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Editor's Address

**Conchi Garcia-Pardo**

Universitat Politècnica de València, Spain

Dear reader,

I am glad to introduce you the ninth issue of this newsletter. In this issue, we focus on the highlights of our 9th technical meeting, which took place in Dublin, Ireland. The day before the meeting, a Joint IRACON-WaveComBE Training Workshop on Radio Channel Modelling for 5G Millimetre Wave Communications in Built Environments was held.

As usual, we'd like you to meet two people behind the Action. In this issue, we have given the floor to Dr. Roberto Verdone, professor at the University of Bologna, and to Dr. François Quitin, from the Université Libre de Bruxelles (ULB), Belgium.

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

Enjoy the reading!

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 is supported
by the EC H2020
Framework**

Chairman's Address

Dear IRACON colleagues,

Welcome back to our Newsletter! With our 9th meeting in Dublin behind us, we are now facing one of our busiest periods of our Action lifetime. Indeed, in the coming weeks and months, some of us will deal with the first draft of our final book, as well as with several actions towards the sustainability of our Action. At the same time, others will write white papers and organize excellent training schools. All of this, with little to no financial support or retribution. The passion shared by our researchers is obviously the key to the success of our COST Action, but it is also a danger as we are sometimes divided between our professional and personal lives. For 2019, I can only wish that we all find a good balance between our research and our families and friends.

If one thing is quite unique about COST Actions, it is the environment they provide to PhD students, through networking, short-term missions and high-quality (though low-fee) training schools. It has recently turned out that these important members of our community are not included in the Early Career Investigator definition of the COST office. This is in sharp contradiction to the inclusiveness motto of COST. Hence, do not hesitate to contact your COST national contact point to share your views about the representation of PhD students in the COST vocabulary. They should be better recognised in the life of a COST action.



Claude Oestges

Université catholique de Louvain,
Belgium

Regarding our final book, the goal is to build a compilation of what we have jointly achieved about 5G and beyond networks, summarising the contributions of hundreds of IRACON researchers. I am confident that the results outlined in these chapters will become recommendations and references for further research, in academia or industry, as well as for regulatory and standardisation bodies. I also take this opportunity to introduce you to François Quitin, whose interview can be found in this issue. François is the co-editor of our final book and I would like to thank him warmly for accepting this challenge.

Our next meeting will be held in Oulu (Finland), on May 27-29, 2019. During this meeting, we will have the opportunity to discuss the first draft of our book. Let me emphasize again that while only some of us are actually contributing to the actual writing, this book is our joint deliverable, so that I am expecting all of you to share your reviews about this first draft. Enjoy the reading of this Newsletter (and of our upcoming draft book) !

ISP-IoT – Information Theory and Signal Processing for Internet of Things

The 5th COST-IRACON Training School entitled "First ISP-IoT – Information Theory and Signal Processing for Internet of Things" was held in Lyon, in November 18th-22th. The school welcomed about 50 trainees from Belgium, Bosnia, England, France, Germany, Ireland, Luxembourg, Portugal, Russia, Serbia. About 15 trainers participated, from industry and academia. The school included one industry oriented panel session, 10 theoretical courses and a series of practical sessions on FIT/CorteXlab. From the experimental side, trainees were in competition to run and optimize an NB-IoT based framework developed in GNU radio on USRPs.

The winning team was from UC Louvain, Belgium with Charles Wiam, Simon Demey, Antoine Paris and Mathieu Xhonneux. They received an USRP offered by National Instruments. The second and third teams with.... received UNB tags offered by SigFox.



Interview with a senior researcher

Short biography

Dr. Verdone was born in 1965. He got his M.Sc. and Ph.D. degrees from the University of Bologna in 1991 and 1995, respectively. Since 2001 he has been full professor at the University of Bologna. He teaches courses on the IoT, mobile radio networks, project management and soft skills. He has been involved in about ten EC research projects, and many industry contracts in the past 15 years. He is senior IEEE member, and published about 150 papers. He is co-founder of an IoT startup (Idesio srl).



ROBERTO VERDONE

Full Professor

University of Bologna & CNIT

What are your favourite areas of interest and research?

IoT and 5G.

What was your motivation to become a researcher?

Knowing more, finding out what's behind surfaces..

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

Making humans and things safely cooperating and integrating in daily life.

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, and which one finished with a "dead end"?

Limiting the answer to the field of wireless communications, the most remarkable is the touch screen for smartphones, for its impact on our daily life; the one that did not get the attention it deserved is renewable energy (in my country).

What was your motivation to be part of COST IRACON?

It was a good training platform for my students..

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

Long story: I was attracted by the international flavour, with 259; after four years of participation, I was asked to act as WG leader for 273. Then, I was asked to act as Chair for 2100...

What would like COST IRACON to achieve?

I would love IRACON to be recognised as the place where 6G is envisioned... but maybe it is not, this is why we need another Action.

What would like COST IRACON to achieve?

We do need to get involved more industries, find innovative ideas to get their contributions on board.

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

My favourite books are "Un amore" ("One love"), by Dino Buzzati, and "Immortality" by M. Kundera. I read both three times. I love Pink Floyd (I know every single song, word, note).

My favourite holiday is...

Travelling over the mountains.

In a few words, I consider myself to be...

An enthusiast.

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

The ability to adapt to ANY situation.

What is your country well known for?

Pasta, pizza, history, and mafia.

What do you like the most about your country?

Pasta, pizza, history, and culture.

My favourite or personal quote is...

Humani nihil a me alienum puto (Terenzio), which means "I am human, and I think nothing human is alien to me".

Is there anything you like to share?

I am 53, and the impression I still have a todo list in front of me much much longer than the list of things done already. Is there anyone who knows the recipe of the long life elisir? I need it. Please call.

Interview with an Early Career Investigator

Short biography

Dr. Quiting received his PhD in 2011 from ULB and UCLouvain jointly, both located in Belgium. I then worked for two years as a postdoc at the University of California, Santa Barbara, and for two more years at Nanyang Technological University, Singapore. In 2016, he came back to Belgium to work as an assistant professor at ULB. His research focus includes channel modelling, localization and tracking and proof-of-concept implementations using software-defined radios.



FRANÇOIS QUITIN

Assistant Professor
Université Libre de
Bruxelles, Belgium

What was your motivation to become a researcher?

I've always been passionate about telecommunications, but back when I graduated, the Belgian industry didn't have much to offer for a telecom engineer. So I went into research, which allowed me to work in an international environment (while staying in Belgium).

What are your favourite areas of interest and research?

Pretty much anything that involves "real" hardware. My thesis focused on experimental channel modelling, and what I liked most about that was setting up more or less complex experimental setups involving state-of-the-art measurement equipment.

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

I became involved in the COST 2100 action, where I presented many TDs over the years and I participated with the definition of the COST 2100 channel model. I was lucky that the duration of COST 2100 corresponded to the duration of my thesis, so there was no COST "gap year" during my thesis.

What was your motivation to be part of COST IRACON?

My motivation was mostly my supervisor instructing me to go to the action. But I soon came to understand why he wanted me to go. I can't think of a conference where there is more collaboration, positive criticism and access to the latest research results as the COST actions.

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

I believe that we are moving to wireless networks that do more than just communication. We will be using wireless networks also for localization and tracking, wireless imaging, autonomous vehicle control and wireless power transfer. As wireless communication systems become more complex (wider bandwidths, more antennas), we are converging more and more to systems that have been used in the radar community of imaging community for decades.

What would you like COST IRACON to achieve?

We do need to get involved more industries, find innovative ideas to get their contributions on board.

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

My favourite authors are John Irving and Paul Auster, which I discovered when I was living in the USA.

I'm most passionate about...

Reading novels and playing with my kids.

In a few words, I consider myself to be...

A pragmatist. I always try to find a middle ground between what I would ideally like to do and what can be done in practice.

What is your country well known for?

I would say that Belgium is best known for its waffles, which always struck me as absurd because Belgian people eat very little waffles on a daily basis. What I like most is the fact that we have people from different communities, with different languages, even though it often leads to political gridlock...

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

To be more effective in my work. I tend to procrastinate just a wee bit too much (which is thankfully compensated by me being very regular).

My favourite or personal quote is...

It's better to ask forgiveness than to ask permission.

My favourite holiday is...

Saint-Nicolas, which is a typical Belgian/Dutch holiday where the aforementioned saint comes to deliver gifts to children.

Selected scientific topic:

"Cooperative Passive Coherent Location: A Promising 5G Service to Support Road Safety". R. S. Thomä, C. Andrich, G. Del Galdo, M. Döbereiner, M. A. Hein, M. Käske, G. Schäfer, S. Schieler, C. Schneider, A. Schwind, and P. Wendland – TD(19)09003

5G promises many new vertical service areas beyond simple communication and data transfer. We propose CPCL (Cooperative Passive Coherent Location) being a distributed MIMO radar service which can be offered by mobile radio network operators as a service for public user groups. CPCL comes as an inherent part of the radio network and takes advantage of the most important key features proposed for 5G. It extends the well-known idea of passive radar (also known as Passive Coherent Location, PCL) by introducing cooperative principles. These range from cooperative, synchronous radio signaling, and MAC up to radar data fusion on sensor and scenario levels. By using both software-defined radio and network paradigms, as well as real-time mobile edge computing facilities intended for 5G, CPCL promises to become a ubiquitous radar service

which may be adaptive, reconfigurable, and perhaps cognitive. Because CPCL makes double use of radio resources (both, in terms of frequency bands and hardware), it can be considered a green technology. Although we introduce the CPCL idea from the viewpoint of vehicle-to-vehicle/infrastructure (V2X) communication, it can definitely also be applied for many other applications in industry, transport, logistics, and for safety and security applications.

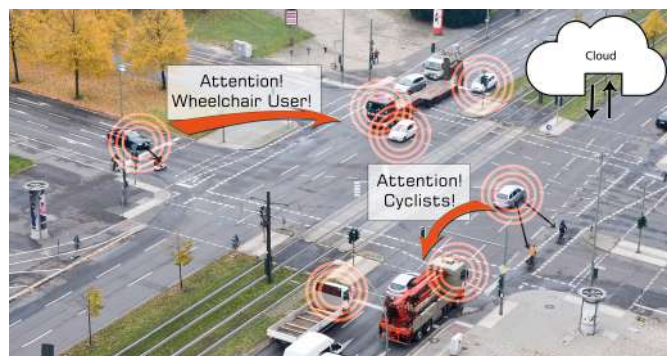


Figure: Cooperative road traffic scenario: connected cars and vulnerable road users.

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Selected scientific topic:

"Learning Approaches to Beam Selection for Hybrid Analog Beamforming" by C. Antón-Haro, and X. Mestre – TD(19)09005

This paper investigates the applicability of deep and machine learning techniques to perform beam selection in the uplink of a mmWave communication system (see Fig. 1 below). Specifically, we consider a hybrid beamforming setup comprising an analog beamforming (ABF) network followed by a zero-forcing baseband processing block. The goal is to select the optimal configuration for the ABF network (namely, the optimal beamformer in a given codebook) based on the estimated angles-of-arrival (AoAs) and received powers. To that aim, we pose the beam selection task as a multi-class classification problem and solve it via two machine-learning (ML) approaches: k-nearest neighbors, support vector classifiers; and one deep learning approach: the multilayer perceptron. Computer simulation results reveal that using MUSIC (vs. Capon) power spectral estimation yields a higher classification accuracy in particular for the MLP scheme. As a result, its sum-rate is virtually identical to that achievable via exhaustive search (i.e., optimal).

As for the ML schemes, they retain some 90% of the optimal sum-rate. Concerning the number of ABFs in the codebook, we learn that, if the search is restricted to the 50% most frequently used ones, the sum-rate degradation is negligible. Besides, we realize that there exists an optimal value for the beamwidth of analog beamformers. This makes it possible to strike the optimal balance between too narrow beams (i.e., in phased arrays) exhibiting poor classification accuracy/sum-rate; and too broad/non-directional ones for which the angles or arrival are not a sufficient statistic.

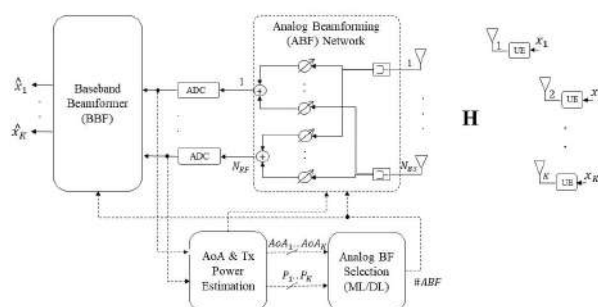


Figure: System model.

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Selected scientific topic:

"Performance Modeling and Analysis for Vehicle-to-Anything Connectivity in Representative High-Interference Channels" by T. Blazek, G. Ghiaasi, C. Backfrieder, G. Ostermayer and C. F. Mecklenbräuker – TD(19)09006

We expect safety messaging between vehicles to increase roadside safety drastically by allowing "looking" around corners and communicating road hazards more effectively. This communication will happen ad-hoc between neighboring vehicles. Such a communication system has to be thoroughly tested and analyzed before widespread deployment. The main challenge here is the difficulty of testing vehicular communication systems on the roads in the necessary scale. Hence, the communication systems are usually analyzed in computer simulations. These are able to capture the protocol and the driving patterns with high fidelity. However, due to complexity restraints, they impose strong simplifications on the underlying physical channel, which mean that the results are not necessary covering real-world behavior. In our paper, we approach the topic from a different direction. We simulate driving patterns, and focus on traffic jam causing bottlenecks (see figure).

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There a large number (more than 100) vehicles are in close proximity, which poses a strong challenge to the safety messaging protocol. We model all these communicating vehicles as a communication graph, and use graph processing algorithms to reduce the complexity of the observed network. After this complexity reduction, we are able to implement the resulting network on lab hardware that accurately emulates the physical transmission process including the vehicular channel. With this approach, we are able to present measured performance in dense networks without the need of outdoor measurement campaigns.



Figure: A traffic jam at a bridge in Linz, Austria leads to a highly dense communication network.

Selected scientific topic:

"Impact of Spatial Consistency on Dynamic Beamforming for Millimeter-Wave Cellular Systems" by H. Tataria and F. Tufvesson – TD(19)09015

Millimeter-wave (mmWave) frequencies are set to play an important role in fifth-generation (5G) wireless systems. A pre-requisite for the design and performance assessment of 5G systems is the understanding of the involved propagation processes and derivation of suitable channel models. Unlike bands below 6 GHz, several additional modelling features need to be catered for at mmWaves. For dynamic scenarios, spatial consistency (SC) is a novel feature of 5G channel models ensuring continuity in the channel parameters with moving user equipments (UEs). Such mobility has an enormous impact on the performance of common beamforming techniques leveraged to deliver high spectral efficiencies. This paper aims to quantify the impact of SC on dynamic mmWave beamforming performance. We focus on the downlink of a 28 GHz urban microcellular (UMi) scenario, where the base station comprises of a 16x16 cross-polarized uniform planar array (UPA) serving multiple 4x4 UPA UEs. Using the standardized Third

Generation Partnership Project 38.901 SC-I procedure, we evaluate the signal-to interference-plus-noise ratio of each UE to predict the system's ergodic sum spectral efficiency with zero-forcing (ZF), block diagonalization (BD), and signal-to-leakage-plus-noise ratio (SLNR) beamforming. Our results show that for practical signal-to-noise-ratio levels, spatially consistent channels yield a significant performance loss relative to channels without SC due to substantial increase of correlation across the channel parameters. The presented results serve as a guideline to recalibrate our expectations from dynamic beamforming at mmWave frequencies.

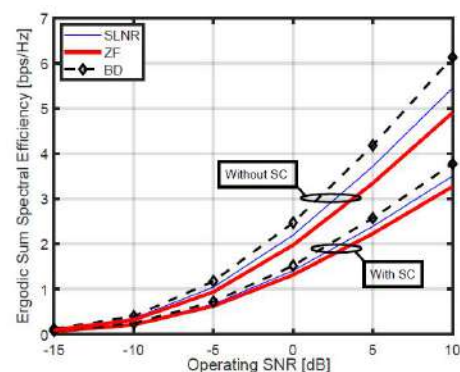


Figure: Performance with and without SC in a downlink 28 GHz UMi with two moving UEs.

Contact Person

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Highlights from the last meeting

DWG1 - Radio channels: DWG1 had 32 TDs. Channel sounding and modeling in vehicular scenarios gained popularity, e.g., in highway, parking and street intersection scenarios at frequencies up to 60 GHz. New channel sounders and sounding campaigns, site-specific radio propagation simulations are reported for outdoor-to-indoor, massive MIMO and radar applications. Understanding and mathematical models on clutter losses, EMF exposure, human body blockage, diffuse scattering, vegetation losses and link/path shadowing are presented. Possible extension ideas of COST 2100 and ITU-R channel models are introduced. Building entry loss measurements included in the generation of the ITU-R building entry loss recommendation 2109-0 (<https://www.itu.int/rec/R-REC-P.2109/en>) were also presented. During the discussion, we went through available measurements from partners and important features of channel models for a possible IRACON channel model..

DWG2 - PHY (Physical) Layer: At Dublin meeting, WG2 had 2 well attended sessions (>25) with 5 TDs presented and rich discussion. TDs' topics ranged from the application of machine learning approaches to PHY signal processing, over low rank channel estimation for multi-antenna systems, various forms of HW aided processing (iterative analog-HW aided detection, RF domain aided precoding), to sparse channel matrix channel detection and estimation for PLNC.

DWG3 - NET (Network) Layer: The Network Layer working group (DWG3) had three sessions as well as several joint sessions with experimental working groups in Radio Access and IoT. Research activities and discussions were grouped in Cellular, WAN/MANET and Planning/Optimisation sessions. Interesting contributions addressing topics as: 5G network deployment and optimisation, measures and realistic scenarios, prediction of moving interference sources and SIR variability, techniques to decrease energy consumption, new SON algorithms for load balancing or inter-frequency handover based on QoE optimisation, measures to characterize the mutual interference of LTE and LoRa working at the same frequency band, rules to improve spectrum efficiency when allocating orthogonal polarisation to nodes, among others. Researchers and attendees were so motivated that discussions continued daily at coffee breaks and lunch.

EWG-OTA - Over-The-Air testing: An update on OTA items in 3GPP was given. Just as for LTE, radiated OTA testing with spatio-temporal channels (MIMO OTA) is to be standardised for New Radio. The differences, however, are that channels for NR, both in Frequency Range 1 (0.5 to 7.125 GHz) and Frequency Range 2 (24.25 to 52.6 GHz) shall have three-dimensional field distributions and that at the moment no consensus exists on which spatial distribution will be defined, especially when applying beam-steering, either at the BS or UE or at both. As a caveat, standardising test methods and requirements for 2D static geometry MIMO OTA for UMTS/LTE took 9 years. Three different application-related metrics were presented for assessing the performance of vehicular antennas based on their patterns.

EWG-IoT - Internet-of-Things: Eight TDs have been presented in the EWG on IoT, including a TD reporting on a joint research activity between UNIBL and UBI dealing with the implementation of Source Routing Minimum Cost Forwarding protocol over 6TiSCH. Other work reported on hardware-assisted testing and simulation of 802.11p-based vehicular communication. Finally, a white paper on future architecture and protocols for the IoT will be edited by the end of March by the EWG..

SEWG-IoT - Internet-of-Things for Health: The SEWG-IoT: Internet-of-Things for Health (IoT-Health) held two sessions with 7 TD presentations during the 9th IRACON technical meeting in Dublin. There were 34 attendees. The presentations included topics such as channel modelling in Body Area Networks (BANs), nanonetworks-BANs interface, and a bitrate adaptation method to increase the usage efficiency of resources in heterogeneous BANs. Discussions were also conducted to highlight collaborative efforts, upcoming events, and the status of the book chapter.

EWG-RA: The Experimental Work Group on Radio Access convened 2 joint sessions in Dublin (WG1 and WG2/3) with presentation of 6 TDs and discussions. Of particular note was TD15 on the examination of spatial consistency of millimetre wave channels and comparing 'drop' and continuous motion models. TD86 took distributed Massive MIMO to the limit with every antenna remotod as well as use of Fog computing and the concept of co-ordination units to mitigate pilot contamination.

EWG-LT - Localisation and Tracking: Nine TDs were presented, providing new insights in the modeling of range and angle measurements for localization, position estimation methods, and system-level studies of positioning systems. Indoor scenarios received strong attention but also vehicle-based and cellular systems have been addressed. The discussions included recent progress towards a correspondence group on channel modeling, identifying modeling needs for positioning systems.



Newcomers to the Action.

COST-IRACON Training School on Machine and Deep Learning Techniques for (Beyond) 5G Wireless Communication Systems. April 8-11, 2019. Castelldefels (Barcelona, Spain)

Organisers: Carles Antón-Haro (CTTC), Adriano Pastore (CTTC).

This training school will revolve around the application of Machine and Deep Learning techniques to the design of future communication systems, with particular emphasis in (but not limited to) physical and lower layer functionalities such as coding and modulation, equalization, radio resource allocation, etc. The training school will comprise keynote and tutorial lectures by renowned researchers from academia and industry, focused presentations on recent advances in this research field, panel discussions, and hands-on sessions

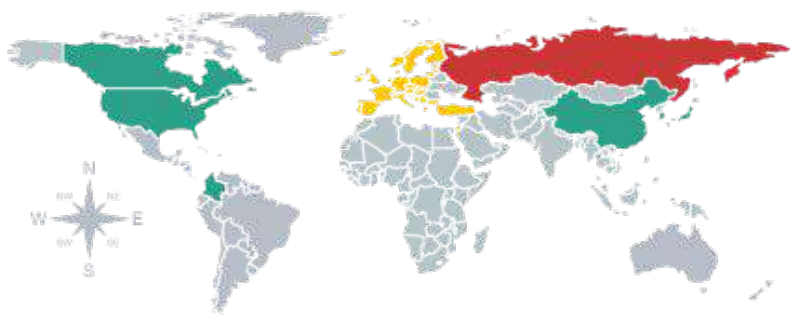
The training school is open to all but young PhDs and early-stage researchers in electrical engineering, computer science or related fields are particularly welcome to attend and participate! The program includes a student poster session and a Machine Learning challenge.

Confirmed speakers (list to be completed):

- Mérouane Debbah (Huawei Paris, France)
- Yair Be'ery (Tel-Aviv University, Israel)
- Osvaldo Simeone (King's College London, UK)
- Sebastian Cammerer (U. Stuttgart, Germany)
- Deniz Gunduz (Imperial College, London, UK)



Facts & Figures



Signatory countries: 35

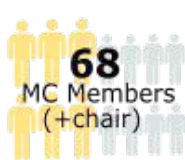
Austria, Belgium, Bosnia and Herzegovina, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, FYR Macedonia, Germany, Greece, Hungary, Iceland, Ireland, Israel, Italy, Lithuania, Luxembourg, Malta, Montenegro, Netherlands, Norway, Poland, Portugal, Romania, Serbia, Slovakia, Slovenia, 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



2%
Small and medium enterprises

