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*Editorial*

# Efficient Spectrum Usage for Wireless Communications

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Wireless technologies have reached an impressive popularity in the last years. However, the radio spectrum is very limited, and therefore as wireless communications have become more and more widespread, problems related to spectrum scarcity have arisen. Radio spectrum, as the physical support for wireless communication, both for fixed applications and especially for mobile broadband, is becoming an extremely strategic, valued, and demanded resource. Therefore, technologies and techniques enabling a more flexible access for service providers and clients and a more efficient and effective usage are needed.

Spectrum scarcity can be addressed from many different perspectives. For instance, from the point of view of signal processing, we can look for higher spectral efficiency in modulations. In the paper "Simple Algorithms for Estimating the Symbol Timing Offset in DCT-Based Multicarrier Systems," F. Cruz-Roldán *et al.* enhance multicarrier modulation based on discrete cosine transform (DCT-MCM), proposing two new blind algorithms to perform tight timing offset and coarse frequency synchronization, which addresses the problem of symbol timing offset in these modulations.

Scheduling the usage of radio resources is also an effective strategy, especially in cellular networks. In the paper "Dynamic Tradeoff between Energy and Throughput in Wireless 5G Networks," C. Gueguen and M. Manini consider radio resource allocation for the mobiles within a single access point coverage zone. Their Dynamic Tradeoff scheduler is able to prioritize energy efficiency or spectral efficiency and delay depending on the network traffic load.

Cognitive radio takes a more active approach, making the devices responsible of efficient spectrum utilization by sensing spectrum usage and adjusting transmission parameters to accommodate communications in unused resources. In the paper "Discrete-Time Analysis of Cognitive Radio Networks with Nonsaturated Source of Secondary Users," V. Pla *et al.* address one of the fundamental problems in cognitive radio: sensing for the detection of white spaces when they occur. Authors use Markovian models to analyze and evaluate sensing strategies.

On a higher level, coordination may happen in a centralized or distributed manner, by establishing protocols allowing base stations and clients to increase spectrum utilization while avoiding interferences. Distributed scenarios like multihop wireless networks may be specially challenging to coordinate. In the paper "Optimal Multicommodity Spectrum-Efficient Routing in Multihop Wireless Networks," M. Saad addresses the optimization of end-to-end spectral efficiency in Multihop Wireless Networks where there are multiple source-destination pairs active at the same moment. Authors provide two alternative approaches, using fixed-size and variable-size time slots.

Optimization techniques, artificial intelligence approaches, or economic paradigms may contribute greatly to a more efficient spectrum usage in wireless communications. Regarding optimization techniques, in the paper "On the Goodness of Using Orthogonal Channels in WLAN IEEE 802.11 in Realistic Scenarios," J. M. Gimenez-Guzman *et al.* study the behavior of optimization techniques and heuristics

in Wi-Fi channel assignments, evaluating the gain (or rather, the lack of gain) of having more available channels instead of the usual "orthogonal" set. For a different domain, in the paper "Optimization of Cell Size in Ultra-Dense Networks with Multiattribute User Types and Different Frequency Bands," Y. Wei and S.-H. Hwang propose a multiple-objective optimization model for ultra-dense cellular networks (UDN), showing the potential of new higher frequency bands in these scenarios.

An economic paradigm is explored in the paper "Strategic Interaction between Operators in the Context of Spectrum Sharing for 5G Networks." E. J. Sacoto-Cabrera *et al.* analyze spectrum sharing in 5G networks from an economic perspective, comparing the monopoly situation, the pooling agreement, and the priority sharing agreement. For this last scenario, authors show the conditions in which network sharing is incentive compatible.

Finally, regulatory frameworks like the recent Licensed Shared Access (LSA) may play a crucial role in helping mobile networks operators to make a more efficient usage of the scarce bandwidth resources. In the paper "A Practical Perspective on 5G-Ready Highly Dynamic Spectrum Management with LSA," P. Masek *et al.* explore an experimental extension of LSA-based spectrum management in LTE which is able to operate in a highly dynamic manner.

## Conflicts of Interest

The authors declare that there are no conflicts of interest regarding the publication of this article.

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