



University of
BRISTOL

EPSRC

Engineering and Physical Sciences
Research Council



EPSRC Centre for Doctoral Training in Communications

Annual Report
2017 - 2018

Welcome



It is with great pleasure that we bring you the EPSRC Centre for Doctoral Training in Communications Annual Report 2017-18.

Since its launch in 2011, our CDT has recruited eight cohorts, with over 80 students having completed their PhD or who are now studying in the Centre. Our students have made significant contributions in their fields of research alongside engagement with industry on projects key to the development of technology. This September we have welcomed the last cohort under the current EPSRC grant.

A new film has been produced, with contributions from our current and past postgraduates, staff and industrial collaborators on the work of the Centre.

We are grateful for the ongoing support from EPSRC and our industrial partners who provide relevant and challenging 'real world' research projects. They also support our complementary skills training and new equipment facilities that make the research generated by our postgraduates possible.

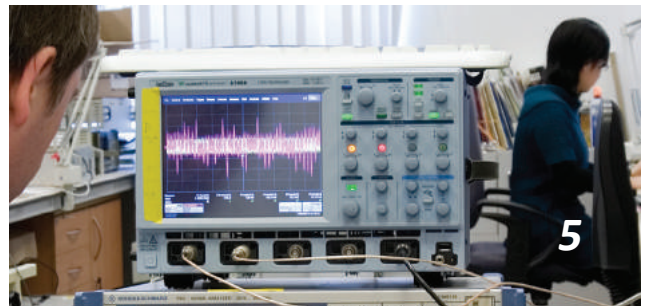
I hope this report will give you an insight into the personalities and the activities associated with our Centre over the past year. Please enjoy reading it and do not hesitate to get in touch if you would like to discuss anything in more detail.

Director
EPSRC Centre for Doctoral Training in
Communications

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Recruitment

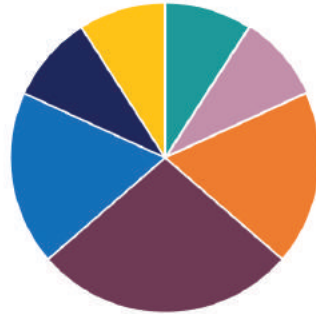
Twelve students joined the programme in September 2017. The academic backgrounds of the intake are shown in the chart below and reflects the Centre's policy of recruiting highly qualified and enthusiastic graduates from a broad range of relevant disciplines.

Most students are funded by EPSRC (Engineering and Physical Sciences Research Council) with additional

support from industry providing enhanced stipends. One of our international students is supported via funding from their government.

As in previous years, the programme has proved attractive to individuals returning to education after a period working in industry who wish to improve their skills to enhance their career prospects.

Subject Background of September 2017 recruits



- | | |
|------------------------------------|--------------------------|
| ■ Computer Science | ■ Cryptography |
| ■ Communications | ■ Electronic Engineering |
| ■ Electronics & Communications | ■ Mathematics |
| ■ Advanced Mechanical/Mechatronics | |



Taught year

The first year of the programme combined taught material (mandatory units, and an extensive choice of optional units), enterprise/innovation skills training, and group and individual problem-based projects as a foundation for PhD research in subsequent years.

A flexible programme structure enabled students joining from varying academic backgrounds and time in industry to enhance their existing knowledge. Those with a first degree in mathematics were not required to take the mandatory mathematics unit and instead took additional engineering units.

Bespoke mathematics training

Students from a non-mathematics background took a mandatory unit 'Mathematics for Signal Processing and Communications', specifically designed for the programme and delivered by academics from both Electrical & Electronic Engineering and the School of Mathematics.

Group project

This bespoke unit introduces training in collaborative working, an essential skill for engineers who need to work in teams with other specialists and therefore not just understand their own discipline/their vocabularies but also the varying cultures.

This year's project was based on "Evaluation of the LoraWAN system" under the guidance of Digital Catapult (<https://www.digitalcatapultcentre.org.uk/>) and Visiting Professor John Haine.

Individual research project

During three months over the summer, each student undertook an individual research project which in most cases formed the in-depth literature review for their PhD studies, giving them a 'head start' on their research. A number of the projects are co-funded by our industrial sponsors who also provide mentors and access to their facilities.

Enterprise

To ensure students have an appreciation of how research can be applied in the commercial world, all students participated in a bespoke unit on Enterprise. This Unit is unique to the CDT in Communications with case studies from the communications sector being used to illustrate concepts. The activities included studying business modelling, the analysis of business plans and finance, and seminars from speakers working in the communications industry. The students' assessment required them to form small teams to create business plans that they pitched to a panel of industry experts and entrepreneurs.



Skills Training

Over the last twelve months our postgraduates have had the opportunity to undertake a range of skills training opportunities - both transferable and technical.

Postgraduates in the early stages of their research journey were provided with fundamental training, including 'Managing your PhD', 'Communicating with your supervisor' and 'Writing your C.V.' (given by University of Bristol Careers Service staff).

The CDT Director, Professor David Bull, provided in-house training on 'Scientific research' and 'Technical writing', and 'Preparing abstracts and posters'. This training is timed to enhance student readiness for our Annual Conference.

The Bristol Doctoral College organised a variety of training events. For the first time this year, postgraduates were given the opportunity to be involved in the University of Bristol's CREATE programme. Several students from the CDT participated in the events which included training on 'Starting to teach', 'Presenting with confidence and flair', and 'Personal impact'.

A range of technical seminars were given throughout the year by industrial experts, academics and postgraduates to widen and enhance our students' knowledge, and to stimulate debate.

Students participated in reading groups on a range of topics agreed amongst the cohorts, and also those organised by associated research groups.

Postgraduates attended off-site subject-specific training in the UK and Europe including the EPSRC CommNet Winter and Summer Schools on Communications, Big Data Summer School 2017, LXMLS 2018 Machine Learning Summer School and the Mathematics Spring School. These events also provided an opportunity to share ideas and network with students from other universities.

In March we were delighted to welcome the EPSRC-funded ORBIT team (Martin de Heuver, Bernd Stahl and Margarita Nulli) to run a workshop on Responsible Research and Innovation, guiding our postgraduates using examples of research projects within the CDT.



Annual Conference and Lecture

In September Professor Mike Short, CEO of Airedale Advisors and former VP Telefonica Europe, gave the CDT Annual Public Lecture on the subject of 'Wireless communications - Building Economies in the Developing World'.

The lecture discussed how the need to access and use the Internet is often regarded as the 5th Utility, however smartphones are not yet consistently available across the globe. The United Nations Sustainable Development Goals have been adopted by the mobile sector globally and it is expected that services will increasingly rely on wireless communications including finance, energy, water, transport, and health evolving to use the technology. Professor Short discussed his work with the global GSM Association and some of the wider plans for 4G/5G investment and support for the Internet of Things (IoT).

The event provided an opportunity for members of the public, students, industry and academics to engage in the debate on the spread of technology around the globe and its implications for society.

The following day students, academics and industry mentors participated in the CDT Annual Student Research Conference at Engineers' House, Bristol. The conference provided the opportunity to network and discuss research in an informal environment. Our new

cohort of postgraduates, who had only arrived that week, had the chance to learn about research topics currently being studied and to meet the staff and multiple cohorts. During the day, our CDT students gave a series of presentations and posters on their latest research on topics ranging from the application of mathematics to communications to hardware design.

Dr Vaia Kalokidou, one of our postgraduate alumni, gave a presentation on her time with the Centre and the opportunities it had given her.

Professor John Haine (Chair, CDT Industrial Advisory Board) discussed 'The value of the CDT experience to industry and students'.

The Centre was also delighted to welcome 3 pupils and the Deputy Headmaster, Dr Paul Hill, of Colston's School to participate in the conference. The Centre has been working with the School for several years on a number of outreach projects designed to inspire interest in STEM subjects. The pupils gave a series of inspiring presentations on their career plans, and what was motivating them to opt for STEM subjects. Dr Hill gave a speech on the importance of parents, teachers, academics and industry encouraging the next generation to consider all career options, and to develop skills in science and engineering to support the UK economic development.



Research Highlights

Over the last twelve months, our postgraduates have researched key challenges in Communications on topics including vehicular communications, 5G and its implementation, video transmission and massive MIMO. Students are based in a research group and guidance is provided by academic experts in the field and industry mentors.

Research results have been published in leading journals, presented and discussed at technical meetings such as COST, and at key international conferences. Staff and postgraduates also participated in the 5G UK trials in Bristol which gave them the opportunity to discuss the impact of the technology on everyday life and the plans for further research (see page 6).

Jenny Chakravarty presented her work at the 2018 IEEE European School of Information Theory (ESIT). In May, Dave McEwan presented his research at the RISCv workshop in Barcelona as part of his sponsor's (UltraSoC) contribution to the event.

The work of Paul Harris, Professor Beach, and Dr Armour, 'From MIMO to Massive MIMO', was the cover story in the September 2017 EuMW Show issue of Microwave Journal.

In September a team from the CDT in collaboration with National Instruments, Lund University (Sweden) and BT, were announced as the winners in the category 'Information, Data & Connectivity' at The Engineer: Collaborate to Innovate (C2I) Awards 2017 for their work on 'Setting World Records in 5G Wireless Spectrum Efficiency using Massive Multiple Input, Multiple Output

(MIMO)'. It addressed the unprecedented demand for increased data rates, expanded network capacity and improved reliability using this new wireless technology.

Michael Collett's research on multiband tuneable antennas, a critical part of many communication and radar systems, has been published in IEEE Transactions on Antennas and Propagation. The work has shown significant advances in antennas by using optically induced plasmas in silicon to tune both radiation patterns and operation frequency and could dramatically improve the performance of future communication and radar systems.

Three of our students - Wael Boukley Hasan, Jenny Chakravarty and David Reyes Paredes - have been shortlisted for the 2018 EPSRC Connected Nation Pioneers competition and have submitted 3 minute videos on their research.

A number of postgraduates are writing-up their research, and moving into employment. For example, Michael Baddeley is completing his work on the use of synchronous network flooding to overcome the challenges faced by Software Defined Networking (SDN) in extremely low-power wireless sensor networks. Wael Boukley Hasan is preparing his thesis on evaluating the practicality of using massive MIMO (MaMIMO) in real-world scenarios and identifying solutions to operational deployments.

After their PhDs, our postgraduates have taken up posts as postdoctoral researchers or with industry in the UK, Europe and the USA, including SMEs.



Public Engagement

Layered Realities Weekend - A 5G Showcase 17th & 18th March 2018

In March 2018, our postgraduates helped demonstrate a range of cutting-edge 5G technologies at the 'Layered Realities' weekend – the world's first public 5G end-to-end trial - organised by the University's Smart Internet Lab in collaboration with the Watershed and We The Curious in Bristol. The event was funded by the UK Government's Department for Digital, Culture, Media and Sport (DCMS) '5G UK Testbeds and Trials programme'. Visitors were given the opportunity to discover how exciting new network technologies will transform cities and the way we live. The showcase provided the opportunity to demonstrate to the public how research funding is utilised to improve the quality of life, and how academia works with industry to achieve these goals.

The CDT postgraduates and academics showcased 5G technologies in two key areas:

Massive MIMO

Massive MIMO allows more information to be packed into the limited wireless bandwidth available by using spatial signal processing. Virtually everyone has experienced poor performance whilst using wireless devices. The problem is often not due to signal strength

but the base station having insufficient capacity to support demands. It is predicted that by 2020 we will require 1000 times more capacity to accommodate new demands such as Virtual Reality (VR) Autonomous Driving and IoT (Internet of Things).

This work was undertaken through close collaboration between Lund University, National Instruments and Bristol Is Open (a joint venture between the University and Bristol City Council).

The results of the work have been published on the Web, in top-class journals, presented at conferences and made accessible via Open Access. The postgraduates also set the current world-record for spectral efficiency using this technology, and have received a number of engineering impact awards.

Connected Autonomous Vehicles

Future driverless vehicles will be integrated into our smart cities infrastructure with effective and efficient wireless communication links to allow propagation of hazard warnings and functionality. During the 5G showcase weekend, the public were given an insight into how this technology will operate.





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Student PhD Research Projects - First Year Researchers

Stephen Boyle

Multi-drone cinematography



The use of unmanned aerial vehicles (commonly known as drones or UAVs) has enabled film-makers to create shots which would have been impossible using standard techniques. Multi-drone cinematography is an emerging technology that could provide extended filming capabilities and enable novel visual effects. It has particular relevance for filming sports such as football or cycling, which extend over a large physical area and in which there are multiple camera targets.

There are many rules and heuristics that film-makers follow to produce visually pleasing shots and sequences that convey a storyline without confusing the viewer. For multi-drone cinematography to become widely adopted a set of shot types and sequences which can enrich the viewing experience (e.g. increasing engagement or aiding narrative) will need to be defined and new cinematographic rules will need to be formulated to ensure successful implementation.

In the first stage of the research simulated drone camera sequences have been created for various scenarios (e.g. cycling and motor racing) using Unreal Engine software. Subjective testing of those sequences has then been used to determine the optimum speed and height of the drone for those shots. The research will aim to develop a methodology for determining optimum drone parameters given the type of shot (e.g. overtaking, closing or establishing) and the target parameters (e.g. size, position and speed of target).

Mark Graham

Reliable communication over dynamic network topologies



The last few decades have seen enormous growth in wireless communications, and this trend is forecast to continue. The wireless medium is significantly more resource-constrained, and more variable, than the wired networks used in the early days of the Internet. This brings new challenges of supporting reliable communications over an intrinsically unreliable medium. A topical example is systems which involve moving vehicles: Vehicle to Vehicle (V2V) and Vehicle to Infrastructure (V2I) networks often face such challenges.

A well-known technique for achieving reliability in communication systems is error correction coding. This approach has been widely used both in storage systems and for point to point communication links since the 1960s. The goal of this project is to study extensions of this approach in broadcast and multicast systems, and also to characterise the achievable performance of such methods. In particular, the project will go beyond classical error correction codes to study digital fountain and network coding approaches to these problems. Whilst there has already been a considerable body of work using such approaches, there have been few attempts to analyse their performance mathematically, or to establish fundamental bounds on what they can achieve. Providing a rigorous mathematical analysis of performance is one of the goals of this project. Another related goal is to study fundamental trade-offs between different objectives such as throughput and latency.

Owen Jones

Backhaul connectivity to moving targets



As the bandwidth demands of consumers grows ever higher, a key area of 5G mobile planning is ensuring that these needs can be met regardless of whether a user is stood perfectly still, or travelling at high speed. It is expected that this will require both vehicle-to-infrastructure (V2I) links exceeding 25Gbps to vehicles moving up to 500km/h, with the perception of almost constant availability and coverage, and vehicle-to-vehicle (V2V) links. The move to the higher frequencies of the millimetre band, with its large amounts of usable spectrum, is seen as one of the key technological steps in reaching the spectral efficiency required to meet these demands. Increased path and propagation losses at these frequencies, combined with the increased channel aging effects introduced by movement, present new challenges in channel estimation and tracking which must be overcome to enable backhaul links to moving targets to be established.

This project focuses on further improving the current state-of-art for links to moving platforms, both sub-6GHz and millimetre wave. The project starts by looking at some of the proposed requirements for high-speed 5G links, and the intended applications, before assessing work done to produce accurate channel models of the expected conditions for these links and determining how they can be adapted to better represent mobility. Beamforming algorithms for mobility, and Massive-MIMO for supporting multiple moving links are also to be investigated.

Di Ma

Optimised acquisition and coding for immersive formats based on visual scene analysis



Currently, with the development of modern video technology, users anticipate new and more immersive video content which presents difficulties in compressing, storing, and transferring the huge amount of raw video data produced. The challenge is how to acquire video data to satisfy the perceptual quality requirements with the lowest bit rates .

This project proposes to use the feature extraction, image/video quality assessment techniques and machine learning methods so that we can optimise the video parameter space.

Many algorithms have been proposed to extract video features and these can be divided into two groups - conventional image and video feature extraction algorithms, and feature learning algorithms.

Our understanding of the relationship between the video parameters and video content statistics is currently very limited. The two key challenges in this project are thus: the development of new and effective video feature extraction methods and quality assessment algorithms, and an understanding of the relationships between the video parameters and features. Through this enhanced understanding, we will be able to develop more efficient, content adaptive, video acquisition and delivery mechanisms.

Dave McEwan

Machine analysis for SoC behaviour



When designing an ASIC for use in a commercial project it is important to ensure that the architecture and Systems on a Chip (SoC) configuration is as optimal as possible in order to gain or maintain a competitive advantage.

This project will analyse the behaviour of components and measurable features within a (SoC) in order to answer two questions: "Why does this happen?" and "What will be the effects of some proposed changes?". Using this information, a system designer will be able to better target their work on improvements. A further aim of the project is to examine the practical implementation in hardware and software of such an analysis system, ideally running in real time.

UltraSoC's monitoring and profiling products are used with modern machine learning techniques, to discern behavioural features of interest on a number of systems and applications which are relevant to the field of communications. Candidate applications include a RISC-V CPU performing DSP algorithms, and an FPGA running a neural network for image processing.

Nigel Preece

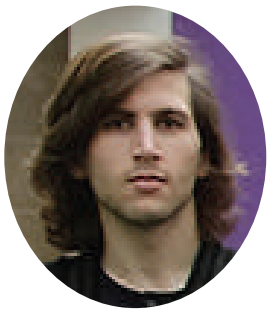
RF system design using standard CMOS technology for NB-IoT



Internet of Things (IoT) is the latest Machine-to-Machine implementation that will allow for a higher integration of sensor technology into everyone's day to day lives. With the introduction of the Narrow-band IoT standard, a new avenue for low powered and long ranged communication devices has been provided by using the existing LTE-A infrastructure. The next step in realising a more autonomous world is by pushing a design for manufacture approach to reduce the size and cost of the next generation of portable embedded systems with an extended battery life. The aim of this research is to design an all-in-one ASIC that will contain the digital logic for processing as well as the power amplifier and power supply circuitry, all to be implemented in CMOS silicon technology. The design will need to incorporate an adaptive approach to accommodate for variations of power supply levels, the signal power envelope and antenna impedances. By implementing the circuit in ASIC form, an unconventional approach can be used by using non-standard impedances on the transmission lines to improve overall power transfer between modules. The innovative approach in this research is to find a way of compensating for the non-linear behaviour that arises from OFDM and CMOS technology through DSP techniques and envelope tracking while keeping to a minimal computational cost and power budget.

Adam Sutton

Semantic analysis using word embeddings



Currently machines are unable to reliably understand human languages and the meaning of text. Natural Language Processing is the field focusing on this problem. Word embeddings are the generation of n-dimensional word vectors that represent the semantic and syntactic meaning of a corpus of text. Word vectors are created currently using machine learning algorithms such as linear regressions and neural networks. Word embeddings can be used for semantic and syntactic analysis, and other parts of natural language processing. This research will consider current algorithms in common use and measure their accuracy, and seek potential areas of improvement. It will also investigate current practical implementations of word embeddings to track the semantic meaning of words over time and their changes from decade to decade.

Constantinos Vrontos

Licence-exemption at mmWave/spectrum sharing between mobile operators



The ever-increasing user demand, along with the scarcity of available microwave spectrum and the considerable licensing cost involved in exclusive spectrum allocation, have resulted in 4G LTE systems being unable to keep up with the communication requirements of current and future commercial trends. The limitations of 4G LTE technology resulted in millimetre-wave (mmWave) frequencies being considered for the purposes of 5G technology. The unique properties of mmWave frequencies such as their propagation characteristics and directional beamforming-based operation have initiated development of new spectrum allocation strategies. Current research indicates that spectrum sharing could become an efficient and relatively low-cost access scheme that will enable multiple service providers to access the same band while catering for their individual needs and requirements. This project focuses on unprecedented spectrum allocation strategies for future generations of mobile communication systems operating in the range of 6 GHz to 300 GHz. Spectrum sharing strategies will be compared to network performance, complexity and inter/intra-operator fairness. 'License-Exemption at mmWave; Spectrum Sharing between Mobile Operators' will propose new and/or improved spectrum sharing strategies that will be investigated and assessed based on lab trials and practical demonstrations.

Michael Wilsher

One-dimensional soft random geometric graphs and their application to vehicular networks



Vehicular networks are becoming a very important field of research as the idea of self-driving cars becomes a reality. The ability for these vehicles to transmit critical safety information to other vehicles within the network is of paramount importance. This communication requires the network to be fully connected. One way of accurately modeling these networks is through the use of soft random geometric graphs (RGGs). A soft RGG is a more accurate mathematical model for the wireless medium than the previous hard RGG, and a rigorous study of the connectivity of these graphs is very new. It is created by generating a Poisson Point Process and connecting the points of this process with a probability associated with the distance between them. The connectivity of these networks can then be analyzed using tools in stochastic geometry and statistical mechanics. Connectivity of these networks in 2 and 3 dimensions has been found to be due to single isolated nodes, and these are found at the corners and edges of confined geometries. In the 1-dimensional case, a case yet to be investigated, the connectivity of the network is unlikely to be due to a single isolated node, but rather a split in the entire graph. Initially, a statistical analysis of the largest splits of these graphs will be undertaken using tools from spatial statistics. The statistical mechanics and stochastic geometry techniques used in the 2 and 3-dimensional cases will then also be applied to this model to discover more about the connectivity of these graphs. The results of this analysis will then be used to improve the quality of the current vehicular network modeling.

Justin Worsley

Automated clutter classification of LIDAR data for Radio Frequency propagation modelling



The variety and use of over-the-air communications continues to increase at an incredible pace and with it comes the requirement for reliable and accurate RF propagation information. However, capturing physical propagation measurements can be both expensive and time consuming. A convenient alternative is to utilise RF propagation modelling tools as an approximation of the real-world. For most site surveys this is deemed sufficient especially as the real-world continually changes. One of the key limitations of a propagation model is its representation of the environment. Models tend to rely upon human intervention to define the environment and this is not easily scalable. In conjunction with the increased demand for modelling, our knowledge of the environment has evolved with the advent of widely available high-resolution imagery and LIDAR datasets. This project introduces and evaluates a pipeline to automatically classify the environment's clutter e.g. buildings and trees. This will include alignment of the aforementioned datasets using common features to allow the seamless transitioning between the differing domains in order to maximise the available geographical features e.g. height from the LIDAR dataset and texture from aerial photography. The latter part of the pipeline will classify the clutter by employing a variety of different machine learning and/or deep learning techniques. If successful, the use of automated clutter classification would allow rapid deployment of environmentally accurate modelling tools.

Recent Graduates and their PhD topics

Imad Al Samman

The integration of Cloud Radio Access Network in 5G

Tom Barratt

Measurements and modelling of the small-scale effects at millimetre wave frequencies

Kibrom Gebremicael

Ultra-broadband power amplifier linearization

Paul Harris

A real world evaluation of massive MIMO: design implementation and deployment

Tom Kealy

Distributed wideband spectrum sensing

George Margelis

Security of the lower layers of the Internet of Things

Divya Mohan

Dynamic spectrum allocation algorithms in large wireless networks with application to machine to machine communication

Themis Omirou

Levitated interfaces - with sound: exploring the use of acoustic levitation for the creation of dynamic and physical visualizations

Odysseas Pappas

A superpixel framework for the detection of difficult targets

Tim Pelham

Analysis of conformal antenna array design using beamforming methods and on-platform aperture modelling

Jaya Thota

MIMO and raptor codes for cellular V2X



Alumni profiles

Leo Laughlin

After graduation Leo has taken a postdoctoral Research Fellow post at the University of Bristol where he is researching radio transceivers for 4G/5G mobile devices.

For further details of Leo's career in the CDT in Communications please see <http://www.bristol.ac.uk/cdt-communications/graduates/leo-laughlin/>



Brett Hosking

Brett is now working at the National Oceanography Centre (NOC) based in Southampton as a Computer Vision and Machine Learning researcher. He is developing techniques to aid Oceanographers identify underwater features and species captured by cameras fitted to autonomous underwater vehicles, including Boaty McBoatface.

For details of Brett's studies in the CDT in Communications please see <http://www.bristol.ac.uk/cdt-communications/graduates/brett-hosking/>



Alex Kartun-Giles

Alex held a postdoctoral research fellowship in random spatial networks at Hanyang University in Seoul, South Korea after graduating and is now working as a postdoctoral research associate in the Complex Systems Group at Queen Mary University of London. He is about to start a visiting position at The Max Plank Institute for Mathematics in the Sciences in Leipzig, working on topics in spatial networks.

To see Alex's full profile please see <http://www.bristol.ac.uk/cdt-communications/graduates/alexander-kartun-giles/>



Vaia Kalokidou

Since graduating Vaia has been working as a Senior Research Associate at the University of Bristol on UK and EU projects focusing on mm-Wave technology for access/backhaul/fronthaul of 5G networks, specialising on beamforming techniques and signal processing.

Vaia's career profile is available at <http://www.bristol.ac.uk/cdt-communications/graduates/vaia-kalokidou/>



Peter Bagot

After completing his studies Peter worked as a Research Associate at the University of Bristol. He is now working at Dyson.

Peter's full profile can be seen at <http://www.bristol.ac.uk/cdt-communications/graduates/peter-bagot/>



Paul Worgan

Following his PhD Paul is now a postdoctoral Research Associate at the Massachusetts Institute of Technology Computer Science and Artificial Intelligence Laboratory where he is continuing his research into providing energy to mobile computing devices and considering how to provide energy to shape changing mobile computers.

For further details of Paul's career in the CDT in Communications please see <http://www.bristol.ac.uk/cdt-communications/graduates/paul-worgan/>



Paul Harris

Paul is now working as a Massive MIMO Platform Architect / Senior Systems Engineer at Cohere Technologies, a wireless communications startup based in Santa Clara, California.

For further details of Paul's career in the CDT in Communications please see <http://www.bristol.ac.uk/cdt-communications/graduates/paul-harris/>



Tom Barratt

Tom works for Blu Wireless Technologies, experts in providing millimetre wave baseband solutions for advanced wireless access, who partially funded his PhD studies.

For further details of Tom's career in the CDT in Communications please see <http://www.bristol.ac.uk/cdt-communications/graduates/tom-barratt/>



Tim Pelham

Tim joined the CDT in 2012 after leaving MBDA where he was working as a Senior Systems Engineer. Following his PhD, he has held a position as a Senior Research Associate in the University of Bristol, focusing on research into 5G propagation, measurement and modelling.

For further details of Tim's career in the CDT in Communications please see <http://www.bristol.ac.uk/cdt-communications/graduates/tim-pelham/>



Divya Mohan

Divya is working in the software Research and Development department at Renishaw. She is looking into data visualisation, analysis and defect identification of the parts build from cutting edge Additive Manufacturing technology.



Our Supporters & Collaborators



Part of the
Chemring Group

The Team



Professor David Bull

Director



Professor Mark Beach

*Centre Manager &
Year 1 Tutor*



Dr Simon Armour

*Taught Programme Director
& Year 1 Tutor*



Dr Evangelos Mellios

Admissions Tutor



Professor Kevin Morris

Group Project Co-ordinator



Professor Oliver Johnson

Years 2-4 Tutor



Dr Ayvandi Ganesh

Admissions Co-ordinator

EPSRC Centre for Doctoral Training in Communications,
Merchant Venturers Building, Woodland Road, Bristol, BS8 1UB

Tel: +44 (0)117 954 5395

Email: cdt-communications@bristol.ac.uk

bristol.ac.uk/cdt-communications

 [@BristolCDTComms](https://twitter.com/BristolCDTComms)

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