Board of Studies

Course Proposal Template

PROPOSED COURSE TITLE: Internet of Things Systems, Security, and the Cloud (IoTSSC)

PROPOSER(S): Paul Patras and Bjoern Franke

DATE: 28/02/2017

SUMMARY

This template contains the following sections, which should be prepared roughly in the order in which they appear (to avoid spending too much time on preparation of proposals that are unlikely to be approved):

1. Case for Support
– To be supplied by the proposer and shown to the BoS Academic Secretary prior to preparation of an in-depth course description

1a. Overall contribution to teaching portfolio

1b. Target audience and expected demand

1c. Relation to existing curriculum

1d. Resources

2. Course descriptor
- This is the official course documentation that will be published if the course is approved, ITO and the BoS Academic Secretary can assist in its preparation

3. Course materials
- These should be prepared once the Board meeting at which the proposal will be discussed has been specified

3a. Sample exam question

3b. Sample coursework specification

3c. Sample tutorial/lab sheet question

3d. Any other relevant materials

4. Course management

- This information can be compiled in parallel to the elicitation of comments for section 5.

4a. Course information and publicity

4b. Feedback

4c. Management of teaching delivery

5. Comments

- To be collected by the proposer in good time before the actual BoS meeting and included as received

5a. Year Organiser Comments

5b. Degree Programme Co-Ordinators

5c. BoS Academic Secretary

[Guidance in square brackets below each item. Please also refer to the guidance for new course proposals at http://www.inf.ed.ac.uk/student-services/committees/board-of-studies/course-proposal-guidelines. Examples of previous course proposal submissions are available on the past meetings page http://web.inf.ed.ac.uk/infweb/admin/committees/bos/meetings-directory.]

SECTION 1 – CASE FOR SUPPORT

[This section should summarise why the new course is needed, how it fits with the existing course portfolio, the curricula of our Degree Programmes, and delivery of teaching for the different years it would affect.]

1a. Overall contribution to teaching portfolio

[Explain what motivates the course proposal, e.g. an emergent or maturing research area, a previous course having become outdated or inappropriate in other ways, novel research activity or newly acquired expertise in the School, offerings of our competitors.]

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 numbers 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.

The proposed course is intended to replace the current Embedded Systems module.

1b. Target audience and expected demand

[Describe the type of student the course would appeal to in terms of background, level of ability, and interests, and the expected class size for the course based on anticipated demand. A good justification would include some evidence, e.g. by referring to projects in an area, class sizes in similar courses, employer demand for the skills taught in the course, etc.]

The course targets UG4/MSc/MInf students who have previously taken Operating Systems (OS) and Computer and Communications Network (CCN) courses, have reasonable computer programming skills, and an interest in systems, security, and networking.

Judging by the number of students currently taking the OS and CCN courses, we expect a class size of ~60 students.

ARM will provide mbed IoT development platforms and technical documentation for student training purposes (through labs), 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.

1c. Relation to existing curriculum

[This section should describe how the proposed course relates to existing courses, programmes, years of study, and specialisms. Every new course should make an important contribution to the delivery of our Degree Programmes, which are described at http://www.drps.ed.ac.uk/15-16/dpt/drps_inf.htm.

Please name the Programmes the course will contribute to, and justify its contribution in relation to courses already available within those programmes. For courses available to MSc students, describe which specialism(s) the course should be listed under (see http://web.inf.ed.ac.uk/infweb/student-services/ito/students/taught-msc-2015/programme-guide/specialist-areas), and what its significance for the specialism would be. Comment on the fit of the proposed course with the structure of academic years for which it should be offered. This is described in the Year Guides linked from http://web.inf.ed.ac.uk/infweb/student-services/ito/students.]

The course will contribute to the Computer Science and Software Engineering programmes. It complements 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.

IoTSSC will also complement the current Principles and Design of IoT Systems course proposal, as it intends to address in depth theoretical and technical facets of IoT spanning systems, wireless networking protocols, security, and integration with the cloud, which are then applied to implement

1d. Resources

[While course approvals do not anticipate the School's decision that a course will actually be taught in any given year, it is important to describe what resources would be required if it were run. Please describe how much lecturing, tutoring, exam preparation and marking effort will be required in steady state, and any additional resources that will be required to set the course up for the first time. Please make sure that you provide estimates relative to class size if there are natural limits to its scalability (e.g. due to equipment or space requirements). Describe the profile of the course team, including lecturer, tutors, markers, and their required background. Where possible, identify a set of specific lecturers who have confirmed that they would either like to teach this course apart from the proposer, or who could teach the course in principle. It is useful to include ideas and suggestions for potential teaching duty re-allocation (e.g. through course sharing, discontinuation of an existing course, voluntary teaching over and above normal teaching duties) to be taken into account when resourcing decisions are made.]

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)

Teaching support involves demonstrator(s) according to student numbers (approx 60), one marker at 1 hour per student, 40h TA for course preparation. The proposers will share the teaching and a

SECTION 2 – COURSE DESCRIPTOR

[This is the official course descriptor that will be published by the University and serves as the authoritative source of information about the course for student via DRPS and PATH. Current course descriptions in the EUCLID Course Catalogue are available at www.euclid.ed.ac.uk under 'DPTs and Courses', searching for courses beginning 'INFR'*]*

2a. Course Title *[Name of the course.]*:

Internet of Things Systems, Security, and the Cloud

2b. SCQF Credit Points:

[The Scottish Credit and Qualifications Framework specifies where each training component provided by educational institutions fits into the national education system. Credit points per course are normally 10 or 20, and a student normally enrols for 60 credits per semester. For those familiar with the ECTS system, one ECTS credit is equivalent to 2 SCQF credits. See also http://www.scqf.org.uk/The%20Framework/Credit%20Points.]

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[These levels correspond to different levels of skills and outcomes, see http://www.sqa.org.uk/files_ccc/SCQF-LevelDescriptors.pdf At University level, Year 1/2 courses are normally level 8, Year 3 can be level 9 or 10, Year 4 10 or 11, and Year 5/MSc have to be level 11. MSc programmes may permit a small number (up to 30 credits overall) of level 9 or 10 courses.]

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Normal Year Taken: 1/2/3/4/5/MSc

[While a course may be available for more than one year, this should specify when it is normally taken by a student. "5" here indicates the fifth year of undergraduate Masters programmes such as MInf.]

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Also available in years: 1/2/3/4/5/MSc

Different options are possible depending on the choice of SCQF Credit Level above: for level 9, you should specify if the course is for 3rd year undergraduates only, or also open to MSc students (default); for level 10, you should specify if the course is available to 3rd year and 4th year undergraduates (default), 4th year undergraduates only, and whether it should be open to MSc students; for level 11, a course can be available to 4th and 5th year undergraduates and MSc students (default), to 5th year undergraduates and MSc students, or to MSc students only]

5/MSc

2c. Subject Area and Specialism Classification:

[Any combination of Computer Science, Artificial Intelligence, Software Engineering and/or Cognitive Science as appropriate. For courses available to MSc students, please also specify the relevant MSc specialist area (to be found in the online MSc Year Guide at http://web.inf.ed.ac.uk/infweb/student-services/ito/students/taught-msc-2015/programme-guide/specialist-areas), distinguishing between whether the course should be considered as "core" or "optional" for the respective specialist area.]

Computer Systems, Software Engineering & High-Performance Computing;

Cyber Security & Privacy

Appropriate/Important for the Following Degree Programmes:

[Please check against programmes from http://www.drps.ed.ac.uk/15-16/dpt/drps_inf.htm to determine any specific programmes for which the course would be relevant (in many cases, information about the Subject Area classification above will be sufficient and specific programmes do not have to be specified). Some courses may be specifically designed for non-Informatics students or with students with a specific profile as a potential audience, please describe this here if appropriate.]

Computer Science; Software Engineering; Computer Science and Electronics;

Artificial Intelligence and Computer Science

Timetabling Information:

[Provide details on the semester the course should be offered in, specifying any timetabling constraints to be considered (e.g. overlap of popular combinations, other specialism courses, external courses etc).]

Semester 2 course;

2-hour lectures weekly (except ILW), 10 weeks;

4-hour weekly lab sessions, 11 weeks.

2d. Summary Course Description:

[Provide a brief official description of the course, around 100 words. This should be worded in a student-friendly way, it is the part of the descriptor a student is most likely to read.]

IoTSSC will teach students fundamentals concepts of IoT systems, wireless communication paradigms employed in IoT, security and privacy issues, and cloud integration. 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

Course Description:

[Provide an academic description, an outline of the content covered by the course and a description of the learning experience students can expect to get. See guidance notes at: http://www.studentsystems.is.ed.ac.uk/staff/Support/User_Guides/CCAM/CCAM_Information_Captured.html

The course will cover IoT systems architecture, hardware platforms, relevant wireless technologies and networking protocols, security and privacy concepts, device programming and debugging, cloud integration, simple data analytics, and commercialisation challenges. The students should expect to be able to apply the taught concepts in the development of an IoT prototype.

Pre-Requisite Courses:

[Specify any courses that a student must have taken to be permitted to take this course. Pre-requisites listed in this section can only be waived by special permission from the School's Curriculum Approval Officer, so they should be treated as "must-have". By default, you may assume that any student who will register for the course has taken those courses compulsory for the degree for which the course is listed in previous years. Please include the FULL course name and course code].

Operating Systems, Computer and Communications Networks

Co-Requisite Courses:

[Specify any courses that should be taken in parallel with the existing course. Note that this leads to a timetabling constraint that should be mentioned elsewhere in the proposal. Please include the FULL course name and course code].

[Specify any courses that should not be taken in combination with the proposed course. Please include the FULL course name and course code].

Other Requirements:

[Please list any further background students should have, including, for example, mathematical skills, programming ability, experimentation/lab experience, etc. It is important to consider that unless there are formal prerequisites for participation in a course, other Schools can register their students onto our courses, so it is important to be clear in this section. If you want to only permit this by special permission, a statement like "Successful completion of Year X of an Informatics Single or Combined Honours Degree, or equivalent by permission of the School." can be included.]

Good programming experience.

Available to Visiting Students: Yes/No

[Provide a justification if the answer is No.]

No

2e. Summary of Intended Learning Outcomes (MAXIMUM OF 5):

[List the learning outcomes of the course, emphasising what the impact of the course will be on an individual who successfully completes it, rather than the activity that will lead to this outcome. Further guidance is available from https://canvas.instructure.com/courses/801386/files/24062695]

On completion of this course, the student will be able to

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, and understand different cloud integration methods;

4. Design, implement, and test a simple IoT system equipped with sensors and wireless transceivers;

5. Write technical documentation of a research project and results obtained by means of experiments in a workshop style paper format.

Assessment Information

[Provide a description of all types of assessment that will be used in the course (e.g. written exam, oral presentation, essay, programming practical, etc) and how each of them will assess the intended learning outcomes listed above. Where coursework involves group work, it is important to remember that every student has to be assessed individually for their contribution to any jointly produced piece of work. Please include any minimum requirements for assessment components e.g. student must pass all individual pieces of assessment as well as course overall].

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.

Students to work in pairs, the course would minimise the hardware resources required, while allowing examiners to distinguish between individual student contributions.

The concepts learned will be evaluated through written exam at the end of the semester.

Assessment Weightings:

Written Examination: _30__%

Practical Examination: _15__%

Coursework: _55__%

Time spend on assignments:

[Weightings up to a 70/30 split between exam and coursework are considered standard, any higher coursework percentage requires a specific justification. The general expectation is that a 10-point course will have an 80/20 split and include the equivalent of one 20-hour coursework assignment (although this can be split into several smaller pieces of coursework. The Practical Examination category should be used for courses with programming exams. You should not expect that during term time a student will have more than 2-4 hours to spend on a single assignment for a course per week. Please note that it is possible, and in many cases desirable, to include formative assignments which are not formally assessed but submitted for feedback, often in combination with peer assessment.]

Students are expected to spend 12weeks x 6h on individual work which will be evaluated through the written report documenting the practical work carried out and oral presentation. The concepts thought in class will be assessed through a written exam.

Academic description:

[A more technical summary of the course aims and contents. May include terminology and technical content that might be more relevant to colleagues and administrators than to students.]

Syllabus:

[Provide a more detailed description of the contents of the course, e.g. a list of bullet points roughly corresponding to the topics covered in each individual lecture/tutorial/coursework. The description should not exceed 500 words but should be detailed enough to allow a student to have a good idea of what material will be covered in the course. Please keep in mind that this needs to be flexible enough to allow for minor changes from year to year without requiring new course approval each time.]

Lecture 1. Introduction to IoT, industry drivers, applications domain;

Lecture 2. IoT architecture;

Lecture 3. Hardware platforms, low power devices, sensors;

Lecture 4. Wireless technologies (Wi-Fi, Bluetooth, BLE, Zigbee, Z-Wave);

Lecture 5. Networking protocols (M2M, LoRa, IPv6, 6LowPAN);

Lecture 6. Security and privacy;

Lecture 7. IoT device programming and debugging;

Lecture 8. Cloud integration;

Lecture 9. Data analytics and visualisation;

Lecture 10. Commercialisation challenges.

Relevant QAA Computing Curriculum Sections:

[Please see http://www.qaa.ac.uk/en/Publications/Documents/SBS-Computing-consultation-15.pdf to check which section the course fits into.]

Graduate Attributes, Personal and Professional skills:

[This field should be used to describe the contribution made to the development of a student's personal and professional attributes and skills as a result of studying this course – i.e. the generic and transferable skills beyond the subject of study itself. Reference in particular should be made to SCQF learning characteristics at the correct level http://www.sqa.org.uk/files_ccc/SCQF-LevelDescriptors.pdf].

Reading List:

*[Provide a list of relevant readings. See also remarks under **3d**.]*

1. McKinsey Global Institute report “Unlocking the potential of the Internet of Things”.
2. Nitesh Dhanjani “Abusing the Internet of Things: Blackouts, Freakouts, and Stakeouts”
3. Adrian McEwan and Hakim Cassimally “Designing the Internet of Things”

Breakdown of Learning and Teaching Activities:

[Total number of lecture hours and tutorial hours, with hours for coursework assignments.]

[The breakdown of learning and teaching activities should only include contact hours with the students; everything else should be accounted for in the Directed Learning and Independent Learning hours.

The total being 10 x course credits. Assume 10 weeks of lectures slots and 10 weeks of tutorials, though not all of these need to be filled with actual contact hours. As a guideline, if a 10-pt course has 20 lecture slots in principle, around 15 of these should be filled with examinable material; the rest should be used for guest lectures, revision sessions, introductions to assignments, etc. Additional categories of learning and teaching activities are available, a full list can be found at:

http://www.euclid.ed.ac.uk/Staff/Support/User_Guides/CCAM/Teaching_Learning.htm]

Lecture Hours: _20___ hours

Seminar/Tutorial Hours: __0__ hours

Supervise practical/Workshop/Studio hours: __44__ hours

Summative assessment hours: _60__ hours

Feedback/Feedforward hours: __34__ hours

Directed Learning and Independent Learning hours: __72__ hours

Total hours: _230___ hours

You may also find the guidance on ‘Total Contact Teaching Hours’ and ‘Examination & Assessment Information’ at:
http://www.studentsystems.ed.ac.uk/Staff/Support/User_Guides/CCAM/CCAM_Information_Captured.html

Keywords:

[A list of searchable keywords.]

IoT; Security; Systems; Cloud;

SECTION 3 - COURSE MATERIALS

3a. Sample exam question(s)

[Sample exam questions with model answers to the individual questions are required for new courses. A justification of the exam format should be provided where the suggested format non-standard. The online list of past exam papers gives an idea of what exam formats are most commonly used and which alternative formats have been http://www.inf.ed.ac.uk/teaching/exam_papers/.]

Question A

1. A COAP transaction between a client and a server is operated through CONFIRMATION messages. Assuming that the packet error rate (on requests and responses) is p=0.01 (that is, 1% of probability to mistake a request message, 1% of probability to mistake a response message), find average total time to successfully retrieve a resource (assume infinite retrials are allowed).

2. Briefly describe the utility of MQTT retain functionality

3. A ZigBee network is characterized by the following parameters: Lm=3 (three layers), Rm= 2 (number of zigbee routers), Dm = 2 (number of end devices). Tell how many addresses are needed to to support all the devices in the network and plot a consistent address assignment scheme.

Solution

1. The transaction success probability is P=(1-p)2 ; the total number of attempts to the first success is 1/P = 1.02. The total required time is approx. 2[s]

2. Along the following lines: A retained message is a normal MQTT message with the retained flag set to true. The broker will store the last retained message and the corresponding QoS for that topic. Each client that subscribes to a topic pattern, which matches the topic of the retained message, will receive the message immediately after subscribing. For each topic only one retained message will be stored by the broker. A retained message makes sense, when newly connected subscribers should receive messages immediately and shouldn't have to wait until a publishing client sends the next message.

3. The routers at level 2 need 1+Rm + Dm = 5

The routers at level 1 need 1+Dm + Rm (1+Rm + Dm) = 13

The router at level 0 (PANC) needs 1+Dm + Rm [1+Dm + Rm (1+Rm + Dm)] = 29

3b. Sample coursework specification

[Provide a description of a possible assignment with an estimate of effort against each sub-task and a description of marking criteria.]

Prepare a written report explaining your findings from implementing the IoT prototype, key design choices, and the insights gained into the performance of the system. These should be accompanied by plots you produced where appropriate.

3c. Sample tutorial/lab sheet questions

[Provide a list of tutorial questions and answers and/or samples of lab sheets.]

3d. Any other relevant materials

[Include anything else that is relevant, possibly in the form of links. If you do not want to specify a set of concrete readings for the official course descriptor, please list examples here.]

SECTION 4 - COURSE MANAGEMENT

4a. Course information and publicity

[Describe what information will be provided at the start of the academic year in which format, how and where the course will be advertised, what materials will be made available online and when they will be finalised. Please note that University and School policies require that all course information is available at the start of the academic year including all teaching materials and lecture slides.]

A reading list and practical lab manual will be provided at the start of the academic year in PDF format.

The course will be advertised through DPRS and a dedicated course web page will be set up.

4b. Feedback

[Provide details on feedback arrangements for the course. This includes when and how course feedback is solicited from the class and responded to, what feedback will be provided on assessment (coursework and exams) within what timeframe, and what opportunities students will be given to respond to feedback.

The University is committed to a baseline of principles regarding feedback that we have to implement at every level, these are described at http://www.docs.sasg.ed.ac.uk/AcademicServices/Policies/Feedback_Standards_Guiding_Principles.pdf.

Further guidance is available from http://www.enhancingfeedback.ed.ac.uk/staff.html.]

4c. Management of teaching delivery

[Provide details on responsibilities of each course staff member, how the lecturer will recruit, train, and supervise other course staff, what forms of communication with the class will be used, how required equipment will be procured and maintained. Include information about what support will be required for this from other parties, e.g. colleagues or the Informatics Teaching Organisation.]

SECTION 5 - COMMENTS

[This section summarises comments received from relevant individuals prior to proposing the course. If you have not discussed this proposal with others please note this].

"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

5a. Year Organiser Comments

[Year Organisers are responsible for maintaining the official Year Guides for every year of study, which, among other things, provide guidance on available course choices and specialist areas. The Year Organisers of all years for which the course will be offered should be consulted on the appropriateness and relevance on the course. Issues to consider here include balance of course offerings across semesters, subject areas, and credit levels, timetabling implications, fit into the administrative structures used in delivering that year.]

5b. BoS Academic Secretary

[Any proposal has to be checked by the Secretary of the Board of Studies prior to discussion at the actual Board meeting. This is a placeholder for their comments, mainly on the formal quality of the content provided above.]