TEXAS TECH UNIVERSITY
Department *of* Computer Science

Mobile Super-6GHz Directional Wireless Systems for 5G-and-Beyond

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Abstract: Recent proliferation of wireless technologies and choices available to user applications have triggered a tremendous wireless demand, and the wireless nodes are expected to dominate the Internet for the foreseeable future. Accommodating this exploding wireless demand with the legacy cellular capacity does not seem possible in the long run. As the sub-6GHz radio frequency (RF) spectrum is getting scarcer and saturated by recent innovations in attaining high spectral efficiency gains, we urgently need innovations that will enable leveraging of new wireless spectrums and substrates to respond to the exploding mobile wireless traffic demand. Further, the capacity gap between RF wireless and optical fiber backbone speeds will remain huge because of the limited availability of RF spectrum. This gap in the "last mile" of the Internet is getting more troublesome as smart Internet-of-Things (IoT) is becoming a reality and more things around us need wireless connectivity. Enabling super-6GHz (millimeter-wave, optical, and terahertz) spectrum in wireless communications is the needed revolution for high-speed mobile networks of the future.

In this talk, I will present our work on exploring the potential for directional super-6GHz in the context of mobile ad-hoc and opportunistic networking. For free-space optical (FSO), a.k.a. optical wireless, bands, we introduce autonomous building blocks and prototypes for multi-hop FSO-based mobile networking. 3D spherical structures covered with inexpensive FSO transceivers (e.g., LED and photo-detector pairs) solve issues relevant to mobility and beam alignment via availability of several transceivers per node. Such structures facilitate software-defined electronic beam tracking methods instead of traditional mechanical steering techniques used in FSO communications. Using these multi-element modules in the visible optical band, we solve optimization problems to maximize download throughput for mobile devices via lighting fixtures. I will also present our work on the use of machine learning algorithms to perform real-time directional millimeter-wave beamforming from high-level programming languages. This research enables directional super-6GHz wireless communications in ad hoc or low-altitude airborne settings as well as mesh networks at high altitudes. Our work shows the potential of using software capabilities and algorithmic methods along with hardware innovations in realizing autonomous FSO and millimeter-wave IoT systems for emerging 5G-and-beyond applications such as underwater, vehicular, and drone communications.

Bio: Murat Yuksel is a Professor at the ECE Department of the University of Central Florida (UCF), Orlando, FL. He served as the Interim Chair of ECE at UCF. Prior UCF, he was a faculty member at the CSE Department of the University of Nevada – Reno, Reno, NV. He received Ph.D. degree in computer science from Rensselaer Polytechnic Institute in 2002, and B.S. degree in computer engineering from Ege University, Izmir, Turkey in 1996. He worked as a software engineer at Pepperdata, Sunnyvale, CA and a visiting researcher at AT&T Labs and Los Alamos National Lab. His research interests are in the areas of networked, wireless, and computer systems with a recent focus on optical wireless, wireless systems, spectrum sharing, and network economics and architectures. He has been on the editorial boards of Computer Networks, IEEE Transactions on Machine Learning in Communications and Networking, and IEEE Networking Letters. He has published more than 200 papers at peer-reviewed journals and conferences, and is a co-recipient of three Best Paper, one Best Paper Runner-up, and one Best Demo Awards. He is a senior member of IEEE, and a senior and life member of ACM.