CONASENSE2022 Invited Talks – 6G Advanced Visions

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1. INTRODUCTION

The session of invited talks concerning 6G advanced visions aimed at bringing talks by senior experts in the context of fundamental aspects of 6G communications, or challenges that need to be addressed, when scaling services towards a 6G future.

Kwang-Chen Cheng, University of South Florida, USA (Best presentation award), debated on the use of Machine Learning to assist predictive radio resource use and coordination, alerting for the need to address trade-off aspects in uRLLC.

Jean-Paul Linnartz, Signify, Philips Lighting, debated on the possibility to deduce surrounding context at the network layers, including the PHY layer, and how relevant these aspects become, when considering 6G dense environments, in particular involving lighting infrastructures, where over 100 million digitally cloud-connected light points can be considered.

Fred Harris, University of San Diego, USA, brought a debate on the capabilities of channelizers involving multiple bandwidth and arbitrary frequencies, focusing on the possibility to reduce workload processing in orders of magnitude.

2. MACHINE LEARNING ENABLES RADIO RESOURCE UTILIZATION OF uRLLC, KWAN-CHENG CHEN, UNIVERSITY OF SOUTH FLORIDA, USA

Abstract: Proactive open-loop communication in the virtual-cell network architecture emerges as a compelling approach to accomplish minimal end-to-end latency communication. To achieve ultra-reliability, predictive radio resource utilization is required without feedback control mechanism. In this talk, we introduce Machine Learning to facilitate predictive radio resource utilization by smartly taking advantage of delayed information, and effectively accomplish proactive communication. The trade-off between reliability and density of access points is also identified to guide the uRLLC system design.

Kwang-Cheng Chen has been a Professor at the Department of Electrical Engineering, University of South Florida, since 2016. From 1987 to 2016, Dr. Chen worked with SSE, Communications Satellite Corp., IBM Thomas J. Watson Research Center, National Tsing Hua University, HP Labs., and National Taiwan University in mobile communications and networks. He visited TU Delft (1998), Aalborg University (2008), Sungkyunkwan University (2013), and Massachusetts Institute of Technology (2012-2013, 2015-2016). He founded a wireless IC design company in 2001, which was acquired by MediaTek Inc. in 2004. He has been actively involving in the organization of various IEEE conferences and serving editorships with a few IEEE journals (most recently as a series editor on Data Science and AI for Communications in the IEEE Communications Magazine), together with various IEEE volunteer services to the IEEE, Communications Society, Vehicular Technology Society, and Signal Processing Society, such as founding the Technical Committee on Social Networks in the IEEE Communications Society. Dr. Chen also has contributed essential technology to various international standards, namely IEEE 802 wireless LANs, Bluetooth, LTE and LTE-A, 5G-NR, and ITU-T FG ML5G. He has authored and co-authored over 300 IEEE publications, 4 books published by Wiley and River (most recently, Artificial Intelligence in Wireless Robotics, 2019), and more than 23 granted US patents. Dr. Chen is an IEEE Fellow and has received several awards including 2011 IEEE COMSOC WTC Recognition Award, 2014 IEEE Jack Neubauer Memorial Award, 2014 IEEE COMSOC AP Outstanding Paper Award. Dr. Chen's current research interests include wireless networks, quantum communications and computing, cybersecurity, artificial intelligence and machine learning, IoT/CPS, and social networks.

3. Reaching out to billions of client devices: Challenges and opportunities in very dense wireless networks, Jean-Paul Linnartz, Signify, Philips Lighting

Abstract: To carry the predicted amounts of traffic from more users, more devices, each generating more bit/s than today, future generations of wireless networks need to be very dense (bit/s/m2) with access points at many locations. The (installation of the) infrastructure to support this can become a major cost factor in the economics of connectivity provision. But the value generated by such network goes beyond pure communication.

The physical layer of an advanced communication infrastructure lends itself well to functions, features and services beyond transporting bits. The estimation of the wireless channel response gives side information about the time of flight between the transmitter and receiver but also the excess distance of reflections gives information about objects and human that are in the propagation environment. Similarly, at the network layer, insights about activities in the environment can be deduced.

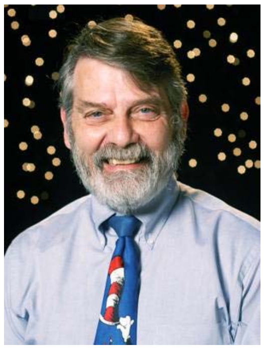
The use of a variety of radio and optical wavelength to leads to interesting propositions. But the convergence of communication, sensing and positioning not

only happening at the lower layers. At an infrastructure level, the presence of power and a high-speed data connection are critically important. The lighting infrastructure is rapidly expanding. With more than 100 Million of digitally cloud-connected light points, it forms (one of) the largest Internet of Things installations.

Jean-Paul Linnartz (Fellow, IEEE) currently is a Research Fellow with Signify (Philips Lighting) Research, and a Part-time Professor with TU Eindhoven, addressing Personalized Human Centric Lighting and optical wireless communication. His inventions led to more than 75 granted patent families and have been a basis for three ventures. From 1992 to 1995, he was an Assistant Professor with the University of California, Berkeley, CA, USA. In 1994, he was an Associate Professor with TU Delft. From 1988 to 1991, he was an Assistant Professor with the TU Delft. He was Senior Director with Philips Research, Eindhoven, The Netherlands, where he headed Security, Connectivity, and IC Design Research Groups.

4. POLYPHASE CHANNELIZERS IN MODERN COMMUNICATION SYSTEMS, FRED HARRIS, UNIVERSITY OF SAN DIEGO

Abstract: We learn to design filters and how to apply their use in the sampled data domain that satisfy their often-repeated constraint; Linear Time Invariant (LTI)! The body of tools with which we are armed in LTI is remarkable: transfer functions, impulse response, superposition, reciprocity, commutability, and so on. One's intuition and understanding about sampled data filters fail us when we change the playing field to Linear Time Varying (LTV). All our tools vanish! In this presentation we will explain how an LTI filter is changed to an LTV filter and the three reasons we choose to do this. They are to reduce cost, to improve performance, and have fun being creative. We take our audience on a trip through Alice's looking glass where things seem to operate backwards and accomplish what appears to be applied magic. We learn how to form an M-path polyphase analysis filter bank and its dual, an M-path polyphase synthesis filter bank. These are amazing processing engines that perform their processing tasks by using spectral aliasing, caused by a sample rate change, to move spectral bands between baseband and selected center frequencies and then separate these aliases by their distinct phase profiles. Remarkably, they accomplish this with a single prototype filter and an inverse FFT that performs channelization of all the filters in the filter bank. Strangely, the same filter is centered at multiple center frequencies simultaneously. Even more remarkable is the capabilities offered by a cascade of the analysis and synthesis filter banks. How about channelizers with multiple simultaneous bandwidths and arbitrary center frequencies. Would an order of magnitude reduction in processing workload be of interest to you? This presentation is low on math and high in comprehension.



Professor harris is at the University of California San Diego where he teaches and conducts research on Digital Signal Processing and Communication Systems. He holds 40 patents on digital receiver and DSP technology and lectures throughout the world on DSP applications. He consults for organizations requiring high performance, cost effective DSP solutions.

He has written some 285 journal and conference papers, the most well-known being his) 1978 paper "On the use of Windows for Harmonic Analysis with the Discrete Fourier Transform" (9400 citations). He is the author of the book **Multirate Signal Processing for Communication Systems,** coauthor with Bernie Sklar of **Digital Communications** and has contributed to several other DSP books. His special areas include Polyphase Filter Banks, Physical Layer Modem design, Synchronizing Digital Modems and Spectral Estimation

He was the Technical and General Chair respectively of the 1990 and 1991 Asilomar Conference on Signals, Systems, and Computers, was Technical Chair of the 2003 Software Defined Radio Conference, of the WPMC-2006 Wireless Personal Multimedia Conference, of the DSP-2009, DSP-2013 Conferences and of the SDR-WinnComm 2015 Conference. He became a Fellow of the IEEE in 2003, cited for contributions of DSP to communications systems. In 2006 he received the Software Defined Radio Forum's "Industry Achievement Award". He received the DSP-2018 conference's commemorative plaque with the citation: *We wish to recognize and pay tribute to fred harris for his pioneering contributions to digital signal processing algorithmic design and implementation, and his visionary and distinguished service to the Signal Processing Community.*

The spelling of his name with all lower case letters is a source of distress for typists and spell checkers. A child at heart, he collects toy trains, old slide-rules, and gyroscopes.