# Context-Aware Resource Allocation for Wireless Networks

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Providing seamless, high quality wireless service anytime and anywhere requires substantial changes in today's wireless cellular networks. One such change, introducing small cell base stations overlaid on existing networks, is seen as a highly promising solution. However, it requires meeting fundamental challenges: 1) heterogeneity, in nodes' types and capabilities, 2) high sensitivity of the resource allocation decisions to parameters such as location or demand, and 3) maintaining tolerable interference. In this research, our goal is to address these challenges by boosting the cellular network's ability to observe, learn, and better utilize its environment. This is achieved by exploring a dimension that has often been overlooked: the user's context. A user's context is defined as the set of information, extracted from dimensions such as social networks, smartphone features, or geolocation data that can be used to improve resource management in wireless networks. In this research, we have been extensively working on enabling context-awareness for future 5G and beyond cellular networks. To do so, we are drawing on interdisciplinary tools from machine learning, matching theory, and communications.

Some of our recent results in this area include:

**Social-aware wireless resource management:** In [1], we proposed a context-aware scheme that leverages the social interactions and the similarity of interests between users to allocate resources in a device-to-device (D2D) enabled small cell network. The results show that the proposed matching-based algorithm yields socially well-connected cluster between D2D links, thus, allowing to offload significantly more traffic than conventional context-unaware approach. Our results provide novel insights into the gains that future wireless networks can achieve from exploiting the social context. The results show that with manageable complexity, a context-aware approach can substantially improve the wireless resource utilization by offloading a large amount of traffic from the backhaul-constraint small cell network.

**Millimeter-wave backhaul management:** In addition, in [2] we developed a distributed backhaul traffic management that allows multiple network operators to provide wireless backhaul links (operating at high frequencies, such as millimeter wave frequencies) for the base stations with no fiber backhaul support. Hence, the network operators follow a pricing mechanism that

represents the context information here, to share the backhaul resources. The problem is cast as a matching problem in which each network operator aims to maximize the backhaul capacity, subject to a certain cost constraint. The results provide guidelines on designing wireless backhaul networks, in which the network operators may need to combine the monetary aspects with the physical constraints of the wireless network.

[1] O. Semiari, W. Saad, S. Valentin, M.Bennis, and H. V. Poor, "Context-Aware Small Cell Networks: How Social Metrics Improve Wireless Resource Allocation," *IEEE Transactions on Wireless Communications*, to appear, 2015.

[2] O. Semiari, W. Saad, Z. Dawy, and M. Bennis, "Matching Theory for Backhaul Management in Small Cell Networks with mmWave Capabilities," in *Proc. of the IEEE International Conference on Communications (ICC), Mobile and Wireless Networks Symposium*, London, UK, June 2015.