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I. Unitary Beamforming with Cross-Layer Cooperation
- Unitary Preceding Matrices determined offline.
- Each Mobile Station selects identifies suitable beams that provide preferential channel conditions.
- Beams generated according to a Fourier basis to ensure uniform sector coverage.
- Codebook $E$ consists of a unitary matrix set, $E = [e_1, e_2, \ldots, e_M]$ where $e_g$ is the $g$-th preceding matrix and $e_g^m$ being the $m$-th preceding vector. According to the Fourier basis, $e_g^m = \exp\left(\frac{2\pi i m}{M}\right)$.

II. Introduction to Beam Selection with Partial Feedback
- Exploitation of Multiuser Diversity requires Channel Quality Indicator (CQI) feedback from each Mobile Station.
- Unitary Beamforming requires CQI values for each of the preceding matrices resulting in a $M$-fold increase in uplink feedback overhead.
- MU-MIMO requires CQI values to be fed back for each of the spatial layer of each preceding matrix, resulting in a further increase in uplink overhead.
- The Base Station makes a decision on the optimum preceding matrix and performs resource allocation based on received CQI values.
- Partial Feedback strategies limit uplink feedback overhead by considering only CQI values for a preferred preceding matrix from each Mobile Station.
- Since Mobile Stations decide independently on preferred beams, the Base Station cannot fully optimise resource allocation. We think you could explain this better; i.e. that it’s a joint decision process between MS and BS.
- Partial Feedback algorithms achieve inferior downlink performance with respect to full feedback.

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IV. Beam Selection and Group Priorities for SU-MIMO with Partial Feedback
- For SU-MIMO all spatial layers are assigned to the same user.
- Assign the Mobile Station that achieves the highest aggregate SNR on its best beam.
- Consider Theoretical Results for different codebook sizes.

- Consider simulated PHY Performance for Different Beam Selection Strategies.

- Optimising performance on the weak spatial layer for SU-MIMO achieves lower overall bit error rates.
- A simple greedy scheduling approach, results in excessive bit errors due to the low SNR on the weak spatial layer.
- Increased benefits extracted by a higher codebook size.

V. Beam Selection and Group Priorities for MU-MIMO with Partial Feedback
- Different Users can occupy different spatial layers of the same Physical Resource Block (PRB).
- Higher Capacity can be achieved with respect to SU-MIMO due to the exploitation of the additional spatial layer.
- For an increasing codebook size and decreasing Mobile Station number, optimisation of both spatial layers becomes harder. Hence no additional diversity benefits can be extracted from a large codebook with partial feedback.
- For a large number of Mobile Stations, independent users should select the beam that maximises performance independently on a spatial layer.
- For a small number of Mobile Stations, independent users should select the beam that maximises aggregate performance across all spatial layers.

- Best subspace partial feedback criterion achieves performance very close to optimum for $K=50$.
  For smaller numbers of Mobile Stations, optimising performance across both spatial layers becomes less likely. A smaller codebook size should be used to ensure all layers are optimised.

Conclusions
- The use of multiple preceding beams can give rise to increased downlink rates due to additional diversity.
- Conventional Unitary Codebook Beamforming imposes additional uplink feedback overhead.
- Partial Feedback CQI and beam selection strategies for SU-MIMO and MU-MIMO proposed in this paper.
- For SU-MIMO a tradeoff exists between codebook size and number of users. For a large number of users, a large codebook can be used. The beam that maximises gain on a spatial layer, irrespective of other layers achieves performance very close to full feedback.