

# Proposed Research Programme in IoT

*Paul Patras and Ewan Klein*

## Overview

We propose an Informatics research programme on the topic of the **Internet of Things (IoT)**. We believe this is timely because although IoT is not yet a well-defined research area, it has considerable potential for bringing together and increasing the value of work across multiple institutes within Informatics (including ICSA, CISA, LFCS, and ILCC), as well as providing bridges to researchers outside the School (e.g. ECA, PPLS). An IoT research programme would act as an anchor point for relatively disparate and uncoordinated activities that currently touch upon embedded systems, computer and sensor networks, security, and data science. Beyond a framework for fundamental research, there are easily identifiable opportunities for more applied and commercially-oriented R&D in the IoT area, and a research programme would enable us to make the most of our existing intellectual assets.

The programme would complement, and interact with, an early-stage University initiative in establishing a LoRaWAN network across the campus. This LPWAN (low-power, wide area network) is expected to cover a large part of the city and provides scope for collaboration with many different kinds of organisations, across all sectors (public, academic, third and commercial).

## Research Areas

IoT activities within the University can be broken down into five streams:

1. **Infrastructure** covers technology and the ability to access and participate in the creation and use of the infrastructure;
2. **Engagement** addresses the inclusion of a wide range of interested parties, and the learning and economic opportunities that will arise;
3. **Applications** concerns the projects and use cases to which the technology can be applied;
4. **Governance** deals with a framework for ensuring that decision-making reflects an equitable balance of interests for different stakeholders, and that concerns about privacy and security are addressed in a robust and transparent manner;
5. **Training** involves the delivery of specialised lectures and practical sessions (currently under development) to final year UG and PG students.

The **Infrastructure** theme is central to the proposed Informatics research programme, and includes:

- Communications Infrastructure: the deployment of low power networking protocols such as BLE, LTE-M, LoRa; and covering issues such as security, contention, power consumption, scalability;
- IoT Systems: development of device and micro-processor architectures; addressing programmability, energy efficiency, resilience;
- Sensors and Sensor Platforms: creation and deployment of fixed and mobile sensors, including wearables; essentially any thing and any person can become a sensor platform;
- Data collection, management and processing: developing the resources and tools to support data engineering, real-time data analysis and presentation/visualisation.

In terms of **Engagement**, companies including ARM and Pycom, have already expressed interest in collaborating with the School on IoT topics. ICSA continues the collaboration with ARM through the ARM Centre of Excellence and ARM have offered to support the newly proposed course on IoT. Pycom agreed to allow our researchers to reverse engineer the operation of their embedded boards, and investigate their security properties, to improve the design of their products.

**Applications** of IoT are rapidly developing, and include areas such as smart tourism, mobility, environmental monitoring (e.g., air quality, flooding), micro-weather forecasting, health telematics. There are interesting

possibilities for leveraging IoT research expertise in GCRF-oriented funding applications and industry/public sector collaborations through CENSIS.

## **Activities & Expected Outcomes**

We envisage an initial phase that is primarily exploratory. Although we know there is considerable interest in IoT technologies across the School, we would like to map the topics and individuals more comprehensively. Consequently, we intend to hold a couple of community-building / scoping workshops in the first 6 months. This will help inform the shape of subsequent activities.

We would also like to encourage small-scale IoT pilots which will help us develop expertise in a vertical space spanning networking, devices, data storage and access, up to applications and social factors.

We plan to set up a series of approximately bi-monthly seminars covering technical areas within IoT research. In parallel we already planned to host over the coming months guest seminars of external academics and half-day meetings with industry stakeholders. In particular, prof. Guevara Noubir of Northeastern University will be visiting the School as a SICSA DVF in March, thereby presenting his research on security and reproducibility, and continuing his collaboration with P. Patras on IoT privacy issues. Two of ARM's VPs will be visiting the School in January in view of investment here.

In the long term, we expect cross-institute funding bids will be prepared to support research on the systems, security, and data science aspects of IoT.

## **Interested Researchers**

- David Aspinall
- Bjoern Franke
- Ewan Klein
- Hugh Leather
- Mahesh Marina
- Michael O'Boyle
- Paul Patras
- Rik Sarkar
- Kami Vania
- Maria Wolters

## **Supporting Facilities**

IoT equipment worth ~£20,000 has been secured through GCHQ research grants and the IS and Corporate Services recently invested in LoRaWAN infrastructure, acquiring >100 devices.

An inclusive IoT mailing list ([iot@mlist.is.ed.ac.uk](mailto:iot@mlist.is.ed.ac.uk)) has been set up and we are building a web (<http://iot.ed.ac.uk/>) and social media (@UoE\_IoT) presence.