COST CA15104 ACTION
Newsletter

Inclusive Radio Communication Networks for 5G and Beyond

IRACON

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 eighth issue of this newsletter. In this issue, we focus on the highlights of our 8th technical meeting, which took place in Podgorica, Montenegro. During this meeting, we had the opportunity to listen the talk of Mališa Vučinić, from the University of Montenegro, about how Internet-of-Things (IoT) technology is being developed within the Internet Engineering Task Force (IETF).

As usual, we'd like you to meet two people behind the Action. In this issue, we have given the floor to Dr. Gerarld Artner, researcher at the Technische Universität Wien, and to Dr. Per Hjalmar Lehne, senior researcher at Telenor Research in Norway.

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

Dear IRACON colleagues,

Welcome to the 8th issue of our Newsletter!

Winter is slowly coming, also bringing the first commercial roll-outs of 5G, mostly targeting enhanced data rates and fixed wireless access. And yet... many research projects on 5G are still under way, including within IRACON. Simultaneously, we are surrounded by such hype and so many buzz words, somehow reminiscent of 3G, that, at this stage, it is still unclear which key innovations will truly make their way to the market in 2019 and 2020. Millimeter waves and network slicing might be part of 5G, or not ? Wouldn't that actually be a good time to sit and talk about 6G? Rightfully, you could claim that I am adding yet a new buzzword. As already mentioned on our blog by one of our members, there should not be anything after 5G, as 5G was envisioned by business analysts as THE solution to all applications. However, many challenges remain, so that 5G will likely not be the universal answer it was intended to be (or it would be called 42G). In particular, the energy consumed by wireless technology is becoming critical and should probably be addressed by any future generation. What else? As a gathering of so many experts in wireless communications, I am sure that we, that is you, have many ideas. Now is actually the good time to share them, as we also consider our sustainability as a network. Hence, I would like to renew my invitation to share your vision about future generations of wireless radio!

Claude Oestges
Université catholique de Louvain, Belgium

Whereas talking about the future is always like reading in a crystal ball, looking into the past of our action is actually much easier, and I am so far really proud of the results we have achieved. These achievements were clearly acknowledged by the review of our action conducted last summer: let me express my warm thanks to all of you who contributed to our report, with joint publications, deliverables and lots of dissemination activities. What is probably missing is to increase further our global reach and industrial impact, but I am very much confident as I witness the table of content of our final book slowly building up.

As already advertised, our next meeting will be held in Dublin (Ireland), on January 16-18 2019. Until then, I would like to wish you an excellent end of 2018 as well as a tremendous 2019.

Enjoy the reading !

EuCNC 2018 Special Session: COST Actions on Networks and Communication

At EuCNC 2018, which was held in Lubjana last June, selected COST Actions presented their work dealing with topics related to 5G and beyond. This special session highlighted the aim and research work of some selected starting, running and ended Actions. It provided and deepened the exchange between those researchers engaged in the COST Actions and the audience of the session. In addition, the audience was advised on how to create or to join existing COST Actions. IRACON activities were presented by Prof. Dr Gordana Gardašević. It has been emphasized that this COST Action aims at scientific breakthroughs by introducing novel design and analysis methods for the 5th-generation (5G) and beyond-5G radio communication networks. Challenges and preliminary results were also highlighted. Other presented COST Actions were: COST Action CA16220 – "European Network for High Performance Integrated Microwave Photonics"; COST Action CA15127 – "Resilient communication services protecting end-user applications from disaster-based failures (RECODIS)"; COST Action IC1303 – "Algorithms, Architectures and Platforms for Enhanced Living Environments (AAPELE)"; COST Action CA16226 – "Indoor living space improvement: Smart Habitat for the Elderly".

Interview with a senior researcher

Short biography

Dr. Per H. Lehne got the MSc degree from the Norwegian Institute of Science and Technology (NTH) in 1988. Since then, he has been with Telenor working on different aspects of terrestrial mobile communications. Since 1993 it has been in the area of radio technology for cellular systems, especially on multiple antenna systems, radio access technologies, spectrum management techniques and cognitive radio. His current focus is on radio access for 5G and massive MIMO systems. He has previously participated in several international research projects in the EU framework, as well as in previous COST actions in the field.

PER HJALMAR LEHNE
Senior Researcher
Telenor Norway

What are your favourite areas of interest and research?

Since I started my education and work career, I have been fascinated by wireless communications, all from the electromagnetic theory, antennas and to propagation. Later, I also find the merging of signal processing and electromagnetics interesting, in understanding how multiple antenna systems are able to exploit the spatial domain. Of course, working for a mobile operator also makes it both interesting and necessary to study the effects of wireless technology on society and business.

What was your motivation to become a researcher?

Already from childhood, I was curious about physics and nature and technology. I wanted to understand how everything worked and used to take things apart. I started my career as a telco engineer, but got bored after some years, so I decided to seek more challenging work.

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

Actually, I think there are three "big things" which combined will lead to great transformation on people, society and how we do business. The first is artificial intelligence (AI) which has developed quite a lot the last years, and it will most likely evolve much further and have a big impact on our lives. The second is the emergence and growth of machine-type communications, and Internet of Things (IoT). This will create huge amount of data, which again will feed the first trend, AI. The third big thing is, of course, 5G, which transforms networks and will enable all the data to be transported. All in all, since these three things coincide and enforce one another it will surely have a big impact.

What was your motivation to be part of COST IRACON?

I was introduced to COST in 1995 (COST 231!), and soon became very fond of the concept, so I stayed on.

What would like COST IRACON to achieve?

To make a difference in moving wireless technology forward, and to help the career of future researchers.

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

I don't have one favourite book, but I like historical novels from the 20th century, especially understanding the European history. Currently I am reading the "Century Trilogy" by Ken Follett. Regarding music I am all into jazz, and if I were to pick one favourite it has to be Miles Davis who I was lucky to listen live to in 1984.

My favourite holiday is…

Outdoor recreation, including fishing.

What is your country well known for?

Norway is probably most known for three things: Nature, fish and oil. What I have learned to like most is the values: a liberal and open society with a high degree of trust between people, authorities and businesses.

My favourite or personal quote is …

"Jazz isn't dead. It just smells funny", by Frank Zappa (1978)

Interview with an Early Career Investigator

Short biography

Gerald works on vehicular antennas and carbon fiber reinforced polymer. He has a Bachelor's degree in Electrical Engineering and Information Technology, a Master's in Telecommunications and a PhD in Electrical Engineering, all from Technische Universität Wien, Austria.
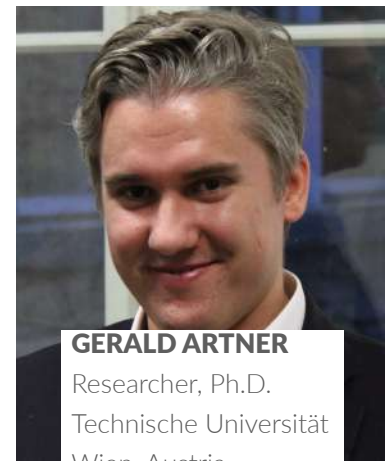
GERALD ARTNER
Researcher, Ph.D.
Technische Universität
Wien, Austria

What was your motivation to become a researcher?

I wanted to get educated and do interesting things. I got the opportunity to be a researcher while I was on my way.

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

Colleagues from my institute introduced me to COST IC1004.

What was your motivation to be part of COST IRACON?

I already was part of COST IC1004. I saw how important it is to connect with colleagues. So it felt natural for me to continue in COST IRACON.

What would like COST IRACON to achieve?

IRACON already achieves its most important mission. It connects researchers from all over Europe so that we can share, cooperate and discuss.

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

Communicative vehicles. When people in the future look back at our time, they will wonder how traffic even worked when cars could only communicate by blinking lights and honking horns.

What are your favourite areas of interest and research?

Automotive antennas and antennas with carbon fibre reinforced polymer.

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

Making top ten lists is better left to the Youtube professionals, but here are some things worth checking out: Bojack Horseman has some witty writing for an animated series. In the last decades, German hip-hop has become mainstream and is now near its peak. Thirteen of the top fifteen tracks in the Austrian charts are currently from the same artist duo. It's weird. I'm a fan of the writer Thomas Bernhard.

I'm most passionate about …

Teaching university courses. When I awaken the student's interest in telecommunications and see their enthusiasm, then it also reignites my own interest to work in the field.

What is your country well known for?

Most people know Austria for the scenic Alps and the historic buildings. Most people also know someone who is from Austria - it has quite a high density of great persons.

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

Reading books in one sitting. Somehow, I always read the first half of a book, and then I let it rest for a few weeks and after that mysteriously decide to finish it.

My favourite or personal quote is …

We decide who is worthy of our works.

My favourite holiday is …

New Year's Day.

Is there anything else you like to share?

I will invite the first three people who send me an email with the subject "I read your interview in the IRACON newsletter" to a coffee (at the next COST meeting, or when we meet again).

Selected scientific topic:

"Novel Over-the-Air test method for 5G mmWave devices with beam forming capabilities". D. Reyes, M. Beach, E. Mellios, M. Rumney - TD(18)08001

To deliver the high capacity and throughput goals for 5G, the effective use of millimetre wave spectrum is necessary. When compared to sub-6 GHz spectrum, these higher frequencies incur greater attenuation due to path loss and blockages, necessitating the use of directional antennas at both ends of the communications link. These are most likely to be implemented by means of an antenna array and beamformer in a highly integrated form within the RF transceiver. The radio environment is known to be highly dynamic in both spatial and temporal domains. Hence, Over-The-Air (OTA) conformance testing of such systems will be necessary since traditional conducted non-spatial test methods will not predict the radiated performance in space, and antenna connectors are typically not available or not used in such systems.

This paper presents a highly novel millimetre OTA test method for emulating spatially dynamic channels exploiting the reflective properties of ellipsoidal surfaces facilitating the excitation of a Device Under Test from multiple dynamic narrow angles of illumination, thus representing typical operating conditions. The theoretical and experimental analysis showed that this method could be good a candidate for testing Radio Resource Management and demodulation requirements of 5G mmWave mobile devices in dynamic spatial environments and could be proposed to be included as one of the test methods within the Release 16 study item on testability at 3GPP which will consider dynamic spatial environments.
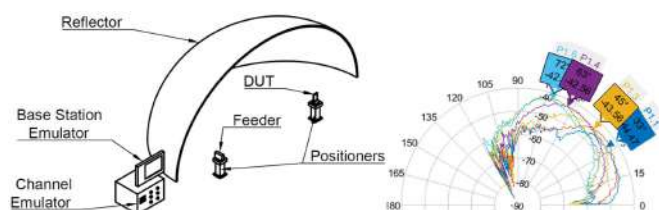

Figure: mmWave OTA test method setup with an ellipsoid reflector (left hand side) and results from Angular power distribution with horizontal polarization (right hand side).

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Selected scientific topic:

"Outdoor 3G Location Tracking of Mobile Devices in Cellular Networks" by J. Trogh, D. Plets, E. Surewaard, M. Spiessens, M. Versichele, L. Martens and W. Joseph - TD(18)08006

This paper presents a technique for anonymous outdoor location tracking of mobile devices, completely performed on the network side without any interventions on the mobile side. The proposed technique uses 3G measurements, the topology of a mobile cellular network, and enriched open map data. Location updates are based on timing information, signal strength measurements, base station configurations, mode of transportation estimation, and advanced route filtering. Validation data consisting of millions of parallel location estimations from over a million users are collected in real-time in cooperation with a major network operator in Belgium. Experiments are conducted in urban and rural environments near Ghent and Antwerp, with trajectories on foot, by bike, and by car, in the months May and September 2017. It is shown that both the mode of transportation, base station density, and environment impact the accuracy and that the proposed AMT location tracking

is more robust and outperforms existing techniques with relative improvements up to 88%. Best performances were obtained in urban environments with median accuracies up to 112m.
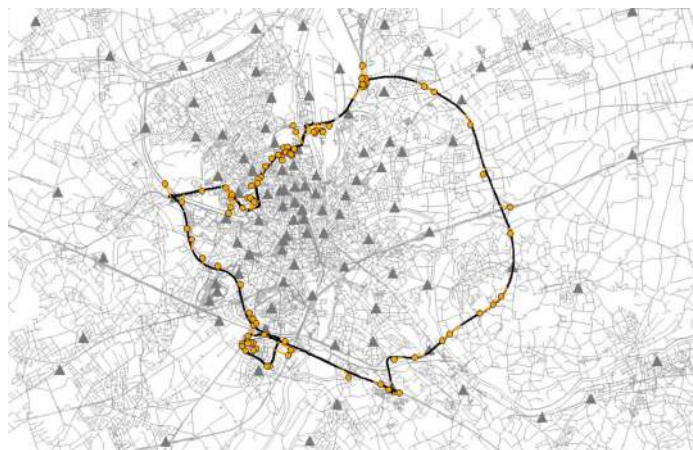

Figure: Estimated locations (yellow) for a trajectory done by car in an urban environment (GPS ground truth indicated in black, road network in gray and base stations are shown as triangles).

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Selected scientific topic:
"Fully Parallel Distributed Massive MIMO Channel Measurements in Urban Vehicular Scenario", by D. Löschenbrand, M. Hofer, L. Bernadó, G. Humer, B. Schrenk, S. Zelenbaba and T. Zemen–TD(18)08031

Massive multiple-input multiple-output (MIMO) is an important enabling technology for the fifth generation of wireless communication systems (5G). It promises increased data rates, reduced energy consumption, and highly reliable communication through the mitigation of fading and increased spectral efficiency.

We present a measurement framework for rapidly time-varying distributed massive MIMO channels, as found in vehicle-to-infrastructure (V2I) scenarios. With this framework, we are able to characterize the wireless propagation channel for 32 receive and two transmit antennas simultaneously with a bandwidth of 115MHz and a repetition rate of 1ms. We introduce (1) a custom-built calibration device to facilitate calibration in the field and (2) a synchronization method for distributed massive MIMO arrays enabling a separation of receive antennas of up to 60m. Our flexible setup allows for extending the receive antenna number to 96 and the receive antenna separation to 200m.

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Measurements are performed at a carrier frequency of 3.52 GHz in an urban vehicular scenario. The transmit antennas are mounted on a car and the receive antenna arrays are placed with varying distances on the rooftop of a building. We analyze the measured channel characteristics and the singular value spread over time for collocated and distributed receive antenna array setups. Our results show that collocated receiver arrays outperform the distributed ones in terms of the singular value spread for the given scenario.

Figure: AIT distributed massive MIMO testbed.

Selected scientific topic:
"Variability of the Dielectric Properties Due to Tissue Heterogeneity and Its Influence on the Development of EM Phantoms" by A. Fornes-Leal, C. Garcia-Pardo, S. Castelló-Palacios, M. Frasson, A. Nevarez, V. Pons-Beltrán, N. Cardona – TD(18)08036

Wireless Body Area Networks (WBAN) are massively researched nowadays given their huge potential in healthcare monitoring. In their design process, researchers make use of electromagnetic phantoms, which are either software or physical tools that emulate the shape and the electromagnetic characteristics of the biological tissues. They are used in software simulations and laboratory trials to determine if a WBAN device or system performs correctly and how it interacts in presence of human bodies. When making use of these phantoms, researchers just consider the average electromagnetic properties provided by Gabriel's database. However, these properties are not constant. They have some dielectric variability mainly due to the natural heterogeneity of the tissues, and they change slightly among subjects due to factors as the age. Our work reports the variability of the electromagnetic properties of tissues of the gastrointestinal area such as muscle, skin, fat, colon,

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small intestine and stomach, in terms of dielectric constant and conductivity. These data were gathered from animal experimentation performed in a conditioned surgery room at Hospital La Fe of Valencia, measuring the tissues of 3 porcine subjects with an open-ended coaxial system. Generally, tissues with lower water content had larger dielectric variability (in relevant terms of the relevant parameter), as one can observe in the figure. This variability should be considered when using phantoms for designing some specific applications, since it can compromise their performance.
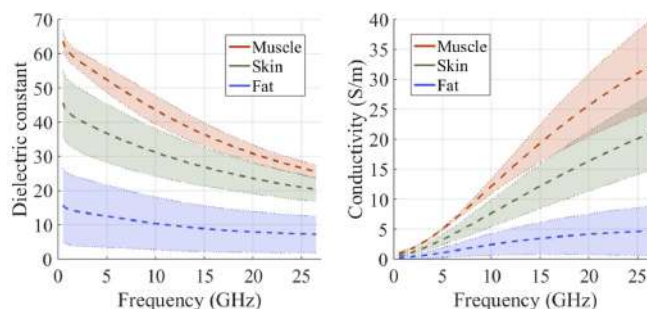

Figure: Mean (dashed line) and variability (shadowed area) of the dielectric properties of muscle, skin and fat tissue.

Highlights from the last meeting

DWG1 - Radio channels: WG1 had 17 TDs. They reported new vehicular, massive MIMO, centimeter- and millimeter-wave channel measurements, studies of frequency dependency of radio channels, site-specific channel simulations for cellular and fixed wireless links, insights into channel model improvement, e.g., ITU-R, 3GPP NR and diffuse scattering and assessment of link performance based on measurements. The discussion session covered a table of contents of book chapters and channel models reported in the IRACON book..

DWG2 - PHY (Physical) Layer: At the Podgorica meeting, the WG2 session had only 2 TDs presented. One on the non-pilot based channel state estimation in physical-layer network coded communications and the second one on throughput optimisation in relay based communication network. We have discussed the topics for final book sections and concluded that some of the TDs presented in RA group have a strong relationship to PHY layer, namely Massive-MIMO and full-duplex topics. As a consequence, one new section is proposed and one section is extended. We have also thoroughly discussed the topics of the upcoming TS in Lyon..

DWG3 - NET (Network) Layer: In Podgorica meeting, DWG3 had two independent sessions with 8 TDs and two joint sessions with WG1 (4 TDs) and RA-EWG2 (3 TDs). Our TDs covered TVWS communications and spectral activity detection, UAV networks, vehicular networks, network slicing, small cell networks, intrusion tracing, RA in wireless mesh networks, and mobile offloading. In this meeting we discussed the book chapter of the working group. We discussed the topics of the book chapter sections based on the classification of TDs that we have. We also agreed to accommodate some contributions of EWG2-RA in our chapter.

EWG-OTA - Over-The-Air testing: In EWG-OTA, TD(18)08001 "Novel Over-the-Air test method for 5G mmWave devices with beam forming capabilities" introduces a new concept in OTA testing radically different from those defined for MIMO OTA in COST2100 a decade ago. The new method targets spatially dynamic environments at mmWave and uses the reflective properties of elliptical reflectors coupled with a steerable source antenna to generate arbitrary angles of arrival with potentially several simultaneous beam directions and test UE beamsteering.

EWG-IoT - Internet-of-Things: During the EWG-IoT sessions, the NB-IoT technology has been described in detail and a mathematical model of the access mechanism to predict the best performance obtainable in a given scenario has been provided together with guidelines on how to set the different system parameters. Moreover, a new real-time multi-threading operating system, RIOT, has been presented, The OS implements a microkernel architecture and supports a wide range of IoT devices, being characterised by energy-efficiency, real-time capabilities, small memory footprint and uniform API access independent of the underlying hardware.

SEWG-IoT - Internet-of-Things for Health: The SEWG Internet-of-Things for Health (IoT-Health) held one session with four TD presentations during the 8th IRACON technical meeting in Podgorica. The topics of the presentations were related to off-body channel modelling for polarised communications and dynamic users, variability of the dielectric properties due to tissue heterogeneity and its influence on the development of EM phantoms, Internet of Things and mobile crowd sensing in hypertensive patients, and finally FRET-based nanocommunication in organic structures of plant origin.

EWG-RA: Many contributors to the IRACON experimental radio access working group (EWG-RA) are heavily involved in the 5G trials carried out by the 5G public private partnership (5G-PPP) phase 3 projects, which have started in July 2018 and will run for 3 years. During the IRACON meeting in Podgorica in October, all three projects, 5G-EVE, 5G-VINI, and 5GENESIS have been represented and been presented in the plenary. We are looking forward to future collaborations between IRACON and 5G-PPP.

EWG-LT - Localisation and Tracking: There was one session of the EWG-LT where 5 TDs were presented (one of them actually in WG-IoT). The main topics comprised positioning with 3G/4G and LoRA measurements; measurement acquisition of RSS SIMO signals using BLE and radar signals with 1 bit quantization; and system level aspects such as beam selection strategies based on AoA data and machine learning (i.e. location-awareness). In the discussion session, the group commented on the organization of IRACON's book chapter (sections, volunteers), how to effectively disseminate the Whitepaper, and plans for activities to be conducted under the umbrella of Corresponding Group 4 (channel modelling for localization).

Newcomers to the Action.

COST-IRACON ISP-IoT – Information Theory and Signal Processing for Internet of Things. November 18-22, 2018. Lyon, France

Organisers: Jean-Marie Gorce (INSA-Inria), Laurent Clavier (Univ. Lille), Philippe Mary (INSA Rennes).

The fifth Training School of the COST CA15104 IRACON training school, entitled "Information Theory and Signal Processing for the Internet of Things," will take place in Lyon, France from 18th to 22nd November 2018. The school is supported by IRACON and the French National Agency for Research (project ARburst) and hosted by Inria-Insa research group MARACAS at Université de Lyon, France (see https://isp-iot.sciencesconf.org/).

This training school focuses on models and techniques for IoT access networks. It will alternate between theoretical courses and experimental training sessions on the FIT/CorteXlab with GNU radio. Theoretical courses will be given by leading experts in signal processing, information theory and wireless networking. Training sessions will be coached by our experts in GNU radio and communication system design. More precisely, attendees will learn about the most advanced tools, which provide a means to model networks for the Internet of Things, overview the most recent protocols and technical solutions designed for the IoT and experiment on the FIT/CorteXlab plateform to design new PHY/MAC protocols through a challenge based on NBIoT.

Facts & Figures
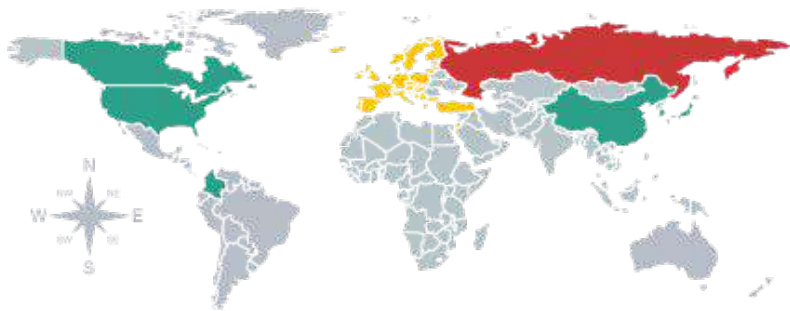
Signatory countries: 35
Austria, Belgium, Bosnia and Herzegovina, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, fYR Macedonia, Germany, Greece, Hungary, Iceland, Ireland, Israel, Italy, Lithuania, Luxembourg, Malta, Montenegro, Netherlands, Norway, Poland, Portugal, Romania, Serbia, 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

288 registered experts

68 MC Members (+chair)

99 participants per meeting (average)

35 research infrastructures

67 presented TD/workshop papers per meeting

181 institutions (industry/university/ research/small and medium enterprises) currently participating

581 participants registered

3 meetings per grant year

5 training school completed

21 STSM completed

16% women

37% ECI

2% Small and medium enterprises

16% Research

8% industry

74% university