Habilitation Defense

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Thinking Outside the Networking Box for Realizing the Potential of Wireless Networks

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Abstract: The main thesis of this habilitation is that for the wireless networks to reach their full potential we need to look beyond the confines of the traditional networking stack. In the first part, we consider two foundational elements defining the performance of wireless networks: spectrum policy and interference management. A legacy of the early 20th century and reflecting the technological constraints of the time, the current spectrum policy relies on a strict separation of users for reliability, leading to a highly inefficient static allocation of the wireless spectrum. We argue for a shift in policy, powered by cognitive radios, allowing for a more dynamic and demand-driven allocation of the spectrum so as to unlock its data carrying capacity. Such a significant shift, however, may necessitate in-depth changes in network architectures and protocols. In this context, we look at the the basic constructs of networking in legacy wireless networks and focus on evaluating the assumptions underpinning these constructs, studying how these assumptions hold in the cognitive radio context and finally, addressing the resulting design challenges. To unlock further capacity, we consider physical-layer approaches aimed at turning the complex and broadcast nature of the wireless medium, often seen as a drawback, into an advantage. We study the problem of integrating physical-layer network coding (PLNC) in multi-hop wireless networks. Our approach consists of a) introducing a theoretical framework for computing the throughput of a multi-hop network employing PLNC; b) using the framework to evaluate the state-of-the-art PLNC-based approaches; c) use the lessons learned for introducing better solutions. The theoretical framework is complemented by simulations and experiments in a USRP-based testbed.

In the second part, we turn our focus on the research and development ecosystem created by the smartphone and the race to 5G it has sparked. Exploiting its powerful computing, sensing and communication capabilities, we introduce solutions to everyday problems, such as indoor localization, mapping and intelligent city parking. We conclude by introducing a research project bringing together the two lines of my work into a cross-technology framework centered around the smartphone and capable of of delivering Gbps capacities, the kind of speeds promised by 5G.

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