# Channel- and QoS-Aware Resource Allocation in MIMO-OFDMA Networks

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**Description**: Third generation mobile communication systems, also known as IMT-2000 (International Mobile Communications-2000), are evolving towards fourth generation systems, also known as IMT-Advanced. Working groups of 3GPP and IEEE/WiMAX Forum, currently leading the standardization process of these systems, have come to agree that the technological pillars of IMT-2000 systems – OFDMA (Orthogonal Frequency Division Multiple Access), MIMO (Multiple-Input Multiple-Output), AMC (Adaptive Modulation and Coding) schemes combined with HARQ (Hybrid Automatic Repeat reQuest), and QoS-aware dynamic resource allocation algorithms – will keep playing a crucial role in IMT-Advanced networks. They have also come to agree that, to meet the requirements specified by the ITU (International Telecommunications Union), IMT-Advanced systems must incorporate technological proposals to improve the performance of the latest versions of IMT-2000 systems. Some of the proposals that have emerged include, among others, the use of cooperative base and relay stations (Cooperative diversity or virtual-MIMO), the use of advanced multiuser MIMO (MU-MIMO) techniques, or the use of cross-layer resource allocation algorithms able to jointly exploit the multiuser diversity that can be found in time, frequency and space selective channels and the heterogeneity of QoS-requirements in services provided by IMT-Advanced networks.

Within this general framework our aim in this project is to propose and analyze algorithms for the efficient allocation of resources in the downlink of MIMO-OFDMA systems. Specifically, we will consider the application of mathematical programming to solve the problem of weighted throughput maximization with constraints on the available transmit power. Furthermore, unlike most previous proposals that do not consider QoS metrics measured at the data link control (DLC) layer, such as packet dropping probability or packet delay, in these projects we will analyze the behavior of packet queues at the DLC layer and develop resource allocation strategies based on the cross-layer design paradigm. In this way, packet scheduling at the DLC layer and the allocation of power, transmission rates, time slots and subcarriers at the PHY layer will be determined not only by the observed channel state information (CSI) at the PHY layer but also by the queue state information (QSI) supplied by the DLC layer.

- **PFC 1 - Unified approach**: Even though expectations regarding channel- and queue-aware resource allocation strategies are great, optimality criteria, performance metrics, and algorithms are still in a rather primitive stage, especially when it comes to handling diverse QoS requirements and coping with heterogenous traffic. In this project, based on preliminary results published in [1, 2, 3, 4], we aspire to provide a unified view for the downlink and uplink resource allocation to multiple connections with diverse QoS requirements.
- **PFC 2 - MIMO and imperfect CSIT**: Over the last few years, the wireless communications research community has developed an increasing interest in multiple-input multiple-output (MIMO) transmission strategies (see, for instance, [5, 6, 7, 8] and references therein). Most practical MIMO designs rely on linear precoding/equalisation to improve the system performance in terms of, for example, reducing the error rate or increasing the system capacity [9, 10]. The majority of these approaches assume perfect channel state information at the transmitter (CSIT) is available, however, this is seldom the case in real systems. The study of what gains can bring along imperfect CSIT has been covered in [11] and [12] assuming the transmitter only has access to the mean value of the true channel coefficients. Based on results published by Awad *et al.* in [13], the main goal of this PFC is to investigate the effects of using MIMO systems with channel-mean feedback on channel- and QoS-aware resource allocation in MIMO-OFDMA networks.

**Project objectives**: The student taking up one of these projects is expected to fulfil the following goals:

- Acquire a reasonable amount of knowledge on modern wireless communication techniques at the physical and data link control layers such as AMC, MIMO, OFDM(A) and scheduling.

- Understand the key bibliographic references in the area of cross-layer design in QoS-guaranteed scheduling for channel-adaptive wireless networks.
- Understand the key bibliographic references in the area of MIMO, precoding and channel-mean feedback.
- Extend the available channel- and QoS-aware resource allocation in MIMO-OFDMA networks with ideal CSIT to the case of MIMO-OFDMA with partial CSIT.
- Implement the developed cross-layer designs into an existing MATLAB simulation platform.
- Write a technical report describing the work done.
- Make an oral presentation of the project.

**Tools**: MATLAB for programming and LaTeX for report writing.

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