Position Paper for NSF Workshop on Biologically Enabled Wireless Networks Design and Modeling

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Ongoing Research Interest:

Over the past few years, we have witnessed the growing pervasiveness of networking technologies, notably wireless and mobile, in areas of critical national importance, ranging from commercial to military. Various new architectures have crystallized, which pose fundamental new questions for network science and engineering, and requiring new theories as well as new engineering tools.

My recent research has focused on stochastic modeling and design of dynamic networks, such as (mobile) sensor networks, mesh networks and mobile multi-hop wireless networks. For example, I studied the problems of event coverage in mobile sensor networks and spectrum sensing in cognitive radio networks. I also developed a new information-theoretic approach for characterizing state dynamism and its relation to protocol information in dynamic networks, and new theoretic approaches for characterizing the properties of time-graphs in social and mobile networks.

Future Bio Enabled Wireless Networks:

In my opinion there are two reasons for considering the development of bio-enabled wireless networks; (1) It is now possible: As biology has matured into science in the past fifty years or so, with the discovery of principles and laws of biological systems, we are at a stage where scientists are making advances in designing controllable biological components with target design objectives that may fit into an overall system. (2) It has significant potential: Biological elements have very different characteristics from physical (electronic) elements, and thus offer potential for orders of magnitude improvements in systems performance.

However, I believe there are also two major challenges in realizing such systems. (1) Although there is significant effort in meeting the particular challenges in designing and modeling individual types of biological elements, there is a lack of abstract models that are suitable for systems -- and, for this workshop, wireless networks -- design. (2) Even in the case where abstract models exist, there is a lack of understanding of how to integrate the diversity of biological elements (for example, energy harvesting schemes power ranges from nano-Watts to Watts, and similar observations can be made about delay, etc) into a coherent system design process.

I am interested in addressing the above two challenges, and particularly the second one. I believe most future systems will not be purely biological but rather will be hybrid bio-physical engineered systems, and thus I am interested in the design and modeling of such hybrid bio systems, starting from the development of abstract models of the biological and bio-physical components of such systems.