**2015**

# COMMUNICATIONS SYSTEMS INTEGRATION AND MODELING TECHNICAL COMMITTEE (CSIM-TC)

# *NEWSLETTER*

**Christos Verikoukis (Chair)**
**Dzmitry Kliazovich (Vice-chair)**
**Burak Kantarci (Secretary)**

**TABLE OF CONTENTS**

<u>**Page**</u>

## Table of Contents

**ABOUT CSIM**

The Communications Systems Integration and Modeling technical committee focus its activities on simulation, analytical tools and measurement of communications links and networks. CSIM has been sponsoring activities on traffic modeling, performance and integration of next generation wireless and wireline networks.

CSIM sponsors its traditional bi-annual workshop CAMAD, as well as special issues in the IEEE Communications Magazine and in the IEEE Journal on Selected Areas in Communications. CSIM is very active in ICC and in GLOBECOM and was one of the co-founders of MILCOM. CSIM has its roots on the Communications Systems Engineering Technical committee and its past chairs are:

2015-now – Christos Verikoukis

2013-2015 – Stefano Giordano

2011-2013 – Harry Skianis

2009-2011 – Fabrizio Granelli

2007-2009 – Pascal Lorenz

2005-2007 – Nelson L.S. da Fonseca

2002-2005 – Mike Devetsikiotis

2000-2002 – Mohammad Ilyas

1999-2000 – Hussein Mouftah

1996-1999 – Guy Omydar

1994-1996 – Bill Tranter

**For more information : http://sites.ieee.org/tc-csim/**

## 1. SUMMER SCHOOLS BY CSIM MEMBERS

### 1.1. Emerging Architectures & Key Technologies for 5G Networks, by Charalabos Skianis (19-28 Aug. 2015, Karlovassi, Samos, Greece)

The new era of communication systems and computer networking is moving towards 5G. 5G emerging technologies aim at the seamless connectivity of all types of devices, networks and communication protocols fulfilling the goals that have been set by the regulatory authorities and standardization bodies. The Computer & Communication Systems Laboratory (CCSL), a research and educational unit in the Department of Information & Communication Engineering of the University of the Aegean organized during the period of 18- 29 August 2015, the 1st International Summer School on Emerging Architectures & Key Technologies of 5G Networks (AegeanNetCom) in Karlovasi, Samos. The AegeanNetCom 2015 Summer School was supported by the Action of Summer Schools of the University of the Aegean.



International attendees of summerschool in Samos, Aug. 2015

The AegeanNetCom Summer School is an international education program that lasted for two weeks and it is the first summer school that is being organized around the area of 5G Communications in Greece. The

AegeanNetCom Summer School, aiming to fulfill the need to answer questions regarding 5G has, provided a series of lectures, workshops and round tables taught by more than 13 world renowned experts. The thematic areas which were covered during the summer school were:

Small Cells and HetNets • Energy and Network Optimization • Cooperative Technologies • MIMO Systems and TeraHertz Communications • Cloud and Pervasive Computing • Energy Efficient and Green Networks • Cognitive Radio Systems • Spectrum Management and Bandwidth Brokerage • Network Technologies and Management • Network Virtualization and Software-Defined Networks

More than 35 lectures were carried out in English (1 and a half hour duration each), including exercises and demos of current research topics of 5G. After the completion of the summer school, all the student participants submitted a report (about 5000 to 7000 words) on a specific subject, 6 weeks after the end of the Summer School. This procedure gave 2 additional ECTS credits, reaching a total of 4 ECTS credits. During the period of two weeks, more than 30 participants, among them, young and senior undergraduate and graduate students (already enrolled in a BSc/MSc/PhD program) from Greek Universities as well as professionals in the fields of electrical engineering, electronic engineering, communication and networking engineering and related disciplines, attended the latest developments and were informed on relevant technical and moral issues, as well as other critical research issues related to 5G technology. Participants from all around the world, got acquainted with the state-ofthe-art technologies in Communication systems and Networking. They worked in teams in order to develop a detailed image regarding simulation procedures based on networking design, while getting familiarized with aspects and terms of Networking, from research to market implementation. Most importantly, they had an unforgettable sunny learning experience in a beautiful Greek island.

The 1st International AegeanNetCom Summer School in now completed and is gearing up for the 2nd International AegeanNetCom Summer School. AegeanNetCom 2015 Summer School is available on the website:

https://aegeannetcom2015.pns.aegean.gr/ Soon, will be available in the summer school's official website all information regarding the 2nd International AegeanNetCom Summer School, AegeanNetCom 2016.

Quoted from Prof. Demosthenes Vouyioukas Scientific Coordinator of the Summer School, AegeanNetCom 2015, Newsletter

## 1.2. The first IEEE ComSoc Summer School (6-9 July. 2015, Trento, Italy; by Frabrizio Granelli)

The first IEEE ComSoc Summer School provided participants with top-level lectures on hot topics in communications as well as a myriad of networking opportunities.

Selected from more than 100 applicants during the Spring of 2015, the Summer School hosted 43 participants from worldwide locations at the University of Trento, one of the youngest Italian universities (funded in the 1960s) and in conjunction with the Dept. of Information Engineering and Computer Science, the 2nd highest ranked ICT department in Italy.

Participants attended short courses by top researchers in the field of communications, including Andrea Goldsmith, Lajos Hanzo, Nelson Fonseca and Giuseppe Bianchi.
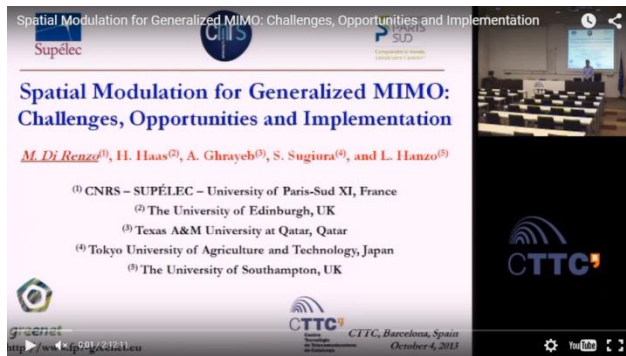
During the course of the four-day event, the IEEE ComSoc Summer School included specific sessions enabling participants to understand the actual problems and technology in the field of communications. To this aim, practical sessions were held on Tuesday and Wednesday and included visits to the datacenter of the University of Trento and to the local network provider, Trentino Network and its Network Operation Center.

## 2. TUTORIALS DELIVERED BY CSIM MEMBERS

Marco Di Renzo has given tutorials on energy efficiency and ultra dense networks (stochastic geometry). Each tutorial had between 20-30 attendees.

"With the increasing growth of mobile access to the Internet and its services, 5G wireless networks represent a key communication infrastructure for ubiquitous

*Marco is delivering a talk on spatial modulation for generalized MIMO in CTTC*

connectivity of the future. The need to support exponential growth in data traffic as



well as availability of several mobile devices (smartphones, tablets, etc.) is leading to a sharp increase in the number and density of base station devices as well as in their complexity, leading to a consequent increase in power usage and consumption. Indeed, high power consumption could represent a limiting factor for the scalability and deployment of 5G wireless networks and one of the possible causes of the well-known operators' cost-revenue gap. The tutorials are aimed at providing an energy efficient perspective on the design of 5G networks, by introducing the 5G scenario and providing an overview of power consumption in cellular networks, aimed at identifying the major sources of power consumption and to understand the basic tradeoffs in energy efficient design of 5G networks. Based on the 5G scenario of heterogeneous coexisting wireless technologies, the tutorials target the most relevant future and emerging technology supporting energy efficiency, and in particular: physical layer design, energy-neutral wireless network design, 5G networks planning, 5G networks operation and cognitive radios and networks in 5G." says Marco about the following tutorials on energy efficiency.

*IEEE CCNC 2015:* Energy Efficiency in Wireless Networks Designing Next Generation Energy Efficient Wireless Networks (jointly given with Fabrizio Granelli and Christos Verikoukis)

*IEEE GLOBECOM 2015:* Designing Next Generation Energy Efficient Wireless Networks (jointly given with Fabrizio Granelli and Christos Verikoukis)

*IEEE CCNC 2016:* Energy Efficient Design of 5G Networks Designing Next Generation Energy Efficient Wireless Networks (jointly given with Fabrizio Granelli and Christos Verikoukis)



Besides, Marco has conducted tutorials on ultra-dense networks (i.e., stochastic

*Marco is delivering a talk on system level analysis and design of cellular networks with stochastic geometry in ICC'15, London, UK*

geometry) which is another exciting field of his area of research.

"The fifth-generation (5G) is coming. Quo vadis 5G? What architectures, network topologies and technologies will define 5G? Are the methodologies to the analysis, design and optimization of current cellular networks still applicable to 5G? This tutorial is aimed to discuss the critical and essential importance of spatial models for an accurate system-level analysis and optimization of emerging 5G ultra-dense and heterogeneous cellular networks, which are expected to rely on a much denser deployment of access points, to a scale that has never been observed in the past. Due to the increased heterogeneity and deployment density, in particular, new flexible and scalable approaches for modeling, simulating, analyzing and optimizing cellular networks are needed. Recently, a new approach has been proposed: it is based on the theory of point processes and it leverages tools from stochastic geometry for tractable system-level modeling, performance evaluation and optimization. We investigate the accuracy of this emerging abstraction for modeling cellular networks, by explicitly taking realistic base station locations, building footprints, spatial blockages and antenna radiation patterns into account. More specifically, the base station locations and the building footprints are taken from two publicly available databases from the United Kingdom. Our study confirms that an abstraction model based on stochastic geometry is capable of accurately modeling the communication performance of cellular networks in dense urban environments. Furthermore, we introduce the concept of computational stochastic geometry and how the mathematical potential of stochastic geometry can be leveraged to an affordable computational complexity, yet retaining its accuracy and capability of modeling practical 5G communication networks. The potential of stochastic geometry for modeling and analyzing cellular networks are investigated for application to several emerging case studies, including massive MIMO, mmWave communication, and wireless power transfer." says Marco about the following tutorials that he has delivered.

*IEEE ICUWB 2015: S*tochastic Geometry Modeling of Ultra-Dense Heterogeneous Cellular Networks: Simulation, Performance Evaluation, and Experimental Validation

*IEEE ComManTel 2015:* Computational Stochastic Geometry – On System-Level Modeling, Simulation, Performance Evaluation, Optimization, and Experimental Validation of 5G Wireless Communication Networks

*IEEE VTC-Spring 2015:* The Path Towards 5G—Essential Technologies, Protocols and Tools for Enabling 5G Mobile Communications (jointly given with Christos Verikoukis)

*European Wireless 2015:* The Path Towards 5G—Essential Technologies, Protocols and Tools for Enabling 5G Mobile Communications (jointly given with Christos Verikoukis)

*IEE ICC 2015:* The Path Towards 5G—Essential Technologies, Protocols and Tools for Enabling 5G Mobile Communications (jointly given with Christos Verikoukis)

*IEEE ICCC 2015:* Modeling, Analysis and Optimization of 5G Wireless Communication Networks (jointly given with Cheng-Xiang Wang)

*IEEE CCNC2016* Stochastic Geometry Modeling of Ultra-Dense Heterogeneous Cellular Networks: Simulation, Performance Evaluation, and Experimental Validation

*IEEE ICNC 2016 (Invited Talk):* On System-Level Analysis & Design of Heterogeneous Ultra Dense Cellular Networks: The Magic of Stochastic Geometry and the Renaissance of Communication Theory

## 3. REPORTS FROM SPECIAL INTEREST GROUPS (SIGs)

### 3.1. Closed SIGs

### 3.1.1. SIG on the Design and Performance Optimisation for Green Networking (led by Christos Verikoukis, CTTC, Spain)

At the Physical (PHY) layer, novel modulation techniques have been introduced for massive MIMO communications, improving energy efficiency up to 5 times, while reducing up to 98% the computational

complexity, compared to state-of-the-art techniques. At the Medium Access Control (MAC) layer, innovative protocols have been proposed and implemented based on the operation of legacy standards (e.g., IEEE 802.11), improving network performance (up to 60% throughput enhancement) and providing up to 360% higher energy efficiency.

The use of Analog and Digital Network Coding (NC) techniques to improve the energy efficiency of wireless networks without degrading performance has been investigated, specifically targeted to cooperative networks and Device-to-Device communications. Overall, the proposed NC-aided solutions have achieved up to 40% increase in energy efficiency, ensuring mobility support and network stability.

Disruptive infrastructure sharing and Base Station switching off schemes that achieve up to 320% energy savings have been proposed, employing game theoretic tools and considering various network parameters (e.g., MIMO operation, network topology, traffic, etc.) Uplink offloading algorithms and innovative pricing schemes have also been considered.

Context-aware cognitive schemes and handover algorithms have been presented and analysed, showing significant energy efficiency gains up to 190% compared to traditional approaches. Moreover the SIG on the Design and Performance Optimisation for Green Networking has organised a plethora to seminars in the area of Green Wireless Networks and it organised Special Sessions in the CAMAD 2012, 2013 and 2014.

### 3.1.2. SIG on 'Future Internet Testbeds -FIT' (led by Charalabos Skianis, The University of Aegean, Greece)

"The SiG was launched in 2008 and concluded in 2012" reports Skianis. Motivation: much interest on the definition of the Future Internet with international research efforts and programs, such as

GENI and FIND in USA, FIRE in Europe, u-Japan in Japan,

that work towards the challenges behind the current Internet as well as the Future Internet Design (FIND).

This effort needs large scale experimental facilities to exhaustively test evolutionary and revolutionary approaches towards Future Internet and all aspects of it such as networks and services.

The SIG - FIT spanned its activities on several aspects of mainly large scale experimental platforms on the Future Internet and its interconnection aspects (federation aspects of heterogeneous platforms, security, authentication, privacy, routing, ect).

The SiG supported main events of CSIM such as symposia at ICC, GC, CAMAD introducing several aspects as topics of the events. Members of the SiG participated in funded projects and submitted project proposals for funding.

### 3.1.3. SIGs on 'Crosslayering and service modeling' (led by Fabrizio Granelli, University of Trento, Italy)

Activities of these SIGs are reported as the design and organization of four editions of the EFSOI (Enabling the Future Service Oriented Internet) workshop during Globecoms 2007-2010. The workshop can then became in terms of content a part of IEEE CAMAD Workshop.

### 3.2. Active SIGs

### 3.2.1. SIG on Software Defined Networking (led by Stefano Giordano, University of Pisa, Italy)

The first actions of the SIG were related to verify if there could be possibilities of some standardization activity in the field of SDN applied to WSN and IoT in general. We all know that inside the data center, in the access network and step by step also in the inner functions of the next generation, 5G, cellular networks SDN is one of the more interesting paradigm particularly for what is concerning a single point of programming of new control applications aimed to allocate heterogeneous (and multivendor) resources ranging from IT (CPU, RAM, DISK) to Telecommunications (ROUTERS, SWITCHES, MIDDLEBOXES). In this framework the idea of extending an SDN approach in the "without border" part of the network (i.e. the peripheral part build up of sensors, actuators, robots, etc) was not very much covered so far exactly as, in a

first stage, IP networking in that portion of the networks was initially considered impossible. Now the first proposals both as research papers and initial experimental deployments are emerging and with Periklis Chatzimitios  a Special Session in the framework of the IEEE CSCN Conference was organized. The name of the session is "Software Defined Sensors Networks and IoT: perspective and proposals for new standardization activities" and very interesting contributions were presented there. SIG leader, Stefano Giordano also participated in the IEEE Standardization Meeting on SDN at Piscataway NJ at the end of June 2015 and again it was an opportunity to stimulate the very active participants to the idea that this approach could enable an "holistic" view not only of the network control but also of all the "in network processing" capabilities of motes and gateways, etc as part of a new picture in that area. The SIG has the interest to stimulate any possible contribution on SDN and possibly increase the action of the CSIM TC in organising workshops, special sessions and tutorials on that domain. It is well known that SDN is not declined only in the direction of OpenFlow and many other possible protocols or functional proposals could be compared and critically evaluated particularly in aspects related to security and reliability. The effectiveness of the approach will be really explicit when independently on the routers, servers or even motes manufacturers third parties will be able, with a single point of programming, to transform a the network and its processing and storage components in something able to deploy new services and their self-management. The SIG is also inviting any contribution that could be related to cognitive or autonomic approaches that in any specific domain could improve the robustness, security and reliability of this new integrated vision of the processing plus networking infrastructure. This open innovation is enabled by a community of users and by the sharing of resources and laboratories worldwide. Activities in that direction will be periodically presented and updated on the Web site of the TC and in the newsletter.

3.2.2. **SIG on Internet Measurement (led by Antonio Pescape at Univrsity of Napoli)**

"The SIG has continued its activities in the 2015 too" reports Antonio. Among its merits, it has carefully followed the research trends in the networking area and has opened its activities to measurement and monitoring of hot research topics like network neutrality, broadband performance, network censorship detection, SDN and Cloud. In these areas a number of Special Issues have been organized on top ranked journals like Future Generation Computer Systems and IEEE Computer and the participation to and the organization of workshops focused on the SIG topics, like TMA (Traffic Monitoring and Analysis), have been fostered.

### 3.2.3. SIG on Smart Grid Communications[*] (led by Periklis Chatzimisios, Alexander TEI of Thessaloniki, Greece and Yan Zhang, Simula Research Laboratory, Norway)

Until today, the activities of the SIG on Smart Grid Communications mainly focused on carrying out related publication and conference activities. In particular, some recent Special Issues that have been organized by members of the SIG are the following:

- IEEE Transactions on Smart Grid, special issue on "Smart Grid Cyber-Physical Security" (deadline: February 28, 2016)

- ACM/Springer Mobile Networks & Applications (MONET), Special issue on "Advanced Industrial Networks with IoT and Big Data" (deadline: March 30, 2017)

- IEEE System Journal, special issue on "Industrial IoT Systems and Applications"

- IEEE Transactions on Industrial Informatics, Special Section on "New Trends of Demand Response in Smart Grids"

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[*] SIG Proposed to be closed

Moreover, members of the SIG participated as Organizing Committee members in the following recent related conferences:

- IEEE SmartGridComm 2015, Cyber Security Symposium (serving as Symposium co-Chair)

- IEEE SmartGridComm 2014, serving as Student Travel Chair

- 1st International Conference on Smart Grid Inspired Future Technologies (SmartGIFT 2016), Liverpool, UK, May 2016 (serving as Technical Program Committee co-Chair)

"Overall the SIG has organized many activities and initiated a live discussion between several researchers and academics about all the topics related to Smart Grid Communications. Since we believe that the main purpose of the SIG has been fulfilled, we propose to close the SIG after having 3 years of exciting time and cooperation." reported the SIG leaders.
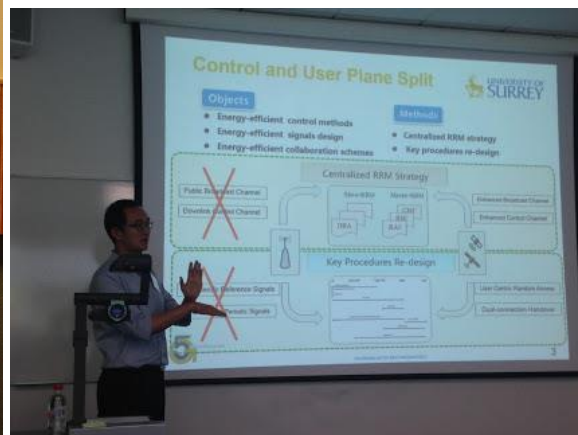
## 4. IEEE CAMAD 2015

IEEE CAMAD 2015 has been held between 7-9 September, 2015, at University of Surrey, Guildford, Surrey, UK. Technical program included five technical sessions, seven special sessions and three keynote speeches and a tutorial. Keynote speeches were delivered by

Professor Steve Uhlig, Queen Mary, University of London, UK, "Perspectives on Software Defined Networking (SDN): origins and likely future"

Dr Artur Hecker ERC Munich - Huawei Technologies, Germany, "Running 5G as a Software"

Professor Mohamed-Slim Alouini, King Abdullah University of Science and Technology (KAUST), Saudi Arabia "Addressing Spectrum Scarcity through Optical Wireless Communications"

The tutorial was delivered entitled "Advanced Green Networks: New paradigms for energy and spectral efficient network design", and was delivered by Dr. Marco Masso (Huawei Research Center-France) and Dr Muhammad Ali Imran (University of Surrey, UK).



**Opening, addressed by Professor Rahim Tafazolli (Left). Technical session, Jiaxin Zhang on Sep.7th 2015 (Right)**

Two best paper awards were presented to the following papers:

#1: Bayesian Game analysis of a queueing system with multiple candidate servers, by Anna Guglielmi and Leonardo Badia

#2: Radio Resource Allocation and System-Level Evaluation for Full-Duplex Systems, by Mohammed Al-Imari, Mir Ghoraishi and Pei Xiao