Advances in Physical Layer II & M2M Communications
Wednesday 1 October, 10:30-13:45
Strand Campus, S1.12

10:20-10:30 Opening/Research Trends in Physical Layer
Prof Arumugam Nallanathan, King’s College London

10:30-11:00 ZF Beamforming for MISO Interference Channels without Crosstalk CSI
Dr Kai-Kit Wong, UCL

Abstract: Despite achieving the capacity for interference channels (IFCs), interference alignment requires global channel state information (CSI) at every transmitter, which is not only hard to manage, but consumes a huge amount of feedback capacity. The objective of this talk is to address the distributed beamforming optimization problem for the multiple-input single-output (MISO) IFC in which only a local CSI feedback from the intended receiver to its corresponding multi-antenna transmitter exists. We propose a step-by-step analytical construction for the sum-rate optimal zero-forcing (ZF) solution where at each step an optimizing transmitter analytically constructs its beamforming vector based on the changes in its (scalar) local interference observation due to a reporting transmitter, while the rest remain fixed. The proposed scheme can be managed by a twin-token approach. Results reveal that the proposed approach achieves the sum-rate of the MISOIFC at high signal-to-noise ratio (SNR) and is fast, requiring only K\((K-1)(6M-3K+2)/2\) steps, with M denoting the number of antennas per transmitter and K the number of transmitters.

11:00-11:30 Research Trends in Future 5G: Millimetre Wave Communications, Security, and Energy Harvesting
Dr Maged Elkashlan, Queen Mary University of London

Abstract: The widespread availability and demand for multimedia capable devices and multimedia content have fuelled the need for high-speed wireless connectivity beyond the capabilities of existing commercial standards. While fiber optic data transfer links can provide multi-gigabit per second data rates, cost and deployment are often prohibitive in many applications. Wireless links on the contrary can provide a cost-effective fiber alternative to interconnect the outlining areas beyond the reach of the fiber rollout. In particular, in the last decade, the wireless medium has greatly attracted both users and industry with a growing expectation for integrated communications across multiple products and services. The realization of this vision strongly relies on the existence of technologies enabling speed, green, and security for smarter and more sustainable societies. This talk will cover topics on millimetre wave communications, wireless security, and energy harvesting.

11:30-12:00 Energy Harvesting in Wireless Networks
Yuanwei Liu, Queen Mary University of London

Abstract: Energy harvesting is an effective means to prolong the life of a wireless network, and has recently received remarkable attention since it is increasingly contributing to green communication. With the recent advancements in the technology of low power devices (e.g. efficient DC-DC convertors and antenna rectifiers), it has been shown that ambient radio-frequency (RF) signals is a new promising source for harvesting energy and is expected to be implemented in low power networks in near future. The motivation behind this approach lies in the fact that most devices are surrounded by RF signals, and potentially, energy and information can be carried together by the RF signals during transmission. This talk will cover topics mainly on two parts: 1) Two-Way Relay Networks with Wireless Power Transfer 2) Wireless Energy Harvesting in Spectrum Sharing Network.
12:00-12:30 Coffee break & Discussion session

12:30-13:00  **Joint Energy Harvesting and Internetwork Interference Mitigation amongst Coexisting Wireless Body Area Networks**
Samaneh Movassaghi, University of Technology, Sydney, Australia

*Abstract*: This talk investigates simultaneous transfer of information and energy for interference mitigation amongst multiple coexisting Wireless Body Area Networks (WBANs). We propose to utilize interference that falls into the network as a source of energy, which is mainly discarded in conventional interference mitigation schemes. More specially, in each time slot, a single sensor node is scheduled to receive information whilst the remaining sensor nodes opportunistically harvest the ambient radio frequency energy. We develop a novel opportunistic scheduling scheme, which offers a significantly high network lifetime through a tradeoff between a sensor's spectral efficiency and average amount of energy harvested. Simulation results show that the proposed energy harvesting with smart channel allocation (E-SCA) scheme can achieve optimal spatial reuse and good energy harvesting. We also show that the proposed approach is robust to variations in channel conditions, density of sensor nodes in each WBAN and increase in number of coexisting WBANs.

13:00-13:30  **Probabilistic Rateless Multiple Access for Machine-to-Machine Communications**
Mahyar Shirvanimoghaddam, University of Sydney, Australia

*Abstract*: Future machine to machine (M2M) communications need to support a massive number of nodes communicating with each other with little or no human intervention. Random access techniques were originally proposed to enable M2M multiple access, but suffer from severe congestions and access delay in a M2M system with a large number of devices. In this work, we propose a novel multiple access scheme for M2M communications based on the capacity-approaching analog fountain codes to efficiently minimize the access delay and satisfy the delay requirement for each device. This is achieved by allowing M2M devices to transmit at the same time on the same channel in an optimal probabilistic manner based on their individual delay requirements. Simulation results show that the proposed scheme have a near optimal rate performance compared to the optimal coordinated approach and at the same time guarantees the delay requirements of the devices. We further propose a simple random access strategy and formulate the average amount of overhead in the random access procedure. Simulation results show that the maximum payload size, which can be supported by the proposed approach, is close to that of the optimal coordinated random access approach.

13:30-14:00  **Closing Remarks/Discussions**
Chaired by Prof. Arumugam Nallanathan, King’s College London
Speakers’ Biographies:

Dr Kai-Kit Wong received the BEng, the MPhil, and the PhD degrees, all in Electrical and Electronic Engineering, from the Hong Kong University of Science and Technology, Hong Kong, in 1996, 1998, and 2001, respectively. He is presently Reader in Wireless Communications at University College London, United Kingdom. Prior to this, he took appointments at the University of Hull, UK and the University of Hong Kong, and also visiting positions at Alcatel-Lucent, Holmdel, US and the Smart Antenna Research Group at Stanford University. His current research interests centre around gametheoretic cognitive radio networks, cooperative communications, physical-layer security, massive MIMO and energy-harvesting wireless communications.

Dr Maged Elkashlan received the Ph.D. degree in Electrical Engineering from the University of British Columbia, Canada, 2006. From 2006 to 2007, he was with the Laboratory for Advanced Networking at University of British Columbia. From 2007 to 2011, he was with the Wireless and Networking Technologies Laboratory at Commonwealth Scientific and Industrial Research Organization (CSIRO), Australia. During this time, he held an adjunct appointment at University of Technology Sydney, Australia. In 2011, he joined the School of Electronic Engineering and Computer Science at Queen Mary University of London, UK, as an Assistant Professor. He also holds visiting faculty appointments at the University of New South Wales, Australia, and Beijing University of Posts and Telecommunications, China. His research interests fall into the broad areas of communication theory, wireless communications, and statistical signal processing for distributed data processing, millimetre wave communications, cognitive radio, and wireless security.

Dr. Elkashlan currently serves as an Editor of the IEEE Transactions on Wireless Communications, the IEEE Transactions on Vehicular Technology, and the IEEE Communications Letters. He also serves as the Lead Guest Editor for the special issue on “Green Media: The Future of Wireless Multimedia Networks” of the IEEE Wireless Communications Magazine, Lead Guest Editor for the special issue on “Millimeter Wave Communications for 5G” of the IEEE Communications Magazine, Guest Editor for the special issue on “Energy Harvesting Communications” of the IEEE Communications Magazine, and Guest Editor for the special issue on “Location Awareness for Radios and Networks” of the IEEE Journal on Selected Areas in Communications. He received the Best Paper Award at the IEEE International Conference on Communications (ICC) in 2014, the International Conference on Communications and Networking in China (CHINACOM) in 2014, and the IEEE Vehicular Technology Conference (VTC-Spring) in 2013. He received the Exemplary Reviewer Certificate of the IEEE Communications Letters in 2012.

Yuanwei Liu is working towards his Ph.D. degree in Electronic Engineering at Queen Mary University of London. Before that, he received the B.Eng. degree and the M.S. degree from Beijing University of post and telecommunications in June 2011 and in March 2014. His research interests include energy harvesting, cooperative networks, cognitive radio, and physical layer security.

Samaneh Movassaghi received a B.Sc. from University of Tehran in 2009 and a Master by Research in Telecommunication Engineering from the University of Technology, Sydney in 2012. She is currently a PhD candidate at the Australian National University (ANU) and is conducting research in the field of Wireless Body Area Networks. She has authored more than 20 papers in the area of
wireless body area networks and is currently an IEEE Student member. She has been the reviewer of a number of conference papers and journals. Her research interests are in Wireless Body Area Networks, Energy Efficient Communication, Interference Mitigation, Energy Harvesting, Address Allocation, Routing Schemes, Sensor Networks, MIMO Communications, Traffic control, Energy efficient Scheduling and QoS provisioning in wireless sensor networks. She has been the recipient of numerous scholarships and awards such as: UTS International Research Scholarship (IRS), UTS President’s scholarship (UTSP), UTS Teaching Fellowship Award, ANU Scholarship and NICTA Scholarship.

Mahyar Shirvanimoghaddam received his B. Sc. degree with 1’st Class Honours from University of Tehran, Iran, in 2008, and his M. Sc. Degree with 1’st Class Honours from Sharif University of Technology, Iran, in 2010, both in Electrical Engineering. He is currently working towards a Ph.D. degree in Electrical Engineering at The University of Sydney, Australia. His research interests include channel coding techniques, cooperative communications, compressive sensing, machine-to-machine communications, and wireless sensor networks. He is a recipient of University of Sydney International Scholarship (USydIS) and University of Sydney Postgraduate Award.