Radio Technology SIG

'Turning Full-Duplex Radio into Reality'

8th July 2015

Hosted by University of Bristol, sponsored by Rohde & Schwarz and supported by SETsquared

This SIG is championed by Brian Collins of **BSC Associates**, Diego Giancola of **PA Consulting Group**, John Haine of **u-blox AG** and Gerald Miaille of **CSR**

Venue: School of Chemistry, University of Bristol, Cantock's Close, Bristol, BS8 1TS

AGENDA

12:00	Registration and networking over lunch
13:00	Introduction to Radio Technology SIG from **John Haine, u-blox AG**
13:10	Welcome from host, **Mark Beach**, Manager, CDT in Communications, **University of Bristol**
13:20	Welcome from **John Crute**, CEO, **The Technology Academy** on behalf of sponsor, **Rohde & Schwarz**
	Session chaired by SIG Champion, Brian Collins, BSC Associates
13:30	**'Division Free Duplex in Small Form Factors'** **Leo Laughlin**, PhD Student, **University of Bristol** Full duplex transceiver technology will only be deployed in future mobile devices if the self-interference cancellation hardware can meet the demanding low-cost and small form factor requirements of handset applications. Electrical Balance Duplexing enables simultaneous transmission and reception from a single antenna, making it an attractive choice for duplexing in mobile devices. In this talk we present our prototype full-duplex transceiver which combines Electrical Balance Isolation with active analogue cancellation to provide high transmit-to-receive isolation over wide bandwidths using low cost small form factor technologies.
13:50	Q&A
13:55	**'Addressing the LTE Bandwidth Challenge on Small Mobile Terminals: One World, One Radio'** **Samantha Caporal Del Barrio**, Industrial Post-Doc, **Aalborg University and WiSpry** This talk concerns frequency-reconfigurable antennas with the aim of addressing the challenge of band proliferation for small mobile terminals. This challenge arose with the worldwide standardization of Long Term Evolution (LTE). Designing a worldwide LTE phone (i.e. a world-phone) with conventional techniques reaches the limit of component integration, given the very tight platforms of typical smart-phones. A shift in architecture is required in order to cover the bandwidth needed for worldwide LTE roaming.
14:15	Q&A
14:20	**'MAC Protocol for In-Band Full-duplex Systems'** **Dr Mir Ghoraishi,** Project Leader 5G Testbed and Proof-of-Concept, Institute for Communication Systems (ICS), **University of Surrey** Full-duplex radio has attracted a lot of attention in recent years and with the introduction of novel self-interference techniques it is proved that the in-band full-duplex operation is possible. Before a fundamental rethinking of the way wireless networks are designed however, the system cannot enjoy the benefits of the full-duplex operation. Specifically, an accurate model for multiple access (MAC) protocol needs to be devised to translate the physical layer full-duplex gains into the overall network improvements. The MAC protocol design for full-duplex is an open area of research which is going to be of interest to both the industry and the academia as this technology matures in the next few years. This talk will provide an overview of the topic including related recent works.
14:40	Q&A
14:45	**Refreshments and networking**

Session chaired by SIG Champion, Brian Collins, BSC Associates

15:15 **'Orbital Angular Momentum Radio: A new possibility for Full Duplex Radio?'** (collaborative work with Alan Tennant, University of Sheffield)

Ben Allen, Visiting Fellow, Department of Engineering Science, **University of Oxford**

Recently Orbital Angular Momentum Radio (OAM-Radio) has been shown to provide huge gains in spectral efficiency for line-of-sight radio links. This has been achieved by means of either using antenna arrays and signal coding (akin to MIMO) or circular phase plates to provide the required signal profile. It may also be possible to use this concept towards enabling full-duplex radio by using the filtering function at the OAM-radio receiver.

This talk introduces and reviews recent work on OAM-radio and then explores the possibility of applying it in the context of full-duplex radio.

15:35 Q&A

15:40 **'Operators perspective on full-duplex'**

David Lister, Research Manager, **Vodafone UK**

This talk will be discussing the use-cases under which full-duplex can be applied and some of the challenges that will emerge when applied to a system with multiple base stations and terminals.

16:00 Q&A

16:05 **'Air Division Duplexing doubles Transmission Capacity for Microwave Backhaul'**

Geoff Carey, Director, **MIMOtech**

The application of full duplex radio techniques as an alternative to line of sight MIMO brings a new dimension to ultra-high capacity transmission for microwave backhaul. MIMOtech has realised a backhaul radio system using the Air Division Duplexing technique to achieve simultaneous transmission and reception on the same frequency. This talk will cover the solution and look at the advantages and challenges of the technology.

16:25 Q&A

16:30 Panel session with all speakers chaired by **SIG Champion, Diego Giancola, PA Consulting Group**

17:00 **Event closes**

With the permission of the speakers, presentations will be loaded to the CW website on the day following the event

Profile of organisers

Cambridge Wireless (CW)

CW is the leading international community for companies involved in the research, development and application of wireless and mobile, internet, semiconductor and software technologies. With 400 members from major network operators and device manufacturers to innovative start-ups and universities, CW stimulates debate and collaboration, harnesses and shares knowledge, and helps to build connections between academia and industry. CW's 19 Special Interest Groups (SIGs) provide its members with a dynamic forum where they can network with their peers, track the latest technology trends and business developments and position their organisations in key market sectors. CW also organises the annual Future of Wireless International Conference and Discovering Start-Ups competition along with other high-quality industry networking events and dinners. With headquarters at the heart of Cambridge, UK, CW partners with other international industry clusters and organisations to extend its reach and remain at the forefront of global developments and business opportunities. For more information, please visit www.**cambridgewireless**.co.uk

Profile of sponsors

Rohde & Schwarz UK

Rohde & Schwarz UK Ltd has been the UK subsidiary of Rohde & Schwarz GmBH for 40 years. Based in Fleet, RSUK employs 105 people to provide dedicated sales, services and support to customers across the UK and Ireland. Rohde & Schwarz has designed and manufactured the highest-quality specialist products in Germany for 77 years across a wide range of technologies and industries, including wireless, broadcast, aerospace, defence and security markets. For more information please visit www.**rohde-schwarz**.co.uk

Profile of host

Professor Mark Beach, University of Bristol

Mark Beach is a Professor in Radio Systems Engineering at the University of Bristol (UK) pursuing research in the field of 5G wireless connectivity. This includes the use and characterisation of millimetre wave bearers, massive MIMO based wireless access and disruptive technologies such as full-duplex. Mark also manages the EPSRC Centre for Doctoral Training in Communications at Bristol and is the host for the CW Full Duplex workshop on 8th July 2015. For further information please visit www.**bris**.ac.uk

Profile of supporter

SETsquared

The SETsquared Partnership is the enterprise collaboration of the Universities of Bath, Bristol, Exeter, Southampton and Surrey. Together, the universities employ 7,400 academic staff; earn nearly 10% of the UK's higher education research budget; and produce 11% of all UK university patents.
The partnership has a 10-year track record of supporting companies through its innovation centres, providing access to industry specialists, investors and experienced entrepreneurs. SETsquared supports over 250 early stage high-tech, high growth potential businesses, and 88% of its incubated companies are still in business three years on. In the past five years, nearly £0.75bn in investment funding has been raised by spin outs and incubated companies. SETsquared supports its student population of over 90,000 graduate and undergraduates to gain hands on business skills and entrepreneurial training through experiential inter-university activities. The Partnership also provides opportunities for industry to access academic ideas with commercial potential and develop collaborative R&D relationships and seeks to promote the impact, economically and socially, of its institutions' research and enterprise activities. Follow on Twitter @SETsquared For more information please visit www.**setsquared**.co.uk

Profile of SIG Champions

Brian Collins, BSC Associates

Brian has designed antennas for applications including radio and TV broadcasting, base stations, handsets and consumer products, and has operated his own consultancy firm for the last 12 years. He has published more than 70 papers on antenna topics and contributed chapters to several recent textbooks. He operates a small consultancy company, chairs the Antenna Interface Standards Group and is an Honorary Visiting Professor in the School of Electronic Engineering and Computer Science at Queen Mary, University of London. For more information please visit www.**bscassociates**.co.uk

Diego Giancola, PA Consulting Group

Diego has spent his career in radio systems R&D and modem design in the wireless communication sector, from 2G to the latest 4G evolutions. His research interests lie in multi-antenna systems and novel signal processing and architectures for radio signals. He currently co-runs PA's signal processing team and leads the research activities in LTE evolution and 5G landscaping. Diego has a first degree in telecommunication engineering and a doctorate in electronics and communication engineering from Politecnico di Milano. For more information please visit www.**paconsulting**.com

John Haine, u-blox AG

John Haine has spent his career in the electronics and communications industry, working for British Telecom, Marconi, PA Consulting, and with start-ups including Cognito and Ionica. His technical background includes R&D in radio circuitry and microwave circuit theory; and the design of novel radio systems for cordless telephony, mobile data, and fixed wireless access. He has led standardisation activities in both the latter areas in ETSI, and contributed to WiMax. In 1999 he joined TTP Communications working on research, technology strategy and M&A activities; and after the company's acquisition by Motorola became Director of Technology Strategy in Motorola Mobile Devices. After leaving Motorola he was CTO Enterprise Systems with ip.access Limited, the leading manufacturer of GSM picocells and 3G femtocells. In early 2010 he joined Cognovo Limited, which was acquired by u-blox AG in 2012. In u-blox John is defining RF platform strategy for future wireless modules and looking at emerging standards for M2M communications. John has a first degree from Birmingham (1971) and a PhD from Leeds (1977) universities. He is a member of the IET and IEEE and serves on the Cambridge Wireless Board. In February 2015 he became Royal Academy of Engineering Visiting Professor at Bristol University, focusing on Radio Systems for the Internet of Things. For further information please visit www.**u-blox**.com

Gerald Miaille, CSR

Gerald Miaille has spent his entire career in the semiconductor industry, designing RF and mixed signal ICs for various wireless technologies including WLAN, BlueTooth, NFC, FM, SoftGPS as well as Cellular radios. He has developed novel ideas, which have seen patents as well as an engineering award appended to his name. Gerald currently works for Cambridge Silicon Radio (CSR plc) as a director of RF/Analog IC design. He leads two design centers which are developing state of the art wireless connectivity IC solutions for standalone as well as Combo chips. For further information please visit www.**csr**.com

Profile of speakers

Ben Allen, University of Oxford

Since Jan 2015 Dr Ben Allen has been a visiting fellow with the Department of Engineering Science at the University of Oxford as well as a Senior Telecommunications Innovations and Strategy Engineer with Network Rail. Prior to that he spent 5 years with the University of Bedfordshire where he was Professor of Computer Science, led the Centre for Wireless Research and was Acting Head of Computer Science for a short time. He is a Chartered Engineer, Fellow of the IET and Senior Member of the IEEE. He is an Associate Editor of IET Microwaves Antennas & Propagation and a member of the IET Knowledge Services Board. Dr Allen's research interests span wireless communications, antennas, propagation, PHY layer and energy harvesting. He has numerous publications in leading journals and conferences, including 3 books. For further information please visit www.**ox**.ac.uk

Samantha Caporal Del Barrio, Aalborg University and WiSpry

Samantha Caporal Del Barrio was born in 1987. She entered a 'Grande Ecole' in Paris, in 2007 to pursue an engineering degree in mobile communications. In 2009, she followed a specialization in antennas and propagation at Aalborg University, Aalborg, Denmark. She received M.Sc. degree both from Paris ECE Grande Ecole and from Aalborg University in 2010. She received her PhD degree from Aalborg University in 2013.
She is currently hired as an industrial post-doctoral fellow, jointly with Aalborg University and WiSpry. Her research interests include small terminal performances, user's influence on MIMO handsets and frequency-reconfigurable antennas for 4G implementation. She is also involved in the COST Action IC 1004 on 'Cooperative Radio Communications for Green Smart Environments' and the COST Action IC 1102 on 'Versatile, Integrated and Signal-aware Technologies for Antennas'. For further information please visit www.en.**aau**.dk or www.**wispry**.com

Geoff Carey, MIMOtech

Geoff is currently the Marketing Director for MIMOtech, a wireless technology company based in Cape Town. He has some 25 years' experience in research, development and application of wireless communications technologies. After graduating from University of Natal in 1988, his career began as a microwave development engineer for Plessey South Africa where he was involved in various developments including point-to-point and point-to-multipoint microwave products, power amplifiers, wireless local loop, cordless and mobile technologies. Geoff then moved into the technical marketing and product management of wireless solutions. His career then shifted to business management where he headed up the highly successful Wireless Business Unit to Nov 2011. Geoff joined MIMOtech in 2012.For further information please visit www.**mimotechnology**.com

Dr Mir Ghoraishi, Institute for Communication Systems (ICS), University of Surrey

Mir Ghoraishi is a senior research fellow in the Institute for Communication Systems (ICS), University of Surrey. He joined the Institute in 2012 and is currently leading 5GIC testbed and proof-of-concept projects. This work area includes several implementation and proof-of-concept projects, e.g. 5G air-interface proof-of-concept, network massive MIMO implementation, wireless in-band full-duplex, millimetre wave hybrid beamforming system, and millimetre wave wireless channel analysis and modelling. He is also leading work package 3 in EU FP7 DUPLO project. He has previously worked in Tokyo Institute of Technology as assistant professor and senior researcher from 2004 to 2012, after getting his PhD from the same institute. In Tokyo Tech he was involved in several large (national) and small scale projects in planning, performing, implementation, analysis and modelling different aspect of wireless systems in physical layer wireless systems, wireless propagation channel and signal processing. He has co-authored 100 publications including refereed journals, conference proceedings and three book chapters. For further information please visit www.**surrey**.ac.uk/5gic

Leo Laughlin, University of Bristol

Leo Laughlin graduated with an M.Eng. in Electronic Engineering from the University of York in 2011 and is currently a Ph.D. student in the Communication Systems and Networks Laboratory at the University of Bristol. During 2009 – 2010, he was with Qualcomm, U.K., working on GSM receivers, and in 2011, he was with Omnisense Ltd., Cambridge, working on radio geolocation systems. His research interests are in the areas of in-band full-duplex radio and multiband RF transceiver design. For further information please visit www.**bris**.ac.uk

David Lister, Vodafone UK

David Lister is a member of Vodafone's R&D team where he leads their research on 5G and new technologies. He has 20 years' experience in mobile telecommunication networks covering a variety of technical and commercial roles. For further information please visit www.**vodafone**.com