Universitat Autònoma de Barcelona

2022/2023

Internet of Things

Code: 105075
ECTS Credits: 6

Degree	Type	Year	Semester
2502441 Computer Engineering	OT	4	1

Contact

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Use of Languages

Principal working language: english (eng)

Some groups entirely in English: No

Some groups entirely in Catalan: Yes

Some groups entirely in Spanish: No

Other comments on languages

The language of instruction will be English if there are ERASMUS students, ortherwise Catalan. Teaching materials are in English.

Teachers

Marc Codina Barbera

Prerequisites

The course is self-contained and therefore there are no specific pre-requisites.

Objectives and Contextualisation

Description:

The ICT world is being structured on various concepts. One of them is the Internet of Things, which is based on expanding the computing domain to connected objects (devices) of small size and energy consumption that interact with the real world via sensors and actuators in different areas: personal / wearables, health, home automation, environment, energy and water distribution, automotive, etc. These connect through various protocols to a fixed or mobile intermediate platform (edge) that manages, filters and processes part of the data locally. In turn, it is connected to the cloud where the data is stored, processed and displayed. The implementation of these systems requires integrating the various concepts, acquired in previous courses, in this new device-edge-cloud paradigm associated with different types of computing platforms (single-, multi-, many-core processors) with different requirements of functionality, power, latency, bandwidth and cost; different programming and communication models; and different cloud options for back-end and front-end, so a higher level of abstraction is required at the interface level (APIs and Middleware) and virtualization (computing and communications).

Goals:

Establish the fundamentals of the internet of things (IOT): device, periphery (edge) and cloud (cloud)
Learn to classify embedded processors, sensors, actuators, and systems, and select communications protocols and cloud options
Evaluate the functional requirements and the performance in terms of cost, real time comnditio and energy efficiency
Evaluate the cost of data structures based on sensors, computing, communication, storage and visualization at each level.
Select embedded and mobile platforms for the edge and cloud solutions for back-end and front-end
Manage the virtualization of computing and communications
Design a theoretical and practical example case of the entire IoT chain for a specific application

Competences

- Capacity to design, develop, evaluate and ensure the accessibility, ergonomics, usability and security of computer systems, services and applications, as well as of the information that they manage.
- Communication.
- Have the capacity to define, evaluate and select hardware and software platforms for the development and execution of computer systems, services and applications.
- Have the right personal attitude.
- Know the basic materials and technologies to enable the learning and development of new methods and technologies, as well as those that that provide large-scale versatility to adapt to new situations.

Learning Outcomes

1. Communicate efficiently, orally or in writing, knowledge, results and skills, both in the professional environment and before non-expert audiences.
2. Compare and evaluate the possible platforms that can fulfil the requirements of applications.
3. Design and develop computer systems that fulfil the specifications of the system and the application, and in particular in reference to embedded and real time systems.
4. Generate proposals that are innovative and competitive.
5. Identify the security needs that embedded systems have to fulfil.
6. Manage information by critically incorporating the innovations of one's professional field, and analysing future trends.
7. Recognise and identify the methods, systems and technologies of computer engineering.
8. Select the most suitable platform for a specific application and design and develop the solution based on the corresponding microprocessor.
9. Use English as the language of communication and professional relations .

Content

Lectures

1. Global View of the Internet of Things

- IoT Systems: Functionality & Architecture. Device, edge,cloud
- Examples and Use Cases
- HW Components: processors, sensors, actuators, batteries
- Performance: cost, real-time (latency, throughput), and energy efficiency
- Sensor data and its computation
- Standards and Intellectual property

2. Introduction to Wired & Wireless Communications

- Communications standardization
- Wired Protocols for device, edge & cloud

- Wireless Networks for device to edge: WBAN, WPAN, WLAN, LPWAN
- Wireless Networks for edge to cloud: WLAN, WAN, LPWAN, 5G
- Communications data frames

3. Embedded and mobile platforms

- Embedded platforms: open & industrial
- Platform examples
- Mobile platforms

4. Virtualization

- Cloud back-end & front-end
- Virtual platforms for embedded systems
- Virtual platforms for cloud systems: IaaS, PaaS, SaaS
- Communications Virtualization

Guided project: Design of an (original) IoT system
P1. Original ideas for the design of an IoT system and preliminary market study
P2. Functional and performance specifications of the project
P3. Block and communications architecture of the IoT system and implementation alternatives
P4. System implementation. Selection of components and platforms
P5. Estimation of planning, costs and business model
P6. Document, presentation and defense of the project

Labs: Prototyping the (original) IoT system
L1. Introduction to programming on a MCU-BLE
L2. Sensor + MCU + Bluetooth dataflow emulation
L3. Android APP Programming I: Bluetooth Low energy Data Acquisition.
L4. Android Programming II: Computation and JSON application to a server.
L5. Cloud application: back-end & front-end

Methodology

The learning methodology will combine: master classes, activities in tutored sessions, project based-learning and use cases, debates and other collaborative activities; and laboratory sessions.

Attendance will be mandatory for all face-to-face activities (with the permission of the pandemics).

The design of the IoT project and laboratory sessions will be done in groups of 2 or 3 people.

The laboratory sessions will use a supervised format (not guided) to offer greater autonomy to students and a more personalized support.

This course will use UAB's virtual campus at https://cv.uab.cat.

Annotation: Within the schedule set by the centre or degree programme, 15 minutes of one class will be reserved for students to evaluate their lecturers and their courses or modules through questionnaires.

Activities

Title	Hours	ECTS	Learning Outcomes
Type: Directed			
Lessons and Seminars	30	1.2	2, 1, 3, 5, 7, 8, 9

Type: Supervised			
Laboratories & Design Project	28	1.12	1, 3, 7, 9
Type: Autonomous			
Study & Homework	90	3.6	2, 1, 3, 4, 6, 7, 8, 9

Assessment

The evaluation of the course will follow the rules of the continuous evaluation and the final grade for the course, is calculated in the following way:
A - 20% from the mark obtained by the student through the evaluation of activities (i.e. exercises). When an evaluation activity is scheduled, the evaluation indicators will be reported and its weight in this qualification.
B - 40% from the mark obtained through the evaluation of the IoT design project.
C - 40% from the mark obtained by the student of the laboratory work and reports. It is necessary to exceed 5 (out of 10) in this item to pass the subject.

To obtain MH it will be necessary that the students have an overall qualification higher than 9 with the limitations of the UAB (1MH/20students). As a reference criterion, they will be assigned in descending order.

A final weighted average mark not lower than 50% is sufficient to pass the course, provided that a score over one third of the range is attained in every one of the Marks for first 2 items (A and B). If not reached, the mark will be 4.0.

Plagiarism will not be tolerated. All students involved in a plagiarism activity will be failed automatically. A final mark no higher than 30% will be assigned.

An student not having achieved a sufficient final weighted average mark, may opt to apply for remedial activities (individual work or additional synthesis examination) the subject under the following conditions:
- the student must have participated in the laboratory activities and design project, and
- the student must have a final weighted average higher than 30%, and
- the student must not have failed any activity due to plagiarism.

The student will receive a grade of "Not Evaluable" if:
- the student has not been able to be evaluated in the laboratory activities due to notattendance or not deliver the corresponding reports without justified cause.
- the student has not carried outa minimum of 50% of the activities proposed.
- the student has not done the design project.

Repeating students will be able to "save" their grade in laboratory activity.

Assessment Activities

Title	Weighting	Hours	ECTS	Learning Outcomes
Evaluation of activities developed in tutored sessions (laboratories)	40%	0	0	1, 3, 7
Individual activities (i.e. exercices)	20%	0	0	2, 1, 3, 5, 7, 8, 9
Report and defence of the design project	40%	2	0.08	2, 1, 3, 4, 6, 5, 7, 8, 9

Bibliography

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H. Geng (Ed.), Internet of the Things and Data Analytics Handbook, Wiley 2017.

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Software

Students will use the SoC-BLE from Nordic Semiconductors as a device; the Android smartphone as Edge; and an server cloud option (selected by the students) with front-end i back-end.

Improvementets are expected in this whole chain (that will keep the same structure).