

University of Padova,
Dept. of Information Engineering

2016 Summer School of Information Engineering,

Technologies for Internet of Things



Casa della Gioventù'
via Rio Bianco
39042 Bressanone (BZ), Italy
July 3 – 9, 2016

the co-Directors

prof. Gaudenzio Meneghesso, gauss@dei.unipd.it

prof. Silvano Pupolin, pupolin@dei.unipd.it

University of Padova, Dept. of Information Engineering
2016 Summer School of Information Engineering,
Bressanone (Brixen, BZ), Italy - July 3 – 9, 2016

Technologies for Internet of Things

Sunday 3/7 (Grüner Baum Hotel)

17:00 – 19:00 SSIE Opening, Welcome, Introduction to the school and Program description (Gaudenzio Meneghesso, Silvano Pupolin, Co-Directors).

Monday 4/7 (Casa della Gioventù)

9:00 – 13:00 **Nicola Laurenti, Lorenzo Vangelista** *Department of Information Engineering, University Padova* “Security aspects and technologies in the IoT”
15:00 – 17:00 PhD students Presentations

Tuesday 5/7: (Casa della Gioventù)

9:00 – 13:00 **Pawel Malinowski**, *IMEC, Belgium*; “Large Area Electronics – Or Magical Plastic Foils”
15:00 – 17:00 PhD students Presentations

Wednesday 6/7: (Casa della Gioventù)

9:00 – 13:00 **Dominique Morche**, *Laboratoire d'électronique des technologies de l'information CEA LETI, France*, “Low power and ultra narrow band communication system (SigFox network)”
14:30 – 16:30 **Paolo Dini**, *Centre Tecnològic de Telecomunicacions de Catalunya (CTTC), Spain*, “Sustainable Mobile Networks: the SCAVENGE vision”
17:00-18:00 Working Group Activity

Thursday 7/7: (Casa della Gioventù)

9:00 – 11:00 **Stefan Dulman**, *Centrum Wiskunde & Informatica (CWI), the Nederland* “Data science meets embedded systems”
11:00 – 13:00 **Nicola Bui**, *IMDEA Networks Institute, Spain*, “Self-Sufficient Sensor Networks: from Energy Profiling to Optimal Sustainable Performance”
14:30 – 16:30 Working Group Activity
19:30 – 22:00 **Social Dinner**

Friday 8/7: (Casa della Gioventù)

9:00 – 11:00 **Djamel Djenouri** *Centre De Recherche Sur L'information Scientifique Et Technique (CERIST), Algiers*, “Time Synchronization in Wireless Sensor Networks: Concepts and Research Trends”
11:00 – 13:00 **Michele Rossi**, *Department of Information Engineering – University of Padua*, “Data mining in the IoT era: practical examples and a peek into future developments”
14:30 – 16:30 Workshop
16:30 – 17:00 SSIE Closing, (Gaudenzio Meneghesso, Silvano Pupolin, Co-Directors)

Saturday 9/7: (Grüner Baum Hotel)

9:00 – 11:00 **SSIE 2013 Final test (for those who need the 2 ECTS)**
Alternative: to write a report on a topic assigned by the Directors to be returned by the end of July.

ABSTRACTS

Nicola Laurenti, Lorenzo Vangelista, Department of Information Engineering, University Padova

“Security aspects and technologies in the IoT”

Abstract: Authentication of messages in an Internet of things (IoT) is a key security feature that may involve heavy signaling and protocol procedures, not suitable for small devices with very limited computational capabilities and energy availability. In this talk we address the problem of message authentication in an IoT context, by using physical layer approaches. We propose a solution based on the use of trusted anchor nodes that estimate the channel from the transmitting node and report them to a concentrator node which takes a decision on the message authenticity. Assuming that the anchor nodes have a limited energy availability, we analyze the lifespan of the authenticating network and propose both centralized and distributed approaches to determine which anchor nodes report the information to the concentrator. The authenticating network overhead is also discussed and a trade-off between energy efficiency and signaling traffic is found.

Paweł Malinowski; IMEC, Belgium

“Large Area Electronics – Or Magical Plastic Foils”

Abstract: We are already used to being surrounded by all kinds of electronic devices. Even though chip size keeps on scaling down, the standard circuit shapes and rigid packages do not allow full proliferation. New form factors are enabled by what hides under a very general term of “large area electronics”. This field covers a wide range of devices based on thin-film materials that can be processed at low cost and at low temperatures, making it possible to perform the fabrication route on large area, plastic substrates. Novel active semiconductor materials are a key enabler, with a variety of organics, oxides, perovskites and quantum dots to choose the right physical properties. In terms of applications, displays are leading the way to commercialization, with circuits, solar cells and image sensors ramping up in products and more new concepts being demonstrated in first proofs-of-principle. Functionalized plastic foils or “smart surfaces” are no longer in the science fiction domain, but are becoming off-the-shelf components, making it possible to add functionality to even more everyday objects. In this lecture, participants will get an overview of thin-film and large-area semiconductor technologies. We will cover many fields – chemistry and materials (what is used), semiconductor physics (how the device works), fabrication technology (how it is done) and metrology (what are the specs). From the application point of view, we will get to know some prototypes made at imec/Holst Centre (rollable display, x-ray imager, microprocessor on foil, flexible solar cell, etc.) and take a look at the market potential. In the end, we will see that our future electronic devices will be not only classic boards and chips, but will be described with words such as flexible, rollable, conformable, disposable, transparent, large-area and pervasive.

Dominique Morche, Laboratoire d'électronique des technologies de l'information CEA LETI, France,

“Low power and ultra narrow band communication system (SigFox network)”

Abstract: In the IoT node, a huge percentage of the energy consumption is still dissipated in the radio communication part and especially in the radio front-end. During the last ten years, the technology evolution has favored the reduction of the power consumption by a factor of ten. However, this evolution seems to saturate and the power consumption is not yet compatible with energy scavenging. New solutions are thus needed today and are presented in this talk:

- An interesting approach to circumvent this limitation is to develop adaptive radio. The motivation for this approach will be first justified and the basic principle will be presented. Then the associated challenges will be described and it will show how the different field of electronic, communication and control theory engineering should be merged to obtain a new power efficient communication system.
- In some applications, most of the power consumed by the communication is in the scanning of the channel while waiting for a communication. An alternative to reduce this wasted energy is to develop a specific radio for the scanning activity which is called a wake-up radio. The compromises in such techniques will be first explained and then the state of the art of research and industrial activity in this area will be presented and analyzed.
- Lastly, the market of the IoT is so large that new dedicated network are deployed today. Some of these network use the ultra-narrow band approach. The basic principle of this communication techniques will be first explained and the interest will be demonstrated.

Paolo Dini, Centre Tecnològic de Telecomunicacions de Catalunya (CTTC), Spain,

“Sustainable Mobile Networks: the scavenge vision”

Abstract: The fifth generation 5G of mobile technology will support 1,000 times more capacity per unit area than 4G, for more than 100 billion devices with typical user rates of 10 Gb/s, and significantly lower latency and higher reliability. The higher capacity demanding human-centric communications will be complemented by an enormous increase in the number of communicating machines, the so called Internet of Things (IoT). 5G will enable the co-existence of multiple types of access technologies, multiple types of devices and applications, and a much higher connectivity density through an ultra-dense network of heterogeneous base stations (BSs). However, this enormous growth in the number of devices and access points will also lead to an equally large

growth in the carbon footprint of the information and communication technologies (ICTs). The world's ICT ecosystem already consumes about 1500 TWh of electric energy annually, approaching 10% of the world electricity generation. Furthermore, connecting this dense network of BSs to the energy grid, and regularly recharging drained end device batteries is physically impractical, if not impossible.

Sustainable design of mobile networks is therefore a key and challenging sector for societal prosperity. In this talk, the SCAVENGE (Sustainable Cellular Network Harvesting Ambient Energy) European Training Network vision is introduced.

The foundation of the project is based on the premise that environmental energy can be scavenged through dedicated harvesting hardware, so as to power the mobile system elements like base stations, mobile terminals, sensors and machines. The resulting paradigm-shift of the system design is presented, together with some study cases examined within the framework of the project.

Stefan Dulman, *Centrum Wiskunde & Informatica (CWI), the Nederland*
“Data science meets embedded systems”

Abstract: Data science and embedded sensing systems are two different disciplines, linked only by the sheer amount of data produced by the later. On the other hand, one of the main design goals of networked embedded systems engineers is simply stated as: "let the network be the tool". In other words, networks should output processed information instead of raw data.

In this lecture we will address the topic of bringing the two concepts closer. We will be asking if basic operations common to data science can be readily made available by existing networking algorithms applicable to technologies such as the Internet-of-Things.

Nicola Bui, *IMDEA Networks Institute, Spain*,

“Self-Sufficient Sensor Networks: from Energy Profiling to Optimal Sustainable Performance”

Abstract: Self-sustainability for energy scavenging networks is a crucial step in modern sensor network developments. During this talk, we analyze a comprehensive framework for self-sufficient sensor networks powered by renewable energy sources. This amounts to study two nested optimization steps: the inner one focuses on characterizing the optimal operating point of the network subject to a given energy consumption figure, while the outer step provides optimal energy management policies to make the system self-sufficient, given the statistical description of the energy source. We will discuss how the framework permits to gauge the impact of key sensor network parameters, such as the battery size, the harvester size (e.g., solar panel), the information transmission rate and the nodes' duty cycle. In addition, the closed form solution of the inner optimization problem lends itself to the implementation, as an online algorithm, on computationally constrained embedded devices. The final part of the talk focus on results describing the consequences of the relevant design choices in terms of network behavior, maximum achievable throughput and dynamics associated with the optimal energy management policies.

Djamel Djenouri *Centre De Recherche Sur L'information Scientifique Et Technique (CERIST), Algiers*,

“Time Synchronization in Wireless Sensor Networks: Concepts and Research Trends”

Abstract: In this seminar, the challenging and fundamental problem of time synchronization in wireless sensor networks (WSN) will be addressed. General concepts will be presented, followed by a detailed state-of-art on the related literature. Some canonical synchronization protocols will be explained in more details, along with comprehensive taxonomies of existing protocols. Both empirical and theoretical issues and challenges will be considered, and lessons we learned throughout our relevant works will be shared.

Michele Rossi, *Department of Information Engineering – University of Padua*,

“Data mining in the IoT era: practical examples and a peek into future developments”

Abstract: After a decade of studies, theoretical and applied research, wireless sensor networks are entering our lives in a very real way, in the form of the so called Internet of Things. Examples are the increasing number of sensors in cars, home appliances, intrusion detection / smart parking systems and wearable devices. Initial challenges were related to the design of transmission and networking technologies, so that the information could be sensed, transmitted and eventually gathered for further distribution and processing. Nowadays, most of these communication challenges are solved but additional problems are to be addressed, especially in the domain of data mining and its use within networking protocols and applications. In this talk, we review some recent research developments and discuss the importance of discovering patterns and relationships in the sensed data. As a first example, we discuss data gathering in distributed sensor fields, where the aim is to measure spatio-temporal signals with sufficient accuracy, while saving as much energy as possible. We then move on to wearable technology, where signal processing is key to understanding user activities and concoct human-centered / assisted living applications. We finally introduce a possible way forward for the design of next-generation IoT systems, where protocol elements are adapted following a cognition-based approach, taking inspiration from how living beings deal with complexity and scalability. This approach develops around the application of machine learning techniques, unsupervised learning and probabilistic generative models to cope with data representation, model learning and decision making.

General info

All info can be found at: <http://www.dei.unipd.it/ssie>

Venue: Casa della Gioventù, via Rio Bianco, 39042 Bressanone, Italia

Participation at the SSIE:

All those young researchers and PhD students who wish to participate at the SSIE must send an e-mail to: gauss@dei.unipd.it

How to Submit a Proposal

All those young researchers and PhD students who wish to present their research activities at the Workshop, should send an email to gauss@dei.unipd.it

clearly indicating:

- Name
- Affiliation/Postal Address
- Phone/Fax
- Contact Email
- Title of the Presentation
- Abstract (e-mail format is also OK)

Please use English language. **The deadline for submitting proposals is June 30th 2016.**

Presenting your Research Activity at SSIE

Each presenter will be assigned a slot of 20 minutes, including 5 minutes for questions. All presentations will be in English.

Registration & Fee

The organizing committee decided that the School has no registration fee for PhD students, but participants will have to pay for their travel and living expenses.

For organization purposes all the participants are invited to Register by sending an e-mail either to gauss@dei.unipd.it

with subject: Registration to Summer School on Information Engineering 2016

clearly indicating:

- Name
- Affiliation/Postal Address
- Phone/Fax
- Contact Email

Accommodation:

As for the past years we have an agreement with **Grüner Baum Hotels** (www.gruenerbaum.it) in Bressanone which will give lodging for all the persons attending the Summer School of Information Engineering (students, teachers and accompanying persons) at discount prices (**July 3th 2016 - July 9th 2016 only**) (see SSIE website for details: <http://www.dei.unipd.it/ssie>)

Net prices	
single room	67.00 Euro per person per day (breakfast included)
double room	52.00 Euro per person per day (breakfast included)
double room (single use)	88.00 Euro per person per day (breakfast included)
half pension supplement	17.00 Euro per person per day
meal	9,00 Euro for a first course
Discount prices if staying for 3 or more nights	
single room	56.00 Euro per person per day (breakfast included)
double room	45.00 Euro per person per day (breakfast included)
double room (single use)	72.00 Euro per person per day (breakfast included)

Taxes: Euro 1,60 per person/night.

Included in the prices:

- Breakfast Grande buffet
- Entrance to swimming pool
- The BRIXENCARD