IRACON

COST CA15104 ACTION

Newsletter

Inclusive Radio Communication Networks for 5G and Beyond

Number 7, June 2018

Contents

About COST IRACON

This COST Action IRACON (Inclusive Radio Communications) aims at scientific breakthroughs by introducing novel design and analysis methods for the 5th-generation (5G) and beyond-5G radio communication networks. Challenges include i) modelling the variety of radio channels that can be envisioned for future inclusive radio, ii) capacity, energy, mobility, latency, scalability at the physical layer and iii) network automation, moving nodes, cloud and virtualisation architectures at the network layer, as well as iv) experimental research addressing Over-the-Air testing, Internet of Things, localisation and tracking and new radio access technologies. This COST Action started on March 2016 and will end in March 2020.

http://www.iracon.org

cost EUROPEAN COOPERATION IN SCIENCE AND TECHNOLOGY

COST is supported by the EC H2020 Framework

Editor's Address

Conchi Garcia-Pardo
Universitat Politècnica de València, Spain

Dear reader,

I am glad to introduce you the seventh issue of this newsletter. In this issue, we focus on the highlights of our 7th technical meeting, which took place in Cartagena, Spain. In the same location, it took place also the interesting seminar about Radio Frequency Localisation Techniques.

As usual, we'd like you to meet two people behind the Action. Therefore, we have given the floor to Luca Feltrin, a PhD student from University of Bologna and the former ECI representative of IRACON, and to Reiner S. Thomä, professor at Ilmenau University of Technology and Fellow member of the IEEE.

We hope that this newsletter will inspire you and can encourage you to join us (further) in the Action.

Enjoy the reading!

Chairman's Address

Claude Oestges
Université catholique de Louvain, Belgium

Dear IRACON colleagues,

Welcome to the 7th issue of our Newsletter!

Since my last address, we held our 7th Management Committee meeting, which took place in sunny Cartagena (Spain) in the last days of May. It gathered again more than 100 participants, with 74 technical documents being presented. During this meeting, we also launched our final book project, which will again rely on many volunteers for defining, writing, editing, proof-reading, etc. many pages. I am confident that this book will reflect the large amount of research which is carried out within our Action.

In April, we also submitted our Progress Report. While preparing it, I couldn't help noticing the high level of collaboration between many partners. I must also admit that IRACON really tries to communicate better its result, not only thanks to an increased presence on social media, but also via numerous special sessions and workshops.

As you have probably noticed, we have a new Newsletter Editor: Conchi Garcia-Pardo was indeed elected as Early Career Investigator (ECI) Representative for the third year of our Action. I wish Conchi all the best in her mission. Let me also take this opportunity to warmly thank Luca for his excellent job, in particular, for bearing with my delays in providing my address.

Talking about good-byes, it is with great sadness that I have to announce the resignation of our secretary owing to the uncertainty of COST funding, Lucia Vitiello decided to start a new career. I have often said that the success of our Action relies on all of you. However, nothing is possible without the dedication of a secretary. Many thanks, Lucia, for being this wonderful secretary during two years. We will miss you dearly, I will miss you terribly ! Of course, we all wish you good luck in your new job!

Our next meeting will be held in Podgorica (Montenegro), on Oct 1-3 2018. In the meantime, I hope you have the opportunity to enjoy some well deserved summer vacation. We enter into our third year!

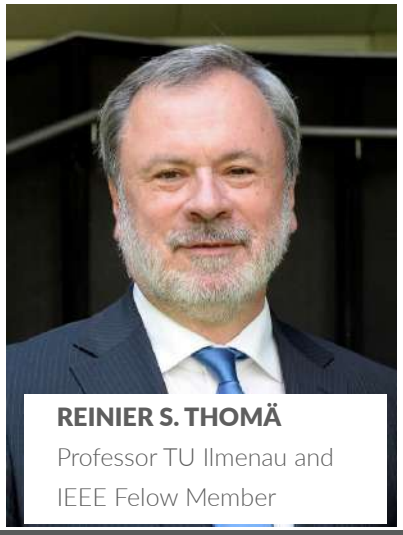
Enjoy the reading!

Joint Winter School on Beyond 5G Networks operating in the Millimetre Wavebands

Twenty enthusiastic students from ten different countries attended the Joint Winter School on Beyond 5G Networks operating in the "Millimetre Wavebands enabled by Joint Analogue-digital Signal Processing" in Instituto de Telecomunicações (IT)/Lisbon, Instituto Superior Técnico (Alameda Campus), from March 5th until 9th, 2018. The Winter School was hosted by IT and was organised by The IEEE VTS Portugal Chapter. The 4.5 days training period has also addressed recent advances in propagation and channel models for millimetre-wave (mmW), signal and multi-antenna processing, making use of information theoretic concepts and with emphasis on massive number of antennas and hybrid beamforming schemes.

Students also had the opportunity to share their own recent research findings in a poster session that allowed for sharing ideas with their colleagues and tutors. The academic vision has been complemented by industry/services experience and a "hands-on" part of the training (prototyping with OpenAirInterface), culminating with a final work on how to create their own business, as entrepreneurs.

Interview with a senior researcher



REINIER S. THOMÄ
Professor TU Ilmenau and IEEE Felow Member

Short biography

Prof. Reinier S. Thomä received his degrees in electrical engineering and information technology from Technische Hochschule Ilmenau, Germany. From 1975 to 1988, he was a Research Associate at the same university. From 1988 to 1990, he was a Research Engineer at the Akademie der Wissenschaften der DDR, Berlin. Since 1992, he has been a Professor of electrical engineering (electronic measurement) at TU Ilmenau. In 2007 he was awarded IEEE Fellow Member for contributions to high-resolution multidimensional channel sounding. In 2014 he received the Vodafone Innovation Award.

What are your favourite areas of interest and research?

My research interests include measurement and digital signal processing methods (correlation and spectral analysis, system identification, sensor array processing, high resolution DoA/TDoA estimation, compressive sensing, time-frequency and cyclostationary signal analysis), their application in mobile radio and radar (multidimensional channel sounding, emitter localisation, propagation measurement and propagation parameter estimation, passive radar, radar cross section measurement, MIMO-, mm-wave-, and ultra-wideband radar), measurement-based performance evaluation of MIMO transmission systems including over-the-air testing in virtual electromagnetic environments, and distributed radar for object detection, tracking and imaging.

What was your motivation to become a researcher?

To understand technical and physical effects and, upon that, design systems which are useful for our daily life.

What was your motivation to be part of COST IRACON?

COST IRACON stands in a sequence of several COST actions on mobile radio. Since I was especially interested in propagation research, I took COST as a chance to build up my European network in that field. I experienced the "Radio COST" meetings as a very effective and exciting place to discuss about latest research results and to develop new ideas. For young researchers COST is an excellent place to meet with the international (not only European!) scientific community in the field of mobile radio. I found many friends there and always enjoyed it. From my point of view, COST is extremely efficient in terms of high output from very little funding.

What would like COST IRACON to achieve?

Of course, COST IRACON is devoted for the future wireless technologies. But it is not restricted to topics that are limited by a certain standard, such as 5G. This makes it so interesting and fruitful for new ideas. IRACON can be the ignition spark of new ideas that are still far ahead of the boring standardisation procedure. COST also supports the idea of European communication and cooperation.

What is the "next big thing" in the wireless communication area?

I am very enthusiastic of the prospective features of 5G. What excites me a lot is the potential of real-time cooperation of mobile devices, which is supported by low latency transmission and close-by edge computing facilities. This will allow very interesting vertical applications going far beyond simple communication and data access. This way the 5G access network turns into a real-time sensor network with cutting edge applications, e.g., in industry, road traffic, and security.

My favourite book, music(ian), movie, TV-series are ...

Currently am mostly reading (serious) historical novels. This helps a lot to understand why our continent now is at it is.

I'm most passionate about …

Cooperative passive radar as an inherent ubiquitous radar service in 5G.

My favourite holiday is…

There are several. I am not fixed to one place. I am trying to get around in Europe. And I am still enjoying that the boarders became open since '89. But I must admit that I missed out eastern Europe too much recently.

What is your country well known for?

Germany may be famous for the quality of its industrial goods, such as cars. But nothing is forever, as it turned out recently. I like the green forests and the small villages anywhere in Germany. And it is not always bad weather!

Interview with an Early Career Investigator

LUCA FELTRIN
Ph.D. Student
University of Bologna, Italy

Short biography

Luca Feltrin received the B.Sc. and M.Sc. in Electronics and Telecommunications engineering in 2011 and 2014, respectively, from University of Bologna, Italy. After his studies, he spent two years working mostly in the automotive field before deciding to start in 2015 a Ph.D. course in Telecommunications engineering at University of Bologna which is currently ongoing. His current research interests are Low Power Wide Area Networks (LPWAN) and new standards for the Internet of Things such as LoRa and NB-IoT.

What was your motivation to become a researcher?

I find exciting trying to discover something new or to find an explanation for an observed behaviour. It is a little bit like being a detective. I also think that working in research, being at the "top" of the technology pyramid, allows us to have the biggest impact on society.

How did you became involved in COST IRACON (or any of the previous Actions)?

My supervisor asked me if I was interested in applying for the ECI representative position. He explained me how COST actions work and I was thrilled. In Lund I got the position so I started participating to each meeting.

What was your motivation to be part of COST IRACON?

I like the friendly and productive environment I found at IRACON meetings. I like also how IRACON finance mobility for Ph.D. students and push institutions to collaborate.

What is the "next big thing" in the wireless communication area?

Now we know a huge amount of different techniques witch apply to many different scenario. The big challenge is to understand how to use them in a smart way and how to use the shared radio resources when all these different scenarios coexist. In general the challenge is flexibility.

What are your favourite areas of interest and research?

My general area of interest is Internet of Things, and the technologies enabling these applications. In particular I'm interested in standards, their configuration, and the performance estimation of a large network.

What would like COST IRACON to achieve?

Collect knowledge on the topics of our interest and sharing it with everybody.

My favourite book, music(ian), movie, TV-series are ...

I very much like science fiction (I'm a huge fan of Star Trek). I listen to rock or metal music.

I'm most passionate about …

Mostly music. I play the drums, even though currently I don't play in a band as I used to do a couple of years ago. I also try to play other instruments with less success. Recently I got involved in the Rockin'1000 project, a big rock band composed of one thousand musicians playing at the same time. It's very fun and something never done before, check it out on youtube!

My favourite holiday is…

Definitely an adventure. For example it could be a trip in Iceland with only a tend and a bycicle.

What is your country well known for?

Of course food! But what I like about this is not just how good it tastes. When an Italian sits in a table with friends to have a meal, it is a moment of relax and sharing, we may spend hours chatting eating and connecting in general.

The habit I don't have and that I like most is …

Doing sports and keeping me fit.

Selected scientific topic:

"Network design for accurate vehicle localization" . J. A. del Peral-Rosado, G. Seco-Granados, S. Kim, and J. A. López-Salcedo

Connected autonomous driving demands unprecedented precise, reliable and secure positioning, with localization requirements below one meter for the 95% of the service area. To fulfil these stringent demands, vehicle's on-board navigation sensors should be complemented with fifth generation (5G) cellular positioning. However, the 5G networks are not designed for positioning but for data communication purposes, which follow a different paradigm for the network deployment and operation. This paper provides theoretical guidelines on the network design of uplink vehicle-to-infrastructure (V2I) communications for 5G-based precise positioning. These guidelines are based on the Cramér-Rao bound (CRB) for joint time-of-arrival (ToA) and angle-of-arrival (AoA) localization. The CRB is used to improve the site placement along the roads, by considering the line-of-sight (LoS) propagation conditions of outdoor urban and rural scenarios.

Our simulation results indicate the need to locate the network sites at both sides of the road, in order to reduce the network density. Using only one distance and angle measurement with a narrow bandwidth of 10 MHz, an improved network placement is found to be equi-spaced sites every 50 and 200 meters along urban streets and highways, respectively. Furthermore, the study indicates that the use of multiple antennas per network site (i.e., a minimum of four antenna elements) is recommended to ensure a vehicle location accuracy below one meter on the 95% of the cases, as well as to increase the equi-distance between network sites.

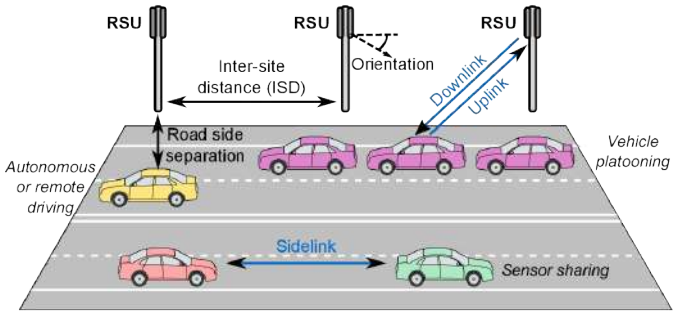


Figure: V2X communications interfaces and emerging vehicular applications.

Contact Person

JoseAntonio.delPeral@uab.cat

Selected scientific topic:

"Modeling Human Blockage at 5G Millimeter Wave Frequencies" by U. T. Virk and K. Haneda - TD(18)07050

Millimeter wave (mm-Wave) spectrum unravels the enormous and accelerating demand for wireless data rates and, therefore, it will be a fundamental ingredient of the fifth-generation wireless technology. In case of mm-Wave access links, humans are one of the most noticeable blockers of electromagnetic waves and hence cause temporal variation in the radio channel. This work reports human blockage measurements in an anechoic chamber at 15, 28 and 60 GHz frequencies employing 15 human subjects of different sizes as illustrated in the top figure. An effective three-dimensional human blockage model as a truncated and absorbing double knife-edge (TDKE) scheme is also proposed. By calculating diffraction from the TDKE, the frequency, body orientation and antenna height dependency of the blockage is reproduced most accurately than existing models such as the absorbing double knife-edge model and the 3GPP human blockage model.

The bottom-left figure illustrates the body orientation effects on the blockage loss, indicating that the losses are proportional to the cross-section of the body with respect to the link. Furthermore, the bottom-left figure shows the decreasing blockage loss as the height of transmitter (TX) increases. It is observed that width and height of the TDKE affect the human blockage significantly.

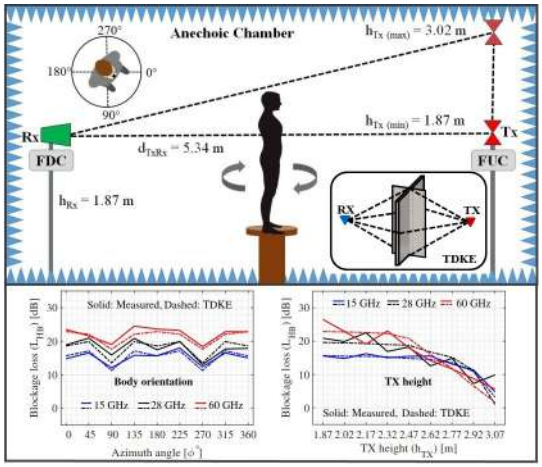


Figure: Experimental setup and layout (UPC: Frequency up-converter, DWC: Frequency down-converter, LO: Local oscillator, IF: Intermediate frequency).

Contact Person

usman.virk@aalto.fi

Selected scientific topic:

"System-theoretical modeling and analysis of phase control in a photonically steered terahertz phased array transmitter" by K. Kolpatzeck, X. Liu, Lars Häring, and A. Czylwik – TD(18)07066

Photomixing – i.e. beating two infrared lasers in a fast photodetector – is currently the state-of-the-art for THz generation and detection. However, photomixing-based systems are limited in range due to their small transmit power. One approach to overcome this limitation is the use of an array of antenna-integrated photodiodes (PDs). By feeding these photodiodes with infrared laser signals with well-defined phase relationships, both the total output power and directivity can be increased. By adjusting the phase relationship between the infrared signals with optical phase shifters, the THz radiation becomes steerable, enabling high-speed scanning of surfaces. However, the optical phase is highly sensitive to thermal and mechanical influences, and fluctuations in the optical phase translate directly into the THz domain. Since electronic phase detectors are limited in carrier frequency, we have developed a concept for phase control without the need for phase detection at THz frequencies. As depicted in the figure, laser diodes (LDs) 1 and 3 are tuned so that they generate THz signals in PD 1 through PD 4. Two additional LDs 3 and 4 are tuned so that they generate signals in the microwave frequency range in PD 1' through 4'. These serve as reference signals whose phase differences are detected by low-cost electronic circuits. It can be shown that the phase differences between the microwave-frequency reference signals closely track those between the THz signals. We have successfully demonstrated closed-loop phase control in a 4-element array.

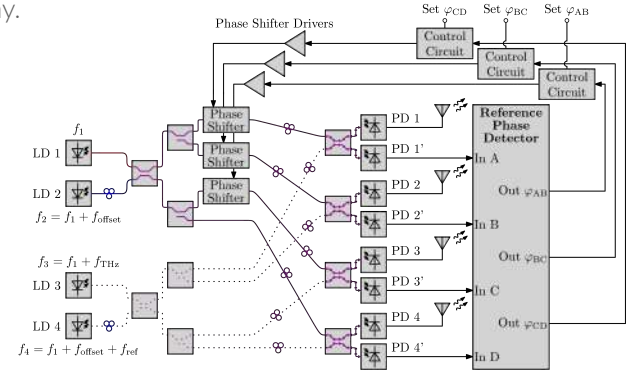


Figure: Proposed setup for phase control in a 4-element array.

Contact Person

czylwik@nts.uni-duisburg-essen.de

Selected scientific topic:

"Tri-Band Mm-wave Directional Channel Measurements in Indoor Environment" by E. M. Vitucci, M.Zoli, K. Guan, F. Fuschini, M. Barbiroli, T. Kuerner, V. Degli-Esposti – TD(18)07069

A measurement campaign has been carried out in a reference indoor environment – a medium-size meeting room – using an ultra-wideband channel sounder operating at 3 different frequency bands: 10 GHz, 60 GHz and 300 GHz. Automatic rotational units have been used at Tx / Rx to achieve a double directional channel characterization. Preliminary results show that multipath is dominated by few single or double-bounce components, and significant contributions may come from objects other than the walls. The measured Power-Angle Spectra have been analyzed by means of simple geometrical considerations. The analysis shows that radial path and single-bounce multipath components from walls are clearly identifiable in all cases (black, red, green, pink and light-blue circles in the Figures) but also objects other than the walls, e.g. TV screen and entrance door, can give strong contributions through single or double-bounce paths (clusters A, B, D).

Most of the contributions are clearly identifiable at all the considered frequencies, although in some cases they appear to be stronger at 60 GHz compared to 10 GHz, and some clusters (B, C) almost disappear at 300 GHz. In general, the radio channel's multipath richness appears to be frequency dependent, and in particular it decreases from 60 GHz to 300 GHz.

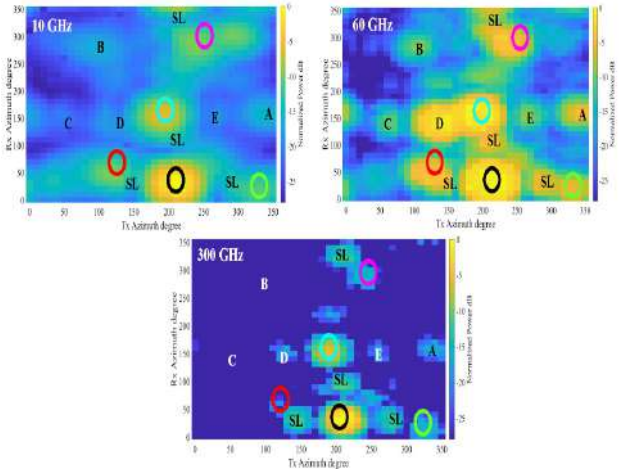


Figure: Shadowing-pattern fitted to measurements for a wearable antenna on the chest.

Contact Person

enricomaria.vitucci@unibo.it

Highlights from the last meeting

DWG1 - Radio channels: DWG1 had 29 TDs. They include many new measurements covering vehicular scenarios and multiple-frequency campaigns. The TDs also brought various new insights about radio channel characteristics and models, including frequency dependency of multipath richness, link blockage models and a unified terrestrial-satellite channel model, among others. The discussion session also covered the topics that the three correspondence groups of DWG1 will work on to towards the IRACON channel model.

DWG2 - PHY (Physical) Layer: There was one WG2 session attended by 15 attendees, 2 TDs (#25,#71) were presented, presenter of TD #45 has not arrieved. TD#25 focussed on physical layer network coding with bit-wise mapped H-SODEM and iterative dual-loop decoding. TD#71 presented capacity optimisation technique for uplink M-MIMO with distributed access points with quantised backhaul links. After presentations, there was quite long and productive discussion inspired by presented TDs and many new potential topics for joint research emerged. At the end, WG2 discussed topics/chapters/sections for the Final Book. We also discussed the profile of TS proposed for Q4/2018 in Lyon.

DWG3 - NET (Network) Layer: In Cartagena MC and technical meeting WG3 had three sessions with 10 TDs as well as several joint sessions with other working groups and experimental working groups. 3 TDs were discusses in a joint session with Radio Access EWG, and 9 in a joint session with IoT EWG. Presented TDs on this meeting were grouped in Networks, Spectrum and Wireless sessions with research activity on predicting coverage maps, Virtual RANs, Radio Resource Slicing, Cloud-RAN, the use of date from social sources in cellular networks, novel 5G frequency bands and spectrum sharing, resource allocation and sharing among cellular and NB-IoT, mesh networks. The discussion was centred on the final book structure, WG3 chapter and sections and collaboration with other DWG and EWG as was done in the past action.

EWG-OTA - Over-The-Air testing: Ever had inspiration in the shower? On the last day of IRACON in Cartagena, Moray Rumney had a faulty shower head in his hotel which perfectly illustrates a worrying gap in the newly released 5G standards for spurious emissions testing. At mmWave, all testing is OTA, but to optimise speed, spurs are only tested at boresight. Energy in other directions is not measured. Will this matter? I guess we will find out after 5G deployment.

EWG-IoT - Internet-of-Things: The main topics discussed in the EWG-IoT and SEWG-IoT for Health were quite diverse. In the EWG-IoT sessions, topics ranged from vehicular antenna systems and multiuser detection in LoRa networks to cloud infrastructure for efficient storage and computing. One contribution reported on collaborative work between University of Banja Luka and University of Beira Interior that has its roots in a short-term scientific mission. This work constitutes a tangible result from the Action. The SEWG-IoT session dealt with subjects ranging from intra-neuron communication using FRET-based (Förster Resonance Energy Transfer) nanonetworks to development of gel phantoms for the 30-67 GHz range. It is indeed quit stimulating for the attendees to be exposed to such a broad range of topics and problems.

SEWG-IoT - Internet-of-Things for Health: IoT-Health held three sessions with nine TD presentations during the 7th IRACON technical meeting in Cartagena. Topics presented were related to radio channel measurements and modelling for off-body and in-body communications at narrowband and ultra-wideband frequencies, development of frequency-dependent gel phantoms for studying 5G/mmWave propagation, RSS-based localisation technique for implants operating in the UWB frequencies, interfacing nano-machines and human neural system, and finally a wavelet-based spatio-temporal gait variables analyse to identify Parkinson disease.

EWG-LT - Localisation and Tracking: There were two sessions of the EWG-LT where 8 TDs were presented. The main topics comprised measurements/ channel modelling, exploitation of multipath, and a number of system level studies (e.g. placement of roadside units for positioning). In the discussion session, the group commented on how to effectively disseminate the WhitePaper, IRACON's book chapter, and joint activities undertaken/planned (seminars, special sessions, training school in Barcelona).

Newcomers to the Action.

COST-IRACON Special Sessions and Workshops at IEEE PIMRC 2018

The 29th Annual IEEE international Symposium on Personal, Indoor and Mobile Radio Communications, PIMRC 2018, will be held on September 9-12, 2018 in Europe, at the city of Bologna (Italy). This year, 4 special sessions and 4 workshops have been originated or or co-originated from the IRACON Action.

IRACON Originated Special Sessions

SS-A Spectrum Management for 5G Systems: Reference Models and Field Trials. Chairs: Sana Salous, Durham University, UK, Marina Barbiroli, University of Bologna, Italy. Mon, 10th Sept, 16:00-17:30.

SS-D UAVs for Future Wireless Networks. Chair: Chiara Buratti, University of Bologna, Italy. Tue, 11th Sept, 14:00-15:30.

SS-E Electromagnetic Exposure in 5G Networks. Chairs: Claudia Carciofi, Samuela Persia, and Simona Valbonesi, Fondazione Ugo Bordoni, Italy. Tue, 11th Sept, 14:00-15:30.

SS-H Deterministic Propagation Modelling and Channel Characterization for 5G and Future Wireless Systems. Chairs: Enrico M. Vitucci, University of Bologna, Italy, Conor Brennan, Dublin City University, Ireland, Katsuyuki Haneda, Aalto University, Finland. Tue, 11th Sept, 14:00-15:30.

IRACON Co-orginated Workshops

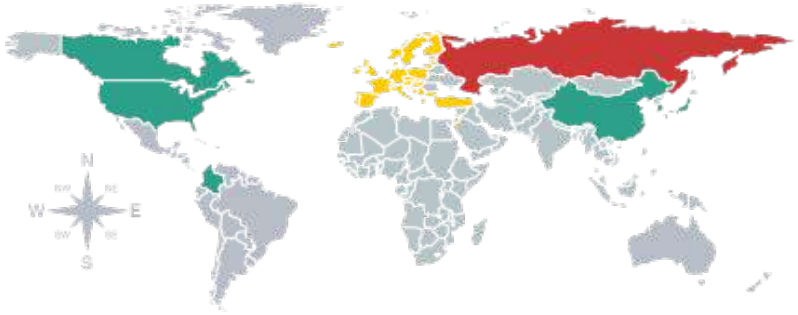
W-B UAV Communications for 5G and Beyond. Chairs: Chiara Buratti, University of Bologna, Italy, Adrian Garcia-Rodriguez, Nokia Bell Labs, Ireland, Gianluigi Ferrari, University of Parma, Italy, Ming Ding, Data61, CSIRO, Australia. Sun, 9th Sept, 14:00-17:30.

W-C International Workshop on V2X Communications and Channel Modeling. Chairs: Christian Schneider, Ilmenau University of Technology, Germany, Massimo Condoluci, Ericsson Research, Sweden. Sun, 9th Sept, 09:00-17:30.

W-F Millimetre Wave Communications. Chairs: Haris Pervaiz, 5GIC, University of Surrey, UK, Reiner S. Thomä, TU Ilmenau, Germany. Sun, 9th Sept, 09:00 - 17:30.

W-I WIreless Body COMunications in Medicine (WIBCOMM). Chairs: Conchi Garcia-Pardo, Narcis Cardona, iTEAM Institute, Universitat Politècnica de València, Spain. Sun, 9th Sept, 14:00 - 17:30.

Facts & Figures



Signatory countries: 35
Austria, Belgium, Bosnia and Herzegovina, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, fYR Macedonia, Germany, Greece, Hungary, Iceland, Ireland, Israel, Italy, Lithuania, Luxembourg, Malta, Montenegro, Netherlands, Norway, Poland, Portugal, Romania, Serbia, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey, United Kingdom

COST international partner countries: 6
Canada, China, Columbia, Japan, South Korea, USA

COST Near Neighbour Countries: 1
Russian federation