Abstract: As mobile and machine-to-machine traffic is expected to grow exponentially in the next decade, tools for the design and optimization of agile and heterogeneous wireless networks are of great interest. Indeed, network design and operation have enormous complexity, due to the huge state space, the lack of global network state information at the decision units, the decentralized operation and resource constraints of wireless devices, thus requiring a holistic approach for network control and design. In the first part of the talk, I will present a principled framework for joint distributed sensing, estimation and control in wireless networks, which captures the interplay between state estimation and control and accounts for cross-layer factors such as the cost of acquisition of state information and the shared wireless channel. The framework will be applied to a spectrum sensing-scheduling application, where a network of secondary users (SUs) attempts to opportunistically access portions of the spectrum left unused by a licensed network of primary users (PUs). Adaptive spectrum sensing and scheduling schemes are jointly optimized so as to maximize the SU throughput, subject to constraints on the PU throughput degradation and the sensing-transmission cost incurred by the SUs. I will show how low-complexity can be achieved by exploiting the large network approximation, a two-stage decomposition of the dynamic programming algorithm, as well as sparsity of network dynamics enabling efficient state estimation via sparse recovery techniques.

The proposed framework serves also to engineer sensing, signaling and adaptation schemes in bacterial networks, which will play a significant role in bioremediation, plant growth promotion, microbial fuel cells, posed to be the engines of renewable energy. Understanding how bacteria interact, communicate, react and adapt to these signals is fundamental to engineer biological networks and devices. While bacterial communication via molecular diffusion is well known, electron transfer in living cells and its role in cell-cell interaction is less understood. In the second part of this talk, I will present a novel stochastic queuing model of electron transfer in bacterial cables, which is coupled with the energetic state of the cells, and I will show that the model tightly reproduces experimental measurements. Moreover, I will discuss information theoretic aspects of communication over a bacterial cable, and provide structural properties of the optimal input signal, demonstrating that, unlike molecular diffusion, communication via electron transfer introduces a new wellness constraint in addition to the information dimension.

Bio: Dr. Nicolo Michelusi received the B.Sc. degree with honors, M.Sc. degree with honors and Ph.D. degree in Electrical Engineering from University of Padova, Italy, in 2006 and 2009, and 2013 respectively. Additionally, he received a second M.Sc. degree in Telecommunication Engineering from Technical University of Denmark in 2009, under the T.I.M.E. double degree program (www.time-association.org). He is currently a postdoctoral research fellow at the Ming Hsieh Department of Electrical Engineering, University of Southern California, USA, working with Prof. Urbashi Mitra. His research interests are in the areas of wireless communications, cognitive networks, energy harvesting, distributed estimation and adaptive control for wireless networks, modeling and design of bacterial systems.