3GPP TSG-RAN WG1 #48bis
Malta **R1-071513**
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Title: **Consideration for CQI and Precoding Feedback Granularity for MIMO Operation in E-UTRAN**

Document for: **Discussion**

1 Introduction

While codebook–based precoding has been adopted for 3GPP-LTE, the feedback structure to support such MIMO operations remains open. MIMO operations enable several benefits, including multi-user scheduling gain, interference mitigation, and enhanced spectral efficiency for the many classes of users and scenarios under which the system will operate. It is expected that EUTRA should be operational for fixed, low-mobility, and mobile users.

Many contributions to 3GPP have illustrated the gain that may be achievable for the EUTRAN when MIMO is employed with codebook-based precoding, e.g., [1-2]. In addition, there have been contributions that show benefits of increased CQI feedback in the network [3]. In general, there exist several key parameters of the MIMO system that will affect performance for many of the scenarios in which the UE is operating; they are:

1) Frequency granularity of CQI feedback to NODE-B

2) Frequency granularity of codebook-based precoding feedback.

3) Fairness of scheduling.

4) Number or users. The lower the number of users, the lower the multi-user scheduling gains

5) Antenna configuration (2x2, 4x2, 4x4). The higher number of antennas, the more precoding feedback to achieve improvement.

6) User's speed. The higher the mobility, the less effective any closed-loop approach, and therefore, the seemingly lower feedback requirements to make any difference in performance.

7) Resource allocation to each user (maximum number of PRBs)

8) Codebook size

Taken separately, we may arrive at a solution that satisfies only certain scenarios while limiting others. For instance, in many cases, there may exist a requirement for increased granularity of CQI feedback to achieve multi-user scheduling gain [3]. In other cases, fine granularity precoding feedback may be required, e.g., to increase throughput for disadvantaged users with low mobility. In the case when a large frequency band (many PRBs) is allocated to a particular user, then fine granularity precoding feedback may also be required. Most likely there exist many cases in between, for which performance highly depends on the parameters 1) – 8) listed above.

Cost of feedback is also very important, in that signalling support to obtain the gain that users may experience will reduce overall cell throughput proportional to rate and granularity required to support any a scheme for MIMO operating in the EUTRAN.

We propose that 3GPP carefully considers all modes of operation and evaluates proposed MIMO schemes with their feedback costs taken into account. A quantitative measure may be obtained in the system level simulation by examining cell throughput and subtracting the overall feedback required on the uplink to support a proposed scheme. In addition to average cell throughput, the throughput distribution should also be evaluated.

2 Proposal

1. We propose that schemes for MIMO operation include the cost of feedback into their measure of performance (cell throughput minus feedback overhead, for example).
2. CQI feedback vs. precoding feedback granularity should be studied as a function of the following parameters: type of scheduling, number of users, number of PRBs per user, antenna configuration (up to 4 Tx antennas), and precoding codebook size.
3. If different scenarios will show different CQI and precoding feedback granularity requirements, then adaptive techniques may be considered, where CQI and precoding feedback granularity is adapted based on changing system parameters.

3 References

[1] R1-062650 Texas Instruments - Codebook Design for E-UTRA MIMO Pre-coding

[2] R1-070936 Panasonic - MIMO Codebook Design for MU/SU-MIMO.

[3] R1-070658 Qualcomm – UE Feedback with Precoding Granularity – System Analysis.