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Editorial

Optimization Techniques in Wireless Communications

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Welcome to this Special Issue of the EURASIP Journal on Wireless Communications and Networking (JWCN). This issue collects several research results on the use of optimization techniques in wireless communications. Recent advances in linear and nonlinear optimization facilitate progress in many areas of communications. In wireless and mobile communications this progress provides opportunities for introducing new standards and improving existing services. Supporting multimedia traffic with end-to-end quality-of-service (QoS) guarantee over multi-hop wireless networks (e.g., wireless sensor networks, mobile ad hoc networks, wireless mesh networks) is a challenging technical problem due to various factors and constraints: limited bandwidth and battery power, channel variability and user mobility, protocol and standard compatibility, fairness consideration, higher data rates, system robustness, and seamless service, to name a few. In addition, several wireless networks may be allowed to co-exist and share the same spectrum, which leads to the requirement of minimal (acceptable) interference between different networks.

Optimization methods have been recognized as extremely useful techniques in helping with addressing the aforementioned challenges. Although optimization techniques are not limited by the convex optimization category, the convex optimization framework has been most successfully applied to a number of problems in wireless communications and signal processing. Over the last few years, convex optimization has found a place among the most useful techniques for algorithm design and analysis of wireless communication systems, and has become a standard engineering tool shared by a large number of researchers worldwide.

The success of convex optimization techniques is largely attributed to several of their unique features. First, very efficient and fast algorithms for solving convex problems have been developed and implemented, which makes convex optimization easy to use in practical wireless communication systems. Second, convex optimization often helps with gaining insight into the optimal solution structures that reveal the very nature of the problems in wireless communications. It makes the convex optimization framework a useful research tool. Third, the general theory of convex optimization is already relatively well developed which makes it very appealing for engineering applications. However, as time has shown, there is still a lot of room for research. This special issue is specifically devoted to such kind of studies with a main focus on the physical layer of wireless communication systems.

We have received about 30 paper submissions for this Special Issue by the deadline in December 2008. After extensive and careful reviews followed by the Editorial Board discussions, we accepted 7 papers that bear the highest quality and the best fit with the topic of this Special Issue. The accepted papers are categorized into 3 categories: Optimization Techniques for Resource Allocation in Wireless Systems, Optimization Techniques for Beamforming and

Precoding in Wireless Systems, and Optimization Techniques for Scheduling in Wireless Systems. Three papers are included in each of the first and the second categories, while one paper fits under the third category.

Optimization Techniques for Resource Allocation in Wireless Systems. This part describes the recent advances on resource allocation for energy-constrained systems, broadcasting systems, and multi-user relay systems.

In the first paper, "On power allocation for parallel Gaussian broadcast channels with common information," Gohary and Davidson consider a broadcast system in which a single transmitter sends messages to a number of receivers over multiple unmatched parallel scalar Gaussian channels. The set of all rate tuples, for such systems, is parameterized by a set of power loads and partitions, and the problem of finding the boundaries of such sets is formulated as an optimization problem. Although this problem is nonconvex, the tight inner and outer bounds can be efficiently computed. These bounds are computed using (convex) geometrical programming.

In "Power allocation and admission control in multiuser relay networks via convex programming: centralized and distributed schemes," Phan et al. address the power allocation problem for multiuser amplify-and-forward relay networks, in which multiple users share the same set of relay nodes. The problems of minimum rate and sum-rate maximization are shown to be convex. However, the joint power allocation and admission control problem is not convex that necessitates the development of approximate algorithms. Two configurations: centralized and decentralized are considered, while in the latter one the Lagrange decomposition method is applied.

In the third paper, "Stochastic resource allocation for energy-constrained systems," Sachs and Jones consider the battery-powered wireless systems with energy constraint. In the traditional resource allocation problem setup, allocation is done by assuming that the same tasks will run from the start-up until a specific future time. In this case, the energy and runtime constraints can be converted into a single power constraint. More general energy and runtime constraints are considered in this paper for the case when these constraints are not convertible into a single power constraint. The problem considered is NP-hard, where efficient stochastic recourse allocation method is developed based on the Lagrange optimization approach.

Optimization Techniques for Precoding and Beamforming in Wireless Systems. In this part, it is demonstrated how the optimization techniques can be used for developing precoding and beamforming methods in multiple-input multiple-output (MIMO) ad hoc networks, MIMO relay networks, and seamless ad hoc networks.

In the first paper of this category, "Transmission strategies in MIMO ad hoc networks," Fakih et al. address the precoding problem in MIMO ad hoc networks via maximizing the system mutual information under power constraints. A fast and distributed algorithm based on the quasi-Newton method is developed to solve the aforementioned problem.

In the paper, "Joint linear filter design in multiuser cooperative non-regenerative MIMO relay systems," Li et al. develop a new relay communication protocol in which linear filters are employed at both the transmitter and the relays. The joint design and optimization of transmitter and relay filters via the minimization of the mean squared error is considered. The work can be viewed as an extension of the traditional amplify-and-forward relay protocol.

In the last paper of this category, "On connectivity limits in ad hoc networks with beamforming antennas," Kiese et al. investigate the fundamental limits on the seamlessness/connectivity in multi-hop wireless networks with beamforming antennas. Authors use the popular "keyhole" antenna model, and formulate a mixed integer program for finding the optimal antenna configurations under various setups of path probability with various auxiliary constraints, node degree, and k-connectivity. A problem-specific large-scale optimization approaches are used to find the optimal antenna configurations efficiently.

Optimization Techniques for Scheduling in Wireless Systems consists on a single paper, "A scheduling algorithm for minimizing the packet error probability in clusterized TDMA networks," in which Toyserkani et al. consider a clustered wireless network, in which transceivers in a cluster use a time-slotted mechanism to access a wireless channel that is shared among several clusters. A scheduling algorithm which minimizes the derived average packet-loss probability is developed and tested.

We are excited to edit this high quality special issue within 8 months since the submission deadline. This would have been impossible without all those who contributed their research papers, numerous patient and diligent reviewers, and the EURASIP Journal on Wireless Communications and Networking Editorial Board and the Editor-in-Chief, Dr. Luc Vandendorpe. Our thanks go to all of them. We hope you will enjoy reading the carefully selected papers on the exciting research area of Optimization Techniques in Wireless Communications.

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