Capacity-Gains with Feedback for Multi-Access and Broadcast Channels

We propose to study the benefits of feedback on the capacity of wireless networks, i.e., on the fundamental limits of achievable data rates over these networks. We are also interested in identifying the coding techniques that achieve the capacity of such networks with feedback. Current systems exploit the possibility of sending feedback signals only in a sub-optimal way. With our results we aim to facilitate an improved utilization of feedback in future wireless systems to support larger data rates. Feedback channels are present in many commercially used wireless networks. A prominent example are mobile cellular networks. Here, the communication between the many mobiles and the only basestation in a cell takes place in both directions. Therefore, for both the uplink (communication from the many mobiles to the single basestation) and the downlink (communication from the single basestation to the many mobiles), the receiver(s) can send feedback signals over the reverse communication link. Feedback can increase the capacity of networks, for example, because it allows the transmitters to learn about the network’s state such as the fading realizations. In multiple-access networks, feedback also allows the various transmitters to learn about each other’s independent private messages, which enables them to cooperate in future transmissions. Moreover, in some broadcast networks feedback can be used to help the single transmitter to identify information that at the same time is useful to several receivers. By sending this common information in future transmission steps, the transmitter can use the broadcast channel in a more efficient way than when sending independent information only. Despite these intuitive understandings of the benefit of feedback in networks, finding the capacity and the capacity-achieving coding technique is an open problem for most networks with feedback. Our aim in this project is to present new results on the capacity and the capacity achieving coding techniques of some wireless networks with feedback. Our main focus in this project will be on memoryless broadcast and multiple-access channels.

The capacity of most memoryless multi-access and broadcast channels with feedback is unknown. Our goal is to provide new capacity results for such setups. We foresee that to achieve this goal we have to provide new coding schemes as well as new techniques for outer bounding the capacity. In our research we will also consider scenarios where the feedback links are noisy or rate-limited.