School of Informatics Teaching Course Proposal Form

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Proposal

Course Name: The Internet of Things (re-submitted)
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Course Year: 4
Names of any courses that this new course replaces :
Embedded Systems

Course Outline

Course Level: 11
Course Points: 20
Subject area: Informatics
Programme Collections:
Computer Science, Software Engineering.

Teaching / Assessment

Number of Lectures: 20
Number of Tutorials or Lab Sessions: 11
Identified Pre-requisite Courses: Operating Systems
Identified Co-requisite Courses: Computer Communications and Networks
Identified Prohibited Combinations: NA

Assessment Weightings:
Written Examination: 30%
Assessed Coursework: 55%
Oral Presentations: 15%

Description of Nature of Assessment:

The course will involve a major coursework that will require students to work in pairs to design, build, and evaluate a practical IoT system. Students will be required to demonstrate their prototypes and present orally their projects at the end of the course, and document their designs and results in a workshop style research paper. By requiring students to work in pairs, the course would minimise the hardware resources required, while allowing examiners to distinguish between individual students contributions.

The course workload is aligned with the school recently agreed workload profile of 200 hours for a 20 credit course. Specifically the hours will be allocated as follows: - 10weeks x 2h lectures - 11weeks x 4h lab sessions - 12weeks x 6h individual work - 1 day oral presentation preparation - 4 days exam preparation - 1/2 day sitting exam and oral presentation - 20 hours programme level activities (ILW, office hours, PT meetings)

One piece of formative assessment will consist of students submitting a short proposal document, outlining the planned IoT prototype. The second piece of assessment is summative and requires marking the workshop style papers that document the projects.

Teaching support involves demonstrator(s) according to student numbers, one marker at 1 hour per student, 40h TA for course preparation.

Course Details

Brief Course Description:

IoT is a rapidly evolving field underpinned by the large scale development of a plethora of networked cyber-physical systems equipped with multi-modal sensing capabilities and heterogeneous communication technology. Interconnecting such large number of devices and intelligently processing the data they generate, requires understanding of embedded systems, networking protocols, algorithms, security, programming, data analytics and visualisation.

Students taking The Internet of Things course will be introduced to the fundamentals of the IoT paradigm, including hardware platforms, communication protocols, and the types of services that can be enabled over this ecosystem. The attendees will build solid grounding in key IoT technologies and different methodologies for addressing domain specific challenges. The course will also have an important practical component, allowing students to design example IoT systems and develop simple software applications running on top of these.

ARM will provide mbed IoT prototyping boards for student training purposes, which would add value to the students profiles in view of employment in technology and data-oriented companies, as well as for eventual doctoral studies.

This course will complement the Computer Systems, Networking, and Data Science research efforts in the University, and will be relevant to students in the PPar and Data Science CDTs. It will also complement our offering in several other areas, including operating systems, security, and robotics.

The course does not aim to replace the SLIP module. Instead it is mean for delivery across a larger cohort and higher years (e.g. UG4/5 and MSc) together with an important taught component (unlike the purely practical SLIP for UG3). Topics such as Security and Privacy and Cloud Integration will also be covered by the new course.

Concerns raised at the previous BoS meeting about a possible clash with SLIP are clarified below:

"1. System Level Integration Practical (SLIP) covers the material being proposed for the course "Internet of Things". The course in its present form has been taught since 2004 using the platforms and software environment developed as part of the EPSRC-funded "Speckled Computing" project. The current platform (Prospeckz-5) is ARM-based and is its fifth generation."

Response: While SLIP offers a valuable practical exercise with embedded systems, the course does not have a structured taught component, as one student who took the course mentioned in his feedback ("This course has almost zero teaching element, you are expected to teach yourself the necessary skills for whatever you choose to do"). Instead, the IoT course proposed herein will have 20h of dedicated lectures during which theoretical and technological concepts will be taught and on which students will be formally assessed through written examination. In terms of practical experience, Prospecks appears to be purpose built and boasts limited computational capabilities. In contrast, the mBed boards are substantially more versatile, offer enhanced programmability, and support a broad range of applications. ARM is keen to provide detailed practical exercise handbooks to be used in the lab sessions. In addition, we are also exploring the possibility of using inexpensive Pycom boards, which work with a simple micro-Python programming environment and multiple wireless technologies.

"2. Speckled Computing presaged the so-called "Internet of Things" by almost a decade and SLIP has pioneered the teaching and training of students in this field. It is 100% coursework-based and covers hardware/firmware, communication protocols, sensor data analytics, low-power embedded system (hardware/software) design and App design. Students work in groups of 4-5, and are chosen with interests/skill sets to cover the ones listed previously. Students are taught the principles of IoT design in weekly sessions in a laboratory setting which they practise by taking their ideas from concepts t to a prototype demonstration to an invited audience over a space of 11 weeks."

Response: The Internet of Things course will target a more experienced and larger audience, while students will not be chosen based on particular skills. It has a formal taught component which is assessed and removes the need to build a web site for dissemination purposes. We believe aspects related to web technologies are already covered by other courses (including SLIP and SELP), while elements of IoT security and cloud integration lack in other courses the School offers.

"3. The "Interaction Design" aspect of IoT has been taught in the Human Computer Interaction (HCI)

course since 2013-14 in the form of 6-8 case studies of real designs (with working versions demonstrated in the class or in the form of videos) and reinforced by a coursework on the design of an "IoT product" [See attachment entitled HCIAssignment2015-16.pdf]."

Response: The Internet of Things course does not have a dedicated HCI element.

"4. The overall format of the course has remained remarkably unchanged since 2004, although refinements have been made based on student feedback. Students over the years have been very complimentary about this course and I have included the student feedback for the academic year 2015-16 (SLIPug.pdf). I will be bringing a proposal to the next BoS for SLIP to be to assigned 20 credits to reflect the amount of work undertaken by the students."

Response: Since the format of SLIP remains largely unchanged and the newly proposed course bridges the gap between theory and practice while covering a set of increasingly pressing technological aspects (such as security and privacy), the overlap between the two should be minimum. It is commendable that students continue to be complimentary of SLIP, while we note again the differences between the two courses, including the fact that we do not expect students "setting up and maintaining a server" for successfully completing the practical exercise. We welcome a proposal for a new version of SLIP, while we leave with with the BoS the decision regarding the number of credits this should carry.

"5. In summary, Informatics was prescient in formulating SLIP a dozen years ago to teach aspects of Internet of Things based on our research , and which now has considerable commercial relevance for students wishing to be trained in this area. The proposed course has considerable overlap with SLIP and would be duplicating scarce resources."

Response: We believe the above points address the concerns about potential duplication of resources and are open to meet with other stakeholders who have an interest in IoT to ensure overlap is minimised.

Finally, we include a list of statements by staff supporting this course proposal:

"I think this looks like a great course that integrates lots of different skills and knowledge." --Sharon Goldwater

"Great idea!" --Mike O'Boyle

"I am very enthusiastic about the class. I think it will be very interesting." --Rik Sarkar

"Delighted to see this proposal and esp the clear inclusion of S&P" --David Aspinall

"I am looking at [...] an IoT MOOC, and for this we will need lots of content and may be of interest to you both" --Simon Chapple

"This looks great!" --Dave Murray-Rust

"I am fully supportive of this course." --Nigel Topham

Detailed list of Learning Objectives:

1: Acquire good understanding of the Internet of Things concept and systems architecture;
2: Operate with wireless technologies and networking protocols specific to IoT systems;
3: Become familiar with standard security and privacy preserving mechanisms;
4: Design, implement, and test a simple IoT system equipped with sensors and wireless transceivers;
5: Understand different cloud integration methods;
6: Present clearly and concisely the design and performance of an IoT system;
7: Write technical documentation of a research project and results obtained by means of experiments in a workshop style paper format.

Syllabus Information:

A tentative list of topics is given below (these are not in 1-1 correspondence to lectures):

1. Introduction to IoT, industry drivers, applications domain;
2. IoT architecture;
3. Hardware platforms, low power devices, sensors;
4. Wireless technologies (Wi-Fi, Bluetooth, BLE, Zigbee, Z-Wave);
5. Networking protocols (M2M, LoRa, IPv6, 6LowPAN);
6. Security and privacy;
7. IoT device programming and debugging;
8. Cloud integration;

9. Data analytics and visualisation;
10. Commercialisation challenges.

Recommended Reading List:

TBD

Any additional case for support information:

The proposed course is intended to replace the current Embedded Systems module and will be delivered together with Bjoern Franke (the current organiser of Embedded Systems).

The course will (1) cover conceptual/theoretical aspects of IoT in lectures and (2) allow students to develop practical skills in hands-on exercises framed as 4-hour lab sessions during which students they will experiment with mbed IoT boards provided by ARM.