

Optical Wireless Communications

Abstract: As the radio frequency spectrum congests, the optical medium provides an attractive alternative, supplying ample and easily-reusable spectral resources. Optical wireless communications (OWC) that use light to carry information through a tetherless channel can offer Gbps connectivity to wireless users. This tutorial covers the essential characteristics of optical wireless systems to provide communications engineers the ability to work within this exciting field. The material discussed focusses on the devices, algorithms, and analyses particular to optical wireless systems that differ from RF wireless. Components and techniques peculiar to OWC (optical signal manipulation, for instance) will be carefully explained for the non-expert. Classical approaches used in optical communications will be reviewed. Channel models, modulation, and signal processing techniques will be presented for various scenarios: short vs. long haul, directed vs. diffuse, indoor vs. outdoor, effect of atmosphere and weather, fading and multipath effects, etc. Then emphasis will be given to current research trends to help researchers transport state-of-the-art ideas from RF wireless to OWC, such as MIMO processing, relaying, higher-order modulation, coding, cross-layer design, optimized resource allocation, etc. Networking issue and approaches to facilitate the convergence of optical wireless with other techniques will be discussed. Application areas described include terrestrial free space optics (FSO), deep space channels, underwater communications, and indoor visible light communications. The tutorial will conclude with a review of current standardization efforts in various sub-disciplines of OWC (infrared transmission, visible light communication, FSO).

Presenters:

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Jean Armstrong is a Professor at Monash University where she leads the Optical Wireless Communications Laboratory. Her research interests include digital communications, engineering education, and women in engineering. Her communications research spans both optical and wireless communications and she pioneered the application of OFDM to optical communications. She has published many very highly cited papers and has six fully commercialized patents. She is currently an editor of the *IEEE Transactions on Communications* with particular responsibility for optical OFDM, optical MIMO and optical localization. She received the B.Sc. (First Class Honours) from the University of Edinburgh, Scotland, the M.Sc. Heriot-Watt University, Scotland, and the Ph.D. in Digital Communications from Monash University, Australia. She has received numerous awards including induction into the Victorian Honour Roll of Women, the 2014 IEEE Communications Society Best Tutorial Paper Award, the Peter Doherty prize for the best commercialization opportunity in Australia, and a Zonta International Amelia Earhart Fellowship. She is currently a member of the Australian Research Council (ARC) College of Experts.



Maïté Brandt-Pearce received her Ph.D. in Electrical Engineering from Rice University in 1993. She then joined the Charles L. Brown Department of Electrical and Computer Engineering at the University of Virginia, where she is currently a full Professor. Her research interests include nonlinear effects in fiber-optics, free-space optical communications, optical networks subject to physical layer degradations, body area networks, and radar signal processing. Dr. Brandt-Pearce is the recipient of an NSF CAREER Award and an NSF RIA. She is a co-recipient of Best Paper Awards at *ICC 2006* and *GLOBECOM 2012*. She serves on the editorial board of *IEEE Communications Letters*, *IEEE/OSA Journal of Optical Communications and Networks*, and *Springer Photonic Network Communications*. She is co-editor of a book entitled *Cross-Layer Design in Optical Networks*, Springer Optical Networks Series, 2013. She was the General Chair of the *Asilomar Conference on Signals, Systems & Computers* in 2009 and the Chair of the Optical Wireless Workshop at *IEEE Globecom 2013*. Dr. Brandt-Pearce has over a hundred and fifty major journal and conference publications.



Zhengyuan Xu received his B.S. and M.S. degrees from Tsinghua University, Beijing, China, in 1989 and 1991, respectively, and Ph.D. degree from Stevens Institute of Technology, New Jersey, USA, in 1999. From 1991 to 1996, he was with Tsinghua Unisplendour Group Corporation, Tsinghua University, as system engineer and department manager. In 1999, he joined University of California, Riverside, first as Assistant Professor and then tenured Associate Professor and Professor. He was Founding Director of the multi-campus Center for Ubiquitous Communication by Light (UC-Light), University of California. In 2010, he was selected by the “Thousand Talents Program” of China, appointed as Professor at Tsinghua University and then at University of Science and Technology of China (USTC). He is Founding Director of the Optical Wireless Communication and Network Center at USTC, and also Key Laboratory of Wireless-Optical Communications of Chinese Academy of Sciences. He is a chief scientist of the National Key Basic Research Program (973 Program) of China. His research focuses on wireless communication and networking, optical wireless communications, geolocation, intelligent transportation, and signal processing. He has published over 170 journal and conference papers. He has served as an Associate Editor and Guest Editor for different IEEE journals, and serves as Associate Editor for the OSA/SIOM journal *Photonics Research*. He was a Founding Chair of *IEEE Workshop on Optical Wireless Communications* and an elected member of IEEE Signal Processing Society’s Technical Committee on Signal Processing for Communications for several years.

