UNIVERSITY OF CAMBRIDGE

Faculty of Computer Science & Technology

Annual Report of the Faculty 2014-15

Personnel

As at 31 October 2015 the Computer Laboratory consisted of 156 members of staff:

Academic staff	41
Academic-related & Assistant staff	29
Research Fellows	5
Post-doctoral Researchers	81

Two members of staff enjoyed personal promotions from October 2015: Dr Alan Blackwell to a Professorship in Interdisciplinary Design and Dr Andrew Moore to a Readership in Systems Research.

Two new academic members of staff were appointed to start in October 2015:

- Dr Timothy Jones, University Lecturer, EPSRC Research Fellow in the Computer Laboratory.
- Dr Rafal Mantiuk, University Senior Lecturer, previously Senior Lecturer at Bangor University.

Jean Bacon, Professor Emerita of Distributed Systems officially retired in December 2014.

A Selection of Honours, Awards and Competitions from 2014/15:

- **Ross Anderson** FRS FREng, Professor of Security Engineering, was named as the recipient of the 2015 BCS Lovelace Medal awarded by British Computer Society.
- **Ross Anderson**, Professor of Security Engineering, has been named the winner of the 2015 SIGSAC Outstanding Innovation award. The award is given for outstanding and innovative technical contributions to the field of computer and communication security that have had lasting impact in furthering or understanding the theory or development of secure systems.
- The Computer Laboratory has received the Athena SWAN bronze award, the charter that recognises commitment to tackling gender inequality in higher education.
- **Mark Batty** received the ACM SIGPLAN John C. Reynolds Doctoral Dissertation Award. His dissertation 'The C11 and C++11 Concurrency Model' makes significant contributions to the understanding of memory models for C and C++. Mark was a member of the Programming, Logic, and Semantics Group under the supervision of Peter Sewell. Mark was also awarded a RAEng research fellowship, which he has taken up at the University of Kent.
- **Luana Bulat** has been awarded a Google Anita Borg Scholarship. Luana is a member of the Natural Language and Information Processing Group, under the supervision of Stephen Clark.
- PhD student **Oliver Chick** received the Best Paper Award at APSys15. The paper, 'Shadow Kernels: A General Mechanism For Kernel Specialization in Existing Operating Systems', is joint work with Lucian Carata, James Snee, Nikilesh Balakrishnan and Ripduman Sohan.
- **John Daugman** OBE FREng, Professor of Computer Vision and Pattern Recognition, has been elected a Fellow of the Royal Academy of Engineering in recognition of his outstanding contribution to engineering.
- **Anuj Dawar**, Professor of Logic and Algorithms, was awarded a prestigious Hind Rattan Award for outstanding services, achievements and contributions in his field of research. The Hind

Rattan is one of the highest Indian diasporic awards granted annually to non-resident Indian citizens (NRIs) by the NRI Welfare Society of India, an organization under the umbrella of the Government of India.

- **Matthew P Grosvenor** received the Best Paper Award at NSDI'15. The paper, 'Queues Don't Matter When You Can JUMP Them!' is joint work with Malte Schwarzkopf, Ionel Gog, Robert Watson, Andrew Moore, Steven Hand, and Jon Crowcroft. Of particular note, this work sets a high bar for repeatability of experimental research with all results and graphs being made available online http://www.cl.cam.ac.uk/research/srg/netos/qjump/
- MPhil in Advanced Computer Science students' **Ran Guan** and **Bob Fang,** as part of team 'GameBob', won the Oxford Instruments Special Award at iCAN UK 2015. The entry received the most audience votes for its "CamTunes" device that embeds sensors into gloves, enabling the wearer to make sounds with different gestures, as if playing the flute.
- Cambridge Ring member **Dr Hermann Hauser** CBE, FRS, FREng was awarded an honorary knighthood in recognition of his services to engineering and industry. Dr Hauser co-founded Amadeus Capital Partners in 1997. In his long and successful history as an entrepreneur and venture capitalist, he has founded or co-founded companies in a wide range of technology sectors.
- PhD student **Heidi Howard** won the ACM Student Research Competition at SIGCOMM 2015 for 'Coracle: Evaluating consensus at the internet edge.' The paper is joint work with Professor Jon Crowcroft.
- **Marwa Mahmoud** was awarded the Best Student Paper award at the 2014 ACM International Conference on Multimodal Interaction (ICMI 2014). The paper on 'Autonomatic detection of naturalistic hand-over-face gesture descriptors' is joint work with **Tadas Baltrušaitis** and **Peter Robinson** of the Rainbow Graphics and Interaction Research Group.
- **Andrew Moore** received the ACM SIGMETRICS Test of Time Award 2015 for "Internet Traffic Classification Using Bayesian Analysis Techniques". The paper is joint work with former intern Denis Zuev. The ACM SIGMETRICS Test of Time Award recognizes an influential performance evaluation paper whose impact is still felt 10-12 years after its initial publication.
- **Frank Stajano** was elected to a Fellowship and College Lectureship at Trinity College.
- Computer Lab researchers **Liang Wang**, **Arjuna Sathiaseelan** and **Jon Crowcroft** have won the best paper award at ACM ICN 2015. The paper 'Pro-Diluvian: Understanding Scoped-Flooding for Content Discovery in Information-Centric Networking' is a joint work between the Networking for Development Lab (a research group within the Computer Laboratory exploring novel ways of delivering universal Internet access), University of Helsinki and Technische Universität München.

Activities

The **Supporters' Club** enjoyed another successful year: 54 companies attended the annual recruitment fair in November 2014; members acted as clients for the Part IB group design projects; sponsorship was secured for the student prizes; a full programme of tech talks was organised for students; and members offered a wide variety of internship and graduate opportunities.

The annual dinner of the **Cambridge Computer Lab Ring**, a professional networking group for Cambridge Graduates working in the computing industry, was held at Queens' College on 25 March 2015 and featured the 11th Hall of Fame Awards. The awards celebrate the success of over 240 companies founded by Computer Lab graduates and staff.

The 2015 winners were:
Company of the Year - SwiftKey
Product of the Year - Bromium for vSentry and LAVA
Publication of the Year - Daniel Wagner, Andrew Rice and Alastair Beresford for 'Device Analyzer: Understanding smartphone usage'.

The annual distinguished **Wheeler Lecture** was held on 26 May 2015 and given by Professor Butler Lampson, Technical Fellow at Microsoft, and Adjunct Professor at the Massachusetts Institute of Technology. His lecture was titled 'Hints and Principles for Computer System Design'.

The second annual **women@CL** Oxbridge Conference was successfully held at Oxford University in March 2015 with approximately 70 females attending in total.

Professor Jon Crowcroft and Professor Ross Anderson hosted a 'Policy-Making in the Big Data Era' conference in June 2015. The conference included contributions from researchers, policy makers, practitioners in industry and all other stakeholders to explore the latest developments and potentials in policy-making processes.

Community Engagement

The Computer Laboratory, in conjunction with Cambridge Coding Academy, held its inaugural summer school for girls in August 2015. The one-week summer school gave the young programmers with little or no prior coding experience the opportunity to design and develop an online game, build Instagram-like image filters and program drones to fly. The event was a great success and achieved its aim of sparking an interest in computer science.

The Computer Laboratory was represented at the Oxbridge Conferences in March 2015 by Rob Harle and Bogdan Roman. The Department participated in the University Open Days in July 2015, opening its doors to students, parents and teachers. 245 students attended, of which 35 were female.

The Computer Laboratory is engaged in a wide range of outreach activities with schools, colleges and communities. Our staff participate in public engagement activities to inspire, inform and foster debate. This year's activities included:

- **Andrew Rice** hosted the finals of the British Olympiad in Informatics in the Department on 28 March 2015
- Lab Research Associate **Sam Aaron** who can often be found in school classrooms teaching children to create music by writing code using Sonic Pi recently welcomed a slightly older pupil, BBC Radio 1 and BBC 1Xtra DJ MistJam. The pair used Sonic Pi to compose a piece, inspired by Bizet's 'Carmen'.
- **Jon Crowcroft** was the local host for Raspberry Pi's 3rd birthday party which was held in the Computer Laboratory at the end of February 2015.
- The Device Analyzer project work by **Daniel Wagner**, **Andrew Rice** and **Alastair Beresford** in the Digital Technology Group now appears in the new Information Age exhibition at the Science Museum providing data about mobile phone usage habits.

Research

The Computer Laboratory's **research programme** continues to produce world-leading work and research continues to be at the heart of the Laboratory's business. Research grant income in the last financial year was £6.9M.

The higher education funding councils released the results of the **REF (Research Evaluation Exercise)** 2014 exercise in late 2014. The Computer Laboratory's profile was 48% 4* (world-leading), 41% 3* (internationally excellent), 10% 2* (internationally recognised), 1% 1* (nationally recognised). This result was slightly stronger than the Laboratory's performance in the 2008

exercise. There was some controversy about how to interpret the REF 2014 data, with various metrics proposed, resulting in a position between fourth and sixth in the UK.

Whilst we are no longer at the top of the REF ranking, it is important to note that the outcome does not necessarily represent an accurate picture of the Computer Laboratory's worldwide impact. The Raspberry Pi was not eligible to be used for the REF, however, it is one of the Department's most magnificent outputs.

A positive outcome of the REF is that the University now recognises the need to support the Computer Laboratory's growth and is committed to support the expansion of our permanent staff base by five new members of staff over the next five years. This allocation of resources begins to level the playing field with respect to our worldwide competitors.

The **annual Academic Off-Site meeting** was held on Wednesday 1 July 2015 at Selwyn College where a 10 year strategic plan was considered.

Amongst the Computer Laboratory's portfolio of active **research grants**, we have a broad spectrum of topics. Highlights from the last year include:

- **Ross Anderson,** Professor of Security Engineering, published a report for the Nuffield Bioethics Council in February 2015 https://www.lightbluetouchpaper.org/2015/02/03/nuffield-bioethics-report/ on what happens to medical ethics in a world of cloud-based medical records and pervasive genomics.
- **Alan Blackwell** in conjunction with the Institute of Public Health (IPH) was awarded a 2 year grant from The Health Foundation for 'Health Foundation: Informatics in Health Care Improvement'.
- The EPSRC funded Cambridge Cloud Cybercrime Centre will be operational from 1 October 2015. The Centre directed by **Richard Clayton**, and together with **Ross Anderson** and **Alastair Beresford**, is a multi-disciplinary initiative combining expertise from the University of Cambridge's Computer Laboratory, Institute of Criminology and Faculty of Law.
- **Jon Crowcroft** and **Arjuna Sathiaseelan** were awarded a 3 year ECH2020 Industrial Leadership (IL) grant for 'Universal, mobile-centric and opportunistic communications architecture (UMobile)'. This is joint work with UCL, DUTH, Copelabs, Senception, Tecnalia, FON, AFA Systems, Tekever).
- **Anuj Dawar** was awarded a 1 year Royal Society grant for 'Infinite Games in Logic and Weihrauch Degrees'.
- The OCaml Labs initiative within the SRG and PLS (**Anil Madhavapeddy**, with **Jon Crowcroft, Ian Leslie and Alan Mycroft**) grew to over 30 people, and presented their work throughout the year at 20+ conferences throughout the world, notably at the annual OCaml Users and Developers Workshop in September 2015. The group also held regular compiler hacking events in Cambridge that were well-attended by Jane Street, ARM, Microsoft, Citrix and other local companies, and which expanded to include guest speakers such as Oleg Kiselyov.
- **Jeremy Yallop, Dominic Mulligan** and **Ohad Kammar** held the first S-REPLS event at Wolfson College. This was the beginning of a regular UK meeting allowing interaction and discussion of the semantics and implementation of programming languages, both academically and professionally. The group continued to develop secure networked infrastructure via the use of unikernels, with the open-source releases of Irmin, Jitsu, and SibylFS.
- The strong emphasis on technology transfer continued by spinning out Unikernel Systems in December 2014, a commercial company dedicated to developing and promoting unikernel technologies such as the MirageOS (initially developed in the Computer Laboratory).
- **Cecilia Mascolo** was awarded a 1 year EPSRC (via Research Strategy) grant for 'Smartphone Sensing for Health Applications'.
- **Andrew Moore** was awarded two EU Horizon 2020 Industrial Leadership grants. ENDEAVOUR: A flexible software-defined network ecosystem and, SSICLOPS: Scalable and Secure Infrastructures for Cloud Operations.

- In 2015 the NetFPGA project (www.netfpga.org) hosted at Cambridge released a new reference platform. This system was a staggeringly challenging project but has resulted in a research and education tool already in use by hundreds of Universities and with many thousands of prospective users receiving their boards over the next twelve months. The foundation directors of NetFPGA C.I.C. are **Andrew Moore** and **Robert Watson** with Nick McKeown (Stanford University).
- **Andrew Rice** (PI), **Alan Mycroft** (Co-I) and Dominic Orchard (Researcher Co-I) were awarded a 3 year EPSRC grant 'CamFort: Automated evolution and verification of computational science models'. They will be working with colleagues in computational science looking to apply ideas from programming language research to refactoring long-lived Fortran programs.
- **Peter Robinson** in conjunction with the CAPE Building was awarded a 3 year Jaguar Land Rover Ltd grant for 'VBRAD'.
- **Arjuna Sathiaseelan** was awarded a 3 year ECH2020 ERC/RIA/IA/CSA grant for joint work with Aalto University, TU Munchen, InterDigital, Avanti, Thales Alenia Space, Guifi.net Martel Consulting) for 'aRchitecture for an Internet for Everybody (RIFE).
- **Arjuna Sathiaseelan's** two EC H2020 grants led to the formation of the Networking for Development (N4D) Lab (http://www.cl.cam.ac.uk/~as2330/n4d/index.html). The N4D Lab conducts research on understanding the fundamental challenges of providing universal Internet access and explores technological solutions to solve some of the challenges.
- **Ekaterina Shutova** was awarded a 3 year Leverhulme and Isaac Newton Trust Fellowship for 'Computational Modelling of Metaphorical Reasoning and Human Creativity'
- **Frank Stajano** was awarded a 1.5 year EPSRC grant for 'Future Authentication Systems (IRIS)'.
- **Robert Watson** was awarded a 1 year Isaac Newton Trust grant for 'Automated Software Compartmentalization'.
- **Eiko Yoneki** was awarded a 3 year ECH2020 Societal Challenge in conjunction with the Department of Psychology for 'The Digital Whistleblower: Fiscal Transparency, Risk Assessment and Impact of Good Governance Policies Assessed'.
- A project to recreate EDSAC has reached a key milestone. The project is being led by **Andrew Herbert** who, early in his career, worked at the Computer Laboratory under EDSAC's designer Sir Maurice Wilkes. The work on the recreated EDSAC is due for completion in late 2015.
- **Sophie van der Zee** and **Ross Anderson** et al, published the paper 'To freeze or not to freeze: A motion-capture approach to detecting deceit' in January 2015
  https://www.lightbluetouchpaper.org/2015/01/04/to-freeze-or-not-to-freeze/
  It will be presented at the Conference: Proceedings of the 48th Hawaii International Conference on System Sciences (HICSS-48) in January 2016.

Teaching

Growth in undergraduate numbers has steadied this year and our first year intake has returned to 2013 levels of 90 students. We are pleased to note that the number of female students has risen from 13% in 2014 to 18% for 2015. The number of students obtaining a First or II.1 also rose to 83% in 2015.

2014 Part II results		*2015 Part II results*	
I	31%	I	31%
II.1	49%	II.1	52%
II.2	16%	II.2	10%
III	4%	III	7%

The MPhil in Advanced Computer Science ran smoothly again this year with 37 modules spanning the wide range of research interests found in the department. Application numbers remain strong, with 178 applying for entry in 2015-16. Unfortunately these numbers are not as strong as previous years, with 203 applications in 2013-14, and 236 in 2012-13. Many of our applicants find it difficult to find funding to pay for fees or maintenance. Therefore encouraging applications from high-quality students, as well as sourcing student funding, remain high priorities for the course.

For 2015-16 the research skills course has been restructured as a compulsory pass/fail component rather than as a taught module. This will allow research skills topics to be covered throughout the year, provides students with a little more time to focus on their research project, and allows us to formally record the course as a research degree with the University. The latter also opens up additional funding opportunities for our students.

Visitors

We have been pleased to host many academic and industrial visitors, including the following:

- Prof Stergios Anastasiadis, University of Ioannina
- Mr Brooks Davis (SRI International) - collaborator on the DARPA CHERI processor project
- Dr David Eyers, University of Otage, Dunedin, New Zealand
- Dr Nikolaos Laoutaris (Telefonica Research)
- Mr Ben Laurie (Google) - collaborator on the Capsicum and DARPA CHERI processor projects
- Mr Ed Maste (FreeBSD Foundation) - collaborator on the DARPA CHERI processor project
- Dr Peter G. Neumann (SRI International) - collaborator on the DARPA CHERI processor project
- Mr George Neville-Neil (Neville-Neil Consulting, FreeBSD Foundation) - collaborator in developing our L41 operating systems course, on our DARPA CADETS project
- Professor Toshiyuki Masui, Keio University, Japan
- Mr Andrew Turner (FreeBSD Foundation) - developer of the FreeBSD/armv8 port
- Dr Alejandro Valero from Universitat Politècnica de València (UPV)
- Prof Hakim Weatherspoon, Cornell University
- Professor Willy Zwaenepoel (EPFL)

AH/CS (November 2015)