Speaker: Joseph Camp, Rice University

Title:
Embedded Links: A Misunderstood and Fundamental Element of Urban-Scale Networks

Abstract:
Many urban communities have unequal access to Internet resources, presenting a technical challenge of providing a high-speed access infrastructure at an extremely low cost. To address this challenge, we have deployed a first-of-its- kind, urban-scale wireless mesh network which provides Internet access to 1000's of users spanning multiple square kilometers in an underserved area in Houston, TX. However, in this and other urban environments, IEEE 802.11 node interactions are affected by a vast array of factors including topology, channel conditions, modulation rate, packet sizes, and physical layer capture. In this talk, I draw from 100's of thousands of urban measurements and develop an analytical model to understand the performance of embedded links in the aforementioned complex scenarios. My focus is on two fundamental concepts involving embedded links. First, choosing the modulation rate which maximizes the throughput is imperative since each bit of the (overly-)shared medium is critical.
Yet, all existing rate adaptation mechanisms fail to track the ideal rate even in a simple, non-mobile urban scenario. Using a custom cross-layer framework, I implement multiple and previously un-implemented rate adaptation mechanisms to reveal the reasons for the failure and present core mechanisms which are able to track urban and downtown vehicular and non-mobile environments. Second, I pose a basic, yet unsolved problem:
given a time-varying channel and traffic matrix in the aforementioned complex scenario, predict the throughput of an embedded link and understand the complex interactions of factors that lead to its performance. By performing thousands of measurements of embedded links on an urban mesh network and developing an analytical model, this work is the first to show that even a 1 dB change in channel state can yield a bi-modal shift in throughput that emulates a change in node connectivity. Finally, I apply our model and experimentation to modulation rate selection and the interaction of control and data traffic to show that understanding these complex interdependencies leads to operation in improved performance regimes.

Bio:
Joseph Camp is a PhD Candidate in the Electrical and Computer Engineering Department at Rice University. He received an M.S. at Rice and B.S. from the University of Texas at Austin, both in ECE. Joseph is the lead grad student and Chief Network Architect on the Technology For All Network, performing measurement studies on the deployment and performance of the network. The TFA Network serves over 4,000 users in several square kilometers in Houston, TX.
Additionally,
he is a member of the team developing the Wireless Open-Access Research Platform (WARP), a platform which enables the clean-slate design of MAC and PHY. On WARP, he has implemented a cross-layer rate adaptation framework and novel rate selection protocols which he has experimentally evaluated in diverse channels and scenarios, including residential and downtown urban areas. Joseph is a technical program committee chair for the first ACM MobiHoc S^3 Workshop which is an innovative technical venue which is "of the students, by the students, and for the students."