual error norm (NREN). To compute the wideband NREN, we exploit the observation that each user is likely to be scheduled on subbands for which it has reported good SINRs (CQIs). Accordingly, each user upon computing its

¹The RI as well as the PMI are invariant across all subbands. Two CQIs per-subband are reported whenever the reported rank is equal to two and one CQI per-subband is reported otherwise.

Parameter	Assumption
Deployment scenario and Channel model	Urban Macro (UMa), scenario A in TR36.871
Duplex method and bandwidth	FDD: 10MHz for downlink
Cell layout	Hex grid 19 sites, 3 cells/site
Transmission power at BS	46 dBm
Number of users per sector	10
Network synchronization	Synchronized
Antenna configuration (eNB)	4 TX cross-polarized ant., $0.5\text{-}\lambda$ spacing
Antenna configuration (user)	2 RX cross-polarized ant.
Downlink transmission scheme	Dynamic SU/MU-MIMO scheduling; MU-MIMO pairing: Max 2 users/RB;
Codebook	Rel. 8 codebook
Downlink scheduler	PF in time and frequency
Scheduling granularity:	5 RBs
Feedback assumptions	5ms periodicity and 5ms delay; feedback mode 3-1 feedback without errors.
Sub-band granularity:	5 RBs
Downlink HARQ scheme	Chase Combining
Downlink receiver type	LMMSE-IRC
Interference estimation error	Wishart distribution model as in 3gpp.TR36.829
Feedback channel error	NA
Control channel and reference signal overhead	3 OFDM symbols for control; Used TBS tables in TS 36.213

Table 1: Simulation Parameters for Homogenous Networks

SU-MIMO CSI also sorts the subbands in the decreasing order of the per-subband rates (which are determined using the corresponding per subband CQIs) and selects the first M subbands which offer the M largest rates. It then computes a normalized residual error norm for each one of these M subbands using the reported wideband precoder and determines the average of the M computed normalized residual error norms. This average NREN is then additionally reported to the eNB. In the simulation we have set M to be 3. At the base station, the scheduler determines the user's transmission rank which could be lower than its reported rank (i.e., rank override is allowed). We note that substantial gains are obtained even with a wideband normalized residual error norm feedback. Further, no OLLA was applied to any scheme involving enhanced CSI feedback so that the gains obtained are quite robust. Similar results are obtained in Table 3 where 20% outdoor UEs are assumed instead of 100% as in Table 2.

We next consider the scenario in which each user employs an inter-cell interference (ICI) sup-

MU-MIMO/SU-MIMO	cell average	5% cell-edge
Baseline	2.445	0.0695
Enhanced feedback (wideband Best $M = 3$ Average NREN)	2.6595 (8.77%)	0.0789 (13.50%)

Table 2: Spectral efficiency of MU-MIMO with near orthogonal transmit precoding with zero-forcing (ZF); Wideband ICI covariance estimation for CSI generation. Relative percentage gains are over the baseline scheme. 100% outdoor UEs.

MU-MIMO/SU-MIMO	cell average	5% cell-edge
Baseline	2.3903	0.067
Enhanced feedback (wideband Best $M = 3$ Average NREN)	2.6048 (8.97%)	0.0722 (7.76%)

Table 3: Spectral efficiency of MU-MIMO with near orthogonal transmit precoding with zero-forcing (ZF); Wideband ICI covariance estimation for CSI generation. Relative percentage gains are over the baseline scheme. 20% outdoor UEs.

pression matrix that is closer to the ideal while computing its feedback CSI. In particular, at each UE a per-subband ICI covariance estimation is used to design the interference suppression matrix for each subband, in order to compute the CSI. Also, for enhanced feedback we consider the case where each user reports one additional wideband normalized residual error norm, as well as the one where each user reports multiple additional normalized residual error norms (one per-subband), which are all computed using the reported wideband PMI. The results are reported in Tables 4 and 5. From Tables 4 and 5 we see that the gains due to enhanced feedback, while still good, are reduced compared to their counterparts in Tables 2 and 3.

3 Conclusions

In this contribution, we considered enhancements to the DL MU-MIMO operation by enhancing the user CSI reporting which enables more accurate MU-MIMO SINR computation at the eNB. Our results using a simple form of enhanced feedback show good system throughput improvements. One important feature of the gains obtained is that they are quite robust in the sense that they are not dependent on an effective OLLA implementation.

References

- [1] NEC Group, “DL MU-MIMO Enhancement Schemes,” *3GPP TSG RAN WG1 R1-130364*.

MU-MIMO/SU-MIMO	cell average	5% cell-edge
Baseline	2.6372	0.0748
Enhanced feedback (subband NREN)	2.7757 (5.25%)	0.0795
Enhanced feedback (wideband Best $M = 3$ Average NREN)	2.7532 (4.40%)	0.0793

Table 4: Spectral efficiency of MU-MIMO with near orthogonal transmit precoding with zero-forcing (ZF); Per-subband ICI covariance estimation for CSI generation. Relative percentage gains are over the baseline scheme. 100% outdoor UEs.

MU-MIMO/SU-MIMO	cell average	5% cell-edge
Baseline	2.5618	0.0671
Enhanced feedback (subband NREN)	2.705 (5.59%)	0.0668
Enhanced feedback (wideband Best $M = 3$ Average NREN)	2.6819 (4.69%)	0.0676

Table 5: Spectral efficiency of MU-MIMO with near orthogonal transmit precoding with zero-forcing (ZF); Per-subband ICI covariance estimation for CSI generation. Relative percentage gains are over the baseline scheme. 20% outdoor UEs.