IRACON

COST CA15104 ACTION

Newsletter

Inclusive Radio Communication Networks for 5G and Beyond

Number 11, October 2019

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

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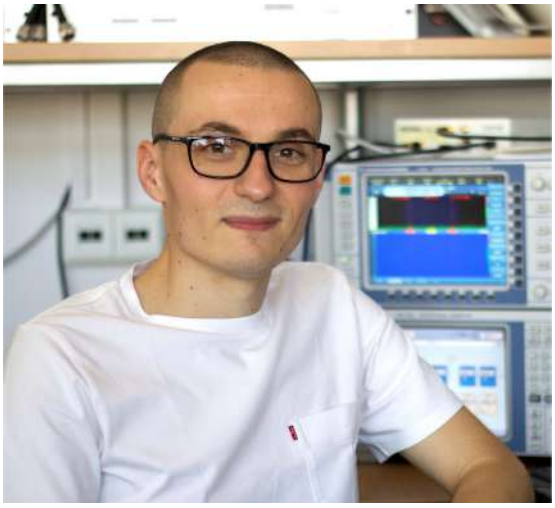
COST is supported by the EC H2020 Framework

Editor's Address



Piotr Rajchowski
Gdańsk University of Technology, Poland

Dear reader,

I am glad to introduce you the eleventh issue of this newsletter. In this issue, we focus on the highlights of our 11th technical meeting, which took place in Gdańsk, Poland. About a month before the meeting, an ESoA/COST-IRACON Joint Training School on "Mobile radio propagation for 5G and beyond" was held.

As usual, we'd like you to meet two people behind the Action. In this issue, we have given the floor to Alister Burr, professor at the University of York (UoY), and to Dr. Conchi Garcia Pardo, from the Universitat Politècnica de València (UPV), Spain.

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 11th issue of our Newsletter! IRACON has really entered into its final months, with a number of tasks ahead of us. On the one hand, the final book must be ready by January 2020. On the other hand, our next and final meeting will be held in Louvain-la-Neuve (Belgium), on January 27-29 2020. On January 28, 2020, a workshop will gather a number of invited speakers, from our Action as well as outside IRACON, who will deliver their view and vision about the future of wireless communications. Stay tuned for more exciting information in the coming weeks.

Between today and January, numerous activities will still take place: training schools and workshops at international conferences are being organised by Action members (all details can be found on our website). Let me take this opportunity to thank all volunteers involved in these dissemination activities, some being even planned after the end of IRACON.

Over these four years, IRACON participants have brought forward contributions which definitely impacted the community outside our Action. As an example, the Radio Channel Working Group recently provided an input to ITU-R, resulting from the joint work of several IRACON researchers.

The strong participation of young researchers who have provided high quality technical contributions is also a sign that our community is striving and appealing to newcomers. Hopefully, they also appreciated the networking impact of IRACON, getting in contact to senior researchers and industrial players during the Action meetings

In view of this success, the challenge awaiting us is clearly to keep this excellent networking alive after IRACON.

I wish you a wonderful semester, and really hope to welcome you in my home university in January (in the meeting but also around a good Belgian beer).

Enjoy the reading!

7th ESoA Course and IRACON training School on "Mobile Radio Propagation for 5G and Beyond"

Mobile radio is getting to a new level with 5G (and beyond) systems: new millimeter-wave frequencies, unprecedented massive-MIMO and beamforming transmission solutions, service coverage extended to IoT, machines and vehicles, as well as new vertical application scenarios, are changing the way we conceive wireless communications and services. The course, held in the picturesque town of Cesenatico, Italy, offered a 5-day overview on these topics. Lessons topics included: general theory of mobile propagation, the MIMO channel, propagation and channel models for 5G and beyond, GIS and network planning, vehicular and air-to-ground propagation and applications, high-speed railway propagation, mm-wave propagation, spectrum allocation and e.m. compatibility issues in 5G. A demo on the air-to-ground propagation measurements as well as a visit to the Marconi Museum in Villa Griffone (near Bologna) completed the Course, which was attended by 20 students from 7 countries.

Course Organisers:
Vittorio Degli-Esposti, University of Bologna
Thomas Kuerner, Braunschweig Technical University
Claude Oestges, Université Catholique de Louvain
Other Professors:
Werner Wiesbeck, Karlsruhe Institute of Technology
Conor Brennan, Dublin City University
Marina Barbiroli, University of Bologna

URL: https://padlet.com/mylink/ITALY

Interview with a senior researcher

Alister Burr

Professor, University of York, UK

Short biography

Prof. Alister Burr received his BSc degree in Electronic Engineering from University of Southampton in 1979, and PhD from University of Bristol in 1984: In 1984 - 1985 he worked for Thorn-EMI Central Research Laboratories in west London, then joined University of York as a lecturer in Electronic Engineering, and became Professor of Communications in 2001.

What are your favourite areas of interest and research?

My main research interest has always been the physical layer of communication systems, mainly but not exclusively wireless. I've also taken an interest on the one hand in how signal propagation affects the physical layer, and also how complete networks perform.

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

From the point of view of applications, certainly the Internet of Things, or more generally the application of wireless communications to machines, devices, sensors etc. This will vastly increase the scale of our wireless networks, which in turn will require many new technologies (among them technologies based on artificial intelligence) to make these networks feasible.

What was your motivation to become a researcher?

I began my career thinking I wanted to design electronic circuits, but was offered the chance to do a PhD and soon realised that understanding and analysing systems was much more interesting – and was also how improved systems could be designed.

What would like COST IRACON to achieve?

To continue this cross-disciplinary collaboration between propagation, physical layer and systems/networks as 5G evolves to support the new applications in IoT etc.

Considering the innovations in the scientific world in the last 20 years, which was the most remarkable one, which one didn't get the attention it deserved?

It's difficult to answer this – most of the innovations that receive the most attention today (AI, quantum technologies, even 5G) are much older than 20 years – it's when they move from the hands of the scientists to the engineers that they start to have practical impact on our lives. However a development that has often been underrated is the understanding of the behaviour of complete systems, especially complex systems, which has been enabled by the huge improvement in simulation capabilities in the past 20 years.

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

I originally got involved in COST 231 in 1993, because it (and its predecessor COST 207) seemed to be the forum in which the most useful research in mobile communications was going on (COST 207 had been instrumental in defining the GSM standard). I realised that the focus on radio propagation research alongside physical layer and system level work was vital to the development of wireless – through 3G, 4G and 5G. There have always been new challenges especially for the physical layer which have required new propagation research to provide relevant channel models.

What is your country well known for?

We used to be known for political stability and pragmatism, but no longer... But the UK has a lot of beautiful countryside, and interesting and very cosmopolitan cities.

In a few words, I consider myself to be…

a citizen or the world.

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

My favourite music is classical, especially the work of Johann Sebastian Bach; my favourite fiction is science fiction, especially the work of Poul Anderson. I enjoy watching non-English detective series (for example what we call "Scandi-noir").

My favourite holiday …

involves walking in the mountains or countryside, either in the UK or in France/Spain/Germany – but we also enjoy visiting more far-flung places (having just returned from a trip to Uzbekistan, Kazakhstan and Kyrgyzstan).

Interview with an Early Career Investigator

Conchi Garcia-Pardo
Senior Researcher, Universitat Politècnica de València, Spain

Short biography

Dr. Conchi Garcia-Pardo was born in 1983. She received PhD degree from the Universidad Politécnica de Cartagena (UPCT), Spain, and the Université de Lille 1 (USTL), France, in 2012. From 2012, she works in the Institute of Telecommunications and Multimedia Applications (iTEAM) of the Universitat Politècnica de Valencia (UPV), Spain, as a postdoctoral researcher. Her research interests are Body Area Communications (BAN), propagation and electromagnetic behavior of the human body. She has been contributing to COST actions since 2009.

What was your motivation to become a researcher?

Definitely, this can be defined in only one word: curiosity. I have always been keen on electronics and communications and my main motivation has been: learning and discovering how everything works.

What are your favourite areas of interest and research?

I have always been attracted by the propagation phenomenon. At the beginning of my research career I mainly focused on indoor environments and special scenarios such as tunnels. After that, I spend some time working on propagation for broadcasting services. In 2014, thanks a to a Short-Term Scientific Mission (STSM) between UPV and the Oslo University Hospital funded by the COST IC1004, I started to work on the propagation throughout the human body for medical applications, which is my main research topic right now.

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

I have been linked to COST actions since I was a PhD student, during COST 2100 and IC1004. Furthermore, I did my thesis in co-supervising between UPCT (Spain) and USTL (France) universities thanks to the relationship that my supervisors already had from COST meetings. Once I joined the UPV, I continued my involvement to the COST IC 1004, during which I was recipient of a Short-Term Scientific Mission (STSM). However, the first meeting I could attend physically was the 2nd technical meeting of IRACON, in Durham (UK). I really loved the experience and I was able to repeat it many times after that. More recently, I have been more involved in IRACON because I have been ECI Representative for a one year.

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

The possibility that every single device is connected to the Internet will modify communications as we know nowadays. This will lead to new applications, new business and new ways of communication.

Is there anything else you like to share?

I would like to thank the members of the CORE group (Claude Oestges, Luis Correia, Roberto Verdone, Narcis Cardona and Laurent Clavier) for supporting and helping me during the year I was a member of the group representing the ECIs. Thanks again!

I'm most passionate about...

Spending my free time with my family (especially now I have a little son) and travel. I love knowing different countries and immerse in their culture and way of life.

What is your country well known for?

I think Spain is well known for its good weather (Valencia in particular) and food. However, Spain is more than that. What I like the most of my country is its great mixture of cultures, weathers, and places that really deserves visiting. Not everything in Spain is sun and beach.

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

I would like to practise some sport more frequently, particularly swimming, what I love. I would like to have the habit of go swimming at least three times per week, but it's difficult to find free time, especially in winter.

My favourite holiday is…

Resting at the seaside. I really love reading a good book under the sun with the sound of the waves and the smell of the sea.

My favourite or personal quote is …

Antonio Machado, a Spanish writer, wrote "there is no path, the path is made by walking" ("caminante no hay camino, se hace camino al andar), which means that anyone can build its own future every day, working and "walking".

Selected scientific topic:

"A Real-time Computational Resource Usage Optimisation in C-RAN" Mojgan Barahman, Luis M. Correia and Lúcio S. Ferreira - TD(19)11018

The proliferation of high data rate applications nowadays has triggered a drastic increase in the demand for data rate. Mobile operators have to invest a huge capital to improve their network infrastructure equipment to be able to meet throughput demands. Cloud Radio Access Network (C-RAN) emerged as an alternative to address this problem. C-RAN centralises the baseband units (BBUs) of multiple Base Stations in a BBU-pool, allowing to maximise the utilisation of the network resources by sharing the resources of the under-loaded BBUs with the overloaded ones. However, since BBUs' resources demand is fluctuating, an efficient management strategy is needed to distribute the scarce resources of the BBU-pool among BBUs. This work proposes a model to optimise the computational resource utilisation of a BBU-pool, based on the concept of bargaining in cooperative game theory. A prioritisation strategy, according to the real-time demand and priority of active services, is suggested to specify the importance of BBUs in a case of resource shortage, when not all the BBUs demand can be served at the same time. One can see in the figure an example scenario of a BBU-pool with seven BBUs performing heterogeneous services, where the allocated computational resources are aligned with the BBUs demand and priority that is listed in the table.

Table: BBU demands and priorities.

BBU Index (b)	1	2	3	4	5	6	7
Demand [TOPS]	2.59	3.01	2.36	2.36	0.4	0.43	0.42
Priority	0.22	0.29	0.18	0.2	0.03	0.04	0.04

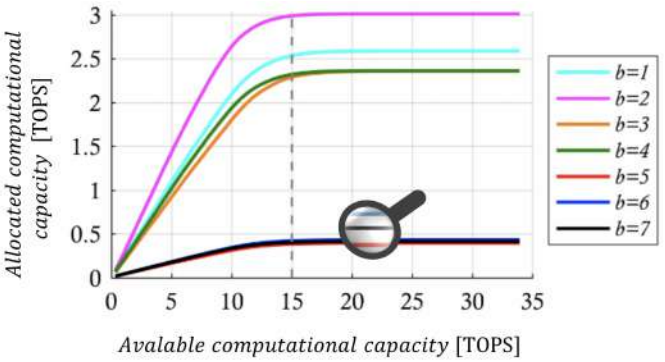


Figure: The BBUs' Allocated computational capacity.

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Selected scientific topic:

"Coordinated beamforming with sparse channel matrix estimation in Cloud-RAN" Charles Wiame, Luc Vandendorpe, Claude Oestges – TD(19)11030

Cloud radio access networks include remote radio heads that are connected to a baseband unit by means of fronthaul links of a very high capacity. A major difference to traditional cellular networks is in the signal processing that can be centralised at the baseband unit for the entire network. Thanks to this architecture, it would be theoretically possible to globally optimise the whole network performance. Cloud-RANs could hence feature efficient algorithms to solve challenges such as resource allocation or power control. On the other hand, one has to take into account the number of connected devices, expected to significantly increase in the coming years. A global optimisation approach is hence not realistic due to the overhead that would be required to estimate all the links. The objective of our work is to evaluate the performance of the Cloud-RANs under the sparsification assumption which consists in ignoring relatively weak links.

In our work, the network coverage is evaluated by means of simulations and stochastic geometry. Our contributions are the following: the access points (radio heads and users) are modelled by means of Poisson Point Processes, where the number N of radio heads serving a given user is a random variable; the radio heads are assumed to have a number of M antennas, possibly greater than 1. Therefore, we analysed a general scenario of N coordinating access points, each equipped with M antennas.

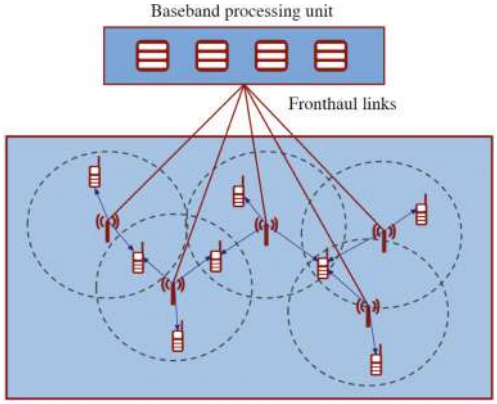

Figure: Simplified representation of the CRAN architecture.

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Selected scientific topic:

"Path Loss Models and Fading Statistics for C-Band Train-to-Train Communication" by Paul Unterhuber, Ibrahim Rashdan, Michael Walter– TD(19)11031

The profound knowledge of propagation mechanisms is essential for wireless communication between vehicles. Especially in the railway domain, reliable train-to-train (T2T) communication is the key technology for the next generation of safety critical railway applications and train control, and will enable virtually coupled and autonomously driving high speed trains. To develop and test communication standards we need channel models in representative environments; typical for railway communication are: railway station, open fields, hilly regions and tunnels.

Therefore, we performed the worldwide first T2T channel sounding measurement campaign with two high speed trains and the DLR-RUSK channel sounder. The large measurement bandwidth and high spatial resolution of the sounding measurements allow a detailed analysis of the propagation characteristics. The data is divided into three parts: railway station, open field and hilly environment.

We derived T2T path loss models and fading statistics for the mentioned environments. Due to the large distance variation from 5 to 1000 m, two-slope log-distance models are applied, where the resulting large-scale fading statistics take the received power fading into account. They are caused by multipath components (MPCs) mainly coming from overhead line masts and cross bridges as shown in the Figure. The ground reflection is taken into account by a two-ray path loss model. Furthermore, we compare the results with previous published intelligent transportation system (ITS-G5) models. The new models are based on more extensive and more precise measurement data and therefore sharpen and extend the old models.

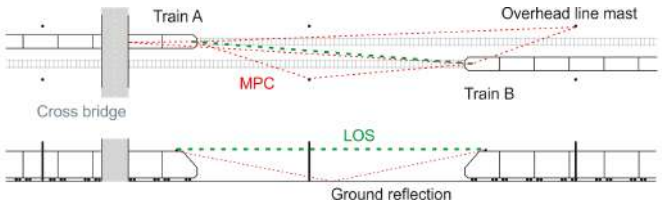

Figure: Top and side view of T2T communication with line of sight (LOS) signal and possible MPCs.

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Selected scientific topic:

"Exploitation of 3D city maps for hybrid 5G RTT and GNSS positioning simulations" by J.A. del Peral-Rosado, F. Gunnarsson, S. Dwivedi et al. - TD(19)11045

The combination of fifth generation (5G) cellular technologies and Global Navigation Satellite Systems (GNSS) is envisaged as a key solution to potentially achieve sub-meter localisation in outdoor urban environments. These positioning technologies are typically evaluated with independent simulations of statistical channel models for satellite and terrestrial links. However, this approach limits the applicability of the performance results to generic urban environments. Thus, a three-dimensional (3D) city map is here exploited to simulate coherent satellite and terrestrial links over a real-world urban scenario. The 3D city buildings are used to simulate 5G round-trip time (RTT) and multi-constellation GNSS observables in line-of-sight (LoS) conditions. The resulting LoS observables are then fused in a hybrid trilateration solution. The evaluation results are focused in a deep urban canyon, where a mobile device is in the middle of a narrow street with one base station (BS) at the rooftop of one of the side buildings.

This is a harsh environment in terms of positioning, because only ranging observables from one 5G BS and few GNSS satellites can be used for mobile localisation. The combination of both 5G RTT and GNSS observables is found to be necessary to achieve a positioning accuracy below 10 m on the 80% of cases. This result shows the significance of exploiting one additional 5G RTT for mobile localisation, due to the reduced number of visible GNSS satellites in deep urban canyons.

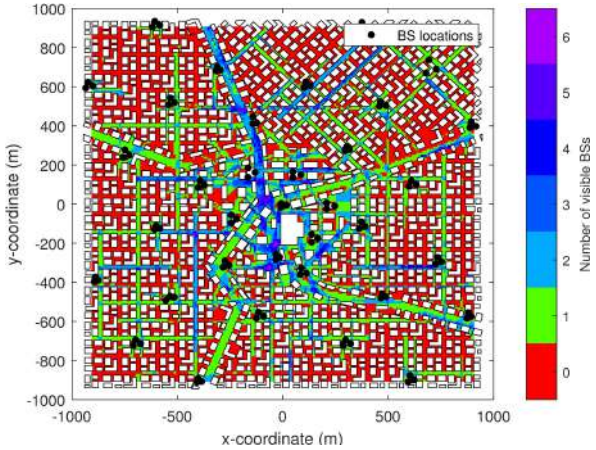

Figure: Cellular base stations in LoS conditions from outdoor positions over an example 3D city map.

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Highlights from the last meeting

DWG1 - Radio channels: DWG1 sessions covered 20 TDs. The sessions covered many new measurement campaigns, showing continued interest to obtain radio channel parameters and models. Covered scenarios are industrial environments such as a ship engine room, radio links between moving vehicles, long-distance links, and outdoor-to-indoor scenarios. Measurement-based analysis of radio channels highlighted different pathloss models and their interpretation based on surrounding environments, deployment of antennas and weather. Analytical studies are presented for field scattering, atmospheric attenuation, tropospheric propagation, Doppler shift in vehicular scenarios and statistics of multi-dimensional channels. During the discussion sessions, DWG1 covered nomination of speakers for the final workshop, dissemination opportunities and book writing.

DWG2 - PHY (Physical) Layer: WG2 had 2 sessions, one dedicated to discussion and one with 5 presented TDs. The discussion had two major topics. First, we discussed the final steps needed to be done on final book drafting (namely association of external publications to TDs, and copyright-free pictures). The second part of discussion was dedicated to preparation of final IRACON workshop. We identified number of topics that are hot candidates for the potential follow-up project. The technical session comprised of TDs addressing topics of MIMO performance in long-range refractive environment, sensing network processing with soft/hard decisions and node clustering, Fog-Massive-MIMO in cell-free scenarios, coordinated beam-forming, and service reliability measures for mobile networks.

EWG-RA Radio Access and DWG3 - NET (Network): There were 2 EWG-RA sessions, both were joint with WG3, and there were 2 individual sessions of the WG3. Most TDs addressed performance assessment and optimisation by mean of simulation, with one presentation addressing experimental validation of sub-6 GHz massive MIMO and spatial stream correlation. An increasing use of the NS3 simulation tools was evident in the TDs, with applications including provision of emergency cellular coverage by means of drones and millimetre wave beam forming. During the discussion the final book chapter was reviewed and speakers for final workshop were proposed.

EWG-OTA - Over-The-Air testing: The presentation on the issue of 5G safety, based on TD(19)11003, illustrated the fact that this issue is becoming an increasingly polarised debate. Even in the coffee breaks, the discussions in the group continued. A review of existing safety guidelines was followed by an analysis of how 5G will impact current regulations. The paper concluded with a summary of research into biological effects of EMF radiation level including mechanism of the voltage gated calcium channel which has been linked to positive and negative biological effects. Another remarkable presentation was that of a 28 GHz Massive MIMO sounder, TD(19)1101. Based on the switched array principle, the sounder multiplexes 256x128 dual-polarised channels with a switching rate of approximately 10 us and with a 1 GHz bandwidth, enabling nanosecond resolution. This outperforms existing sounder solutions.

EWG-IoT - Internet-of-Things: In the EWG on IoT a smart city testbed developed at the University of Málaga was presented. The smart campus is equipped with tens of sensors and actuators of different types, whose communication is allowed through various Radio Access Technologies (e.g., Wi-Fi, Zigbee, LoRa, etc.). Another work presented a prototype of a mobile device for generating an electromagnetic curtain to create a wideband jamming signal. Finally, the concept of Vehicle-to-Everything communication, considering a densely populated highway, was investigated.

SEWG-IoT - Internet-of-Things for Health: During the 11th IRACON technical meeting the SEWG-IoT: Internet-of-Things for Health (IoT-Health) held one session with 3 TDs and one joint session with EWG-IoT with one TD related to IoT-Health. There were 30 attendees in general. The presentations included the following topics: the influence of user dynamics on small-scale fading characteristics in off-body channels, nano-networks operating inside of the human body and interfacing with a BAN, a cost-efficient near field numerical validation method for IoT-Health devices, and the use of deep learning in identifying LOS vs. NLOS UWB communication channels in BANs.

EWG-LT - Localisation and Tracking: In Gdańsk, three TDs were presented. This included advances in hybrid (GNSS + 5G) positioning from a system-level perspective. Specifically, it revolved around the exploitation of 3D maps for an effective determination of LOS/nLOS conditions (outcome of a short-term mission); and on physical-layer abstractions. Complementarily, a detailed analysis of errors in radio distance measurements (i.e., link level, experimental) with a Decawave chipset was presented too. Besides, the group discussed recent progress and next steps in the elaboration of the book chapter and proposed several names of invited speakers for the final event.

Newcomers to the Action.

COST-IRACON Final Workshop
January 28, 2020. Université Catholique de Louvain, Louvain, Belgium

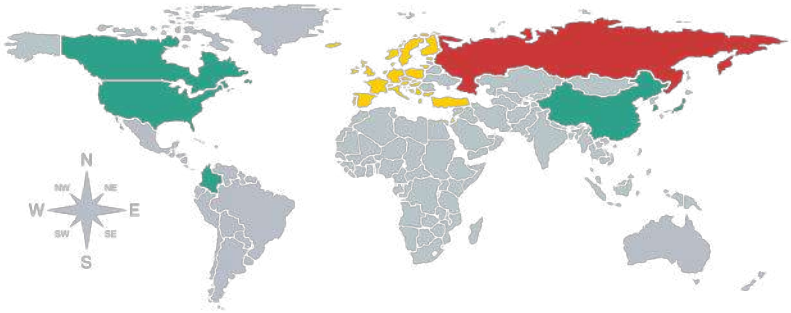
Organisers: Claude Oestges, Université Catholique de Louvain (UCL)

Radio Communications have become one of the pillars on which our Society relies for performing many daily tasks. Today, the number of connected devices is increasing exponentially, reflecting not only enthusiastic smartphone adoption but also increasing connectivity of machines, sensors, vehicles and other devices for health and smart environments.

The Inclusive Radio Communications concept defines those technologies aimed to support wireless connectivity at any rates, for any communicating units, and in any type of scenarios. The Wireless Internet of Things beyond 2020 requires revolutionary approaches in Radio Access technologies, networks and systems. Over its four years of existence, COST Action CA15104 (IRACON) has achieved scientific breakthroughs by introducing novel design and analysis methods for the 5th-generation (5G) and beyond-5G radio communication networks. Results have spanned the whole gamut from radio channel modeling, in particular in the millimeter-wave range to signal processing for massive MIMO and C-RAN, innovative network architectures and protocols and finally experimental research addressing Over-the-Air testing, the Internet of Things, localisation and tracking and new radio access technologies.

The IRACON Final Workshop will bring together several international experts to discuss new emerging challenges in the scientific areas covered by the Action, as well as new research topics raised by a number of Vertical applications, in particular Health, Mobility, Industrial Automation and Smart Environments.

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