Full Stack Software Engineering for IoT

Responsible: Jean-Yves TIGLI

2 ECTS – First Period Semester 9

Language:
English 🇬🇧

In collaboration with

- Stéphane Lavirotte, Polytech'Nice Sophia
- Nicolas Ferry, I3S Inria Sophia Antipolis
- Yves Roudier, Polytech'Nice Sophia
- Gérald Rocher, I3S CNRS
- Fabien Ferrero, LEAT CNRS

Objectives:

An IoT Full Stack developer combines his knowledge of software development (Front End - Back End architecture) with his expertise on the Internet of Things. This involves in a first step to manage, interconnection, networking and communication between sensors, actuators, connected objects and edge computers thanks to standard protocols, without forgetting cross-cutting concerns such as security. In a second step, software for IoT must deal with technical and semantic interoperability thanks to service-oriented approaches and web standard for IoT. The objective of this course is to give an overview the IoT technological stack and required technical skills at for designing and developing software for Cyber-Physical Systems.

Requirements:

- ✓ Software Development background
- ✓ Basic knowledge of network programming

Course Description and Program

To provide students with a complete expertise, the course is built around three values:

- knowledge
- skills
- Know-how

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The sessions are 4 hours long and include:
- one hour of lectures on the main concepts (Knowledge)
- three hours of tutorial with professional devices and tools. (know-how)

A project of writing a high-quality short article teaches students to use automated search tools in dedicated databases and to manage a technical and scientific bibliography to guide the study of a research topic and/or a new IoT technology concept. A project team consists in two students.

Two supervised sessions are dedicated to the project, including an introduction to best practices and tools for bibliography search and management, as well as systematic mapping study (SMS) and Systematic Literature Review (SLR) methods.

- Lecture 1: Jean-Yves Tigli
      Introduction and definition of the IoT domain (Jean-Yves Tigli, I3S)
      Tutorial on Systematic Mapping Study, main bibliography databases and Zotero
- Lecture 2: Fabien Ferrero
      Low Power Wide Area Network for IoT
      Tutorial on LoRaWAN standard
- Lecture 3: Gérald Rocher
      Communication for IoT and message queuing protocols
      Tutorial on MQTT standard (Message Queuing Telemetry Transport)
- Lecture 4: Nicolas Ferry
      Service-oriented approaches for IoT
      Tutorial on WoT (Web of Things) standard and CoAP (Constrained Application Protocol)
- Lecture 5: Jean-Yves Tigli
      Review of the bibliography and outline of the students' papers at mi-term
      Bibliography review and outline of students' papers at mi-term
- Lecture 6: Stéphane Lavirotte
      Research and Discovery protocols for IoT
      Tutorial on SSDP standard (Simple Service Discovery Protocol)
- Lecture 7: Yves Roudier
      Understanding IoT Security
- Lecture 8: Gérald Rocher
      Introduction on Semantic Web of Things (SWoT)
      Tutorial on SWoT with Protege and SPARQL

Hourly volume: 32 h with lecturers and 16h (1h per week) unsupervised work (32h for the project in pairs)
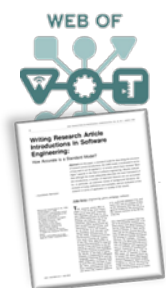
Evaluation methods: QCMs on the tutorials, evaluations of the deliverable article.

References:

(a) Mattern, Friedemann; Floerkemeier, Christian "From the Internet of Computer to the Internet of Things" *(PDF)*. Informatik-Spektrum. **33** (2): 107–121, Retrieved 3 February 2014*.*

(b) Samuel Greengard, The "Internet of Things", MIT Press, 2015, 230 p. ISBN-10 : 9780262527736

(c) Qinghao Tang, Fan Du, "Internet of Things Security: Principles and Practice", Springer, 2021

(d) Arthur M. Langer, "Analysis and Design of Next-Generation Software Architectures: 5G, IoT, Blockchain, and Quantum Computing" , Springer, 2021

Tools:

- Zotero (https://www.zotero.org/), free and open-source reference management software to manage bibliographic data and related research materials.
- Bibliographic databases: IEEE Xplore, ACM Digital Library, Springer, Elsevier, Scopus, HAL …
- Node-Red programming platform (https://nodered.org/) with MQTT broker
- Various librairies for CoAP, SSDP, WoT.
- Ontology editor Protege (http://protege.stanford.edu/), web-based graphical visualization tool named WebVOWL (http://vowl.visualdataweb.org/webvowl.html),