

Newsletter

Number 1, April 2022

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COST CA20120 ACTION



IN THIS ISSUE:

- 1 - EDITOR'S ADDRESS
 - 2 - CHAIRS' ADDRESS
 - 3 - PAST EVENT
 - 4 - INTERVIEWS
 - 5 - SELECTED SCIENTIFIC TOPICS
 - 6 - LAST MEETING'S HIGHLIGHTS
 - 7 - UPCOMING EVENTS
 - 8 - FACTS & FIGURES
- 

EDITOR'S ADDRESS

Dear reader,

I am glad to introduce you the first issue of the COST INTERACT Newsletter.

In this issue we will guide you through the highlights of the first technical meeting, which took place in Bologna, Italy. In this context, we set the basis for what will be the next steps, goals and challenges of this Action. We also gave the floor to Jose-Maria Molina-Garcia-Pardo, full professor at the Universidad Politécnica de Cartagena (Spain), and to Charles Wiame, PhD student and teaching assistant at UCLouvain (Belgium).



Francesca Conserva
University of Bologna, Italy

We hope that this newsletter will turn out to be a great chance to provide you food for thought for next upcoming meetings and initiatives.

Enjoy the reading!

ABOUT COST

This COST Action aims at contributing to the societal transformation, by developing the next generation of radio communication networks, 6G.

The Intelligence-Enabling Radio Communications for Seamless Inclusive Interactions (INTERACT) vision is to go beyond the capabilities of the 5G and to make the radio network itself intelligent, meaning aware, adaptive and parsimonious.

Challenges include:

- 1) Fundamental research in the fields of antennas and propagation, signal processing and localization, network architectures and protocols, to design intelligent-enabling radio communications;
- 2) Exploitation of Machine Learning tools for the implementation of many aspects of this network intelligence;
- 3) Collecting real-world data and making them available to the research community by building the INTERACT datasets.

This COST action started in October 2021 and ends in October 2025.





JOINT INTERACT-HUAWEI WORKSHOP

On February 8th, 2022, a joint Huawei – **INTERACT** workshop on “Intelligent IoT for 6G” has been organized in Bologna, Italy. The Chairperson was Prof. Roberto Verdone, University of Bologna & CNIT/WiLab. The workshop was organized by CNIT/WiLab under the auspices of the WiLab-Huawei Joint Innovation Center established in Bologna in 2020.

It was participated by nearly 300 researchers, of which more than 70 in presence. The workshop included a keynote speech by Dr. Tong Wen (CTO Wireless at Huawei), a presentation of the One6G Association, six speeches offered by WiLab-Huawei, and eight papers chosen among those submitted to the **INTERACT** meeting held in the rest of the week. The **INTERACT** Chairs selected the eight TDs, with the scope of the best match with the topics of the workshop.

A very interesting perspective on the use of THz frequencies, massive multiple access techniques, UAV-based mobile radio networks, joint communication and sensing and other new technologies for 6G and the IoT, was offered to the participants. In particular, the Industrial IoT and the Internet of Vehicles were among the domains more deeply discussed.

The workshop has paved the way for the collaboration between the COST Action INTERACT and a major industry stakeholder in the field of mobile communications.

CHAIRS' ADDRESS

INTERACT is starting and that's great news! If the world shows an interaction based on conflict and isolation, let's promote benevolence and collaboration. The universality of radio networks that has taken so long to build could be challenged.

When division reigns, one of the first effects is the loss of trust in information. This is the opposite of **INTERACT**'s objectives.

With its long history, **INTERACT** must be built to meet the ever-changing challenges of radio networks and, more broadly, to contribute to meeting the societal challenges of our time. For this, we need the contributions of each of you and to ensure a working space in trust.



We must not underestimate the current challenges and we must not underestimate the part we can play in addressing them. **INTERACT**'s community, which is only waiting to grow, will only be effective if we work together towards common goals. The past has shown that we can do this. Let's hope that the future will show that we still know how to do it.

Bologna was the first meeting place for **INTERACT**, partly on site, partly remote. The participation was significant and the discussions were intense, reflecting a lack of participation after years of scarcity and certainly showing a desire to work together.

Wonderfully organized and widely followed, these few days presage an action that will bring us the pleasure of doing our job as researchers!

Laurent Clavier & Chiara Buratti

INTERVIEW WITH A YOUNG RESEARCHER: CHARLES WIAME



**ELECTRICAL ENGINEER
UCLouvain - LOUVAIN SCHOOL
OF ENGINEERING/ICTEAM
INSTITUTE (BELGIUM)**

**PhD student and teaching
assistant at UCLouvain.**

What are your favourite areas of interest and research?

Stochastic geometry for wireless networks, EMF (ElectroMagnetic Field) exposure modelling, cell-free networks.

What was your motivation to become a researcher?

I particularly appreciated my master thesis when I was in my last year of engineering. This was one of the elements that gave me the motivation to apply for a PhD program. I particularly appreciate the freedom I have in my research: the possibility to explore various topics and open questions. In my personal case, my PhD contract was also involving a number of teaching activities. Teaching or supervising younger researchers is a social aspect that can be very nice and rewarding.

What is the “next big thing” in the wireless communication area?

It is hard to truly predict the next groundbreaking finding. Several technologies have aroused a lot of interest in the literature: intelligent surfaces, ML/AI, drone-assisted networks, quantum communications, etc. I would rather say that one of the challenges ahead for the community will be to distinguish directions bringing a practical and societal benefit from those of interest from a theoretical perspective only.

What was your motivation to be part of COST INTERACT?

In the previous action my participation was mostly about listening/attending the talks and training schools. In this new INTERACT action, I am willing to be involved in a more proactive manner: with more discussions with peers, and scientific collaborations.

What would like COST INTERACT to achieve?

Bring/encourage more collaborations between young researchers, especially students at the beginning of their phds.

My favourite book, music(ian), movie, TVseries are ...

Musicians/Bands: Imagine Dragons, Angèle
TV-serie: Game of Thrones
Film: Casinò Royale

What is your country well known for?

I will try to avoid mentioning Belgian fries and chocolate: a fun fact about Belgium is that we have the highest density of castles per km².

My favourite or personal quote is ...

Mmh, I do not really have a personal quote... So I will refer to the previous question and state the motto of my country: ‘Unity makes strength’, which suits well to the spirit of INTERACT when you think about it ;)

Is there anything else you like to share?

Looking forward to meeting you all!

INTERVIEW WITH A SENIOR RESEARCHER: JOSE-MARIA MOLINA-GARCIA-PARDO



**FULL PROFESSOR
UNIVERSIDAD POLITÉCNICA DE
CARTAGENA (SPAIN)**

**Department of Information
Technologies and
Communications in UPCT**

SiCoMo research group leader

What are your favourite areas of interest and research?

Radio-communications, propagation, channel modelling and experimental channel sounding in different frequency band.

What was your motivation to become a researcher?

Difficult question, probably the challenge of continuing studying, but also academic environment and managing your own work in time and space.

What is the “next big thing” in the wireless communication area?

We are actually facing this “big thing” and huge social change, where everything is connected, monitored in the cloud. It ranges from social relationships and health to industry.

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

Limiting to electronic and electrician engineering, where there are many of each one, I would say moving everything to the cloud and imaging, and 3D televisions.

What was your motivation to be part of COST INTERACT?

Having attended for more than 20 years conferences and workshops about my field (propagation), COST is the unique event where 100% of the presentations are interesting for me, but it is not limited to technical contents, but also human relationship, create deep research networks and being part of a family. I am happy to have active collaboration/friendship with France, Belgium, Italy, and Finland.

What would like COST INTERACT to achieve?

Achieving the same as in the past 20 years it would be great: knowledge and research cooperation.

My favourite book, music(ian), movie, TVseries are ...

I like books related with technical things, history, or nautical stories (i.e. Shipkiller, Justin Scott). Music, almost everything ranging from Spanish singer-songwriters (Joaquin Sabina) to Pop Rock. Really love 90's films from Spielberg and Lucas, as well as 007 saga. Many TV serials, such as Breaking Bad or Games of Throne. I really enjoy watching documentaries.

What is your country well known for?

Spain, I guess it is considered as having good weather country since many north European 3rd age people retire in my area, as well as a good place to eat well.

My favourite or personal quote is ...

Happiness is just a question of time and health.

Is there anything else you like to share?

Life runs fast, enjoy it as much as possible.



WG1 - Radio Channels

WG1 focused on: mm-wave and THz, including material, vegetation and diffuse scattering measurements, new MIMO channel sounders; studies of beamforming performance in various propagation environments; stochastic geometry propagation models, ray-based propagation simulation tools, ITU standard propagation models; vehicular propagation measurements and models; propagation modelling for reconfigurable intelligent surfaces. The collaboration between COST WG1 and EurAAP WG9 "Propagation" has been approved as well.

SWG - THz

The presented TDs focused on: advanced set-ups and calibration of channel sounders; measurement in complex scenarios; methods for validation of delay measurements and estimation at 187.5 GHz; vegetation loss from 110 to 170 GHz; novel virtual array scheme based on directive antennas. Among the future challenges we have the creation and sharing of measurement data.

WG2 - Signal Processing and Localization

During this meeting we focused on: localisation, PHY/propagation issues and radio access networks.. Many of them applied machine learning. The final discussion aimed at defining the challenges where we would like to focus. Among these: create/share data sets; define benchmarks, parameters and common framework to ease comparison and cooperation.

WG3 - Network Architectures and Protocols

This time WG3 addressed the topics of: network planning; media access; network parameters optimization and end-to-end performance measurement; use of machine learning for network routing and capacity and coverage optimization was demonstrated; connectivity for/by drones and within intelligent transportation systems. Among the main challenges we have: data sets creation and sharing; ML solutions for network planning, novel communication protocols and topologies and novel PHY layers.

VT2 - Transportation

This second vertical theme focuses on advances in modern transportation.

The importance of this topic was confirmed soundly in Bologna, showing the interpenetration with WG1 and WG3. We foresee to keep up this trend to ensure mature cooperation in INTERACT. There were 13 TDs in VT2, with a strong spread of topics, from pure vehicular channel measurements, over emulation and simulation, up to drone-aided communication for V2X networks.

VT1 - Health and Well-Being

The TDs covered the following topics: wireless protocol diversity in emerging biomedical applications, joint body area and nano networks architecture for cardiovascular health applications, user mobility influence on system loss in off-body scenarios, effect of breathing on UWB propagation characteristics for inbody devices, robotic platform for Search and Rescue missions.

SWG - EMF

The 7 TDs presented dealt with measurements and statistic analysis of EMF data under different circumstances (Covid-19 lockdown, etc); prediction of EMF using different strategies; the calculation of an exclusion zone in the presence of active antennas on 5G base stations and the optimisation of base stations in a city according to EMF restrictions. The final discussion was about the objectives, the kick-off of the work and the ICNIRP recommendations that should be followed.

VT3 - Industrial Automation

In the session for VT3 some of the presented TDs were about industrial Terahertz networks. In particular, on the design of a MAC layer protocol for inter-machine communication and the investigation of Carrier Sense Multiple Access to industrial IoT. Others focused on frameworks for energy efficient operation for time-limited contention in the IEEE 802.11ah standard and the Network Attack Classification in IoT using ML.

VT4 - Smart Buildings and Cities

The discussion occurred in a very participated joint WG2/WG3/VT4 session. The presentation from TD(22)01079, on Flexible radio Access Network Optimization with Cell Coordination, a joint work between UP Catalunya and Aalto University, can be highlighted, as it somehow represents the techno-economic aspects of energy-efficient ultra-dense networks that will be dealt with in Vertical Team 4 (Smart Cities and Buildings).

HA1- Datasets

In Bologna, the final discussion focused on: the definition of a mechanism for licensing and regulating the use of data; the necessity for some data (e.g., data provided by companies) to be stored in particular locations. It was concluded that depending on the dataset, it will be either the dataset provider's liability to store the data on a server, or the dataset could be uploaded on open-access repositories.

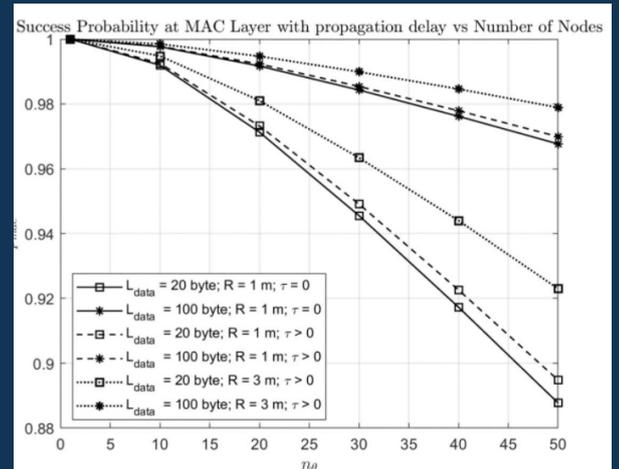
SELECTED SCIENTIFIC TOPIC:

APPLYING CARRIER SENSE MULTIPLE ACCESS TO INDUSTRIAL IOT AT TERAHERTZ FREQUENCIES

We consider an industrial scenario where wireless devices embedded with sensors (denoted as tags) are deployed over an automation machine to collect data for Industrial Internet of Things applications. Tags send data to a centralized control unit, denoted as Gateway (GW). From the wireless communication perspective, this scenario is extremely challenging: the number of tags, as well as the corresponding data-rates, produce network throughput larger than tens of Gbit/s and miniaturization is fundamental. This calls for the use of high frequencies, such as Terahertz (THz), envisioned to satisfy the demand for wireless 6G networks. The GW is equipped with multiple radiating elements generating highly directive beams to mitigate the high path loss, while sensors have one single radiating element for miniaturization purposes. In this scenario, we study the applicability of a slotted Carrier Sense Multiple Access with Collision Avoidance (CSMA/CA) from a mathematical perspective. Differently from literature we design a Semi-Markov chain considering the combined effects of hidden terminals, half-duplex nature of the GW and impact of propagation delays.

SARA CAVALLERO, CHIARA BURATTI, ALEXEY TSAREV, GIAMPAOLO CUOZZO, EMIL KHAYROV, YULIYA GAIDAMAKA, ROBERTO VERDONE

The analytical model based on a Semi-Markov chain is validated via comparison with simulations, and the impact of different simplifying assumptions is shown. We also demonstrate the effectiveness of the CSMA/CA when compared to ALOHA, and we prove that propagation delays cannot be neglected at THz frequencies.



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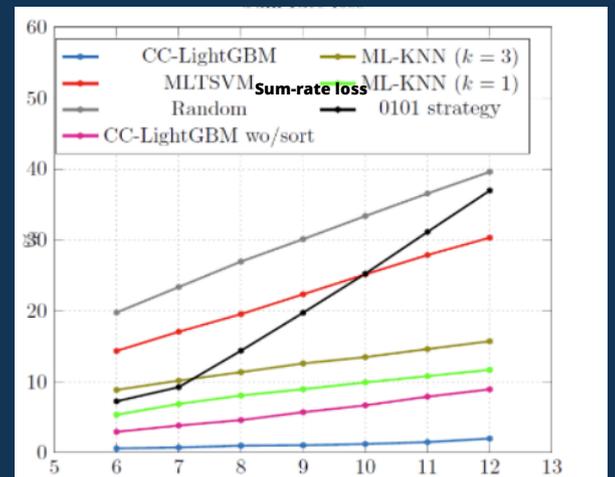
SELECTED SCIENTIFIC TOPIC:

COUPLING GRADIENT-BOOSTING DECISION TREES AND CLASSIFIER CHAINS FOR EFFICIENT USER GROUPING IN MIMO-NOMA

In this paper, we propose a data-driven approach to group users in a Non-Orthogonal Multiple Access (NOMA) MIMO setting. Specifically, we formulate user clustering as a multi-label classification problem and solve it by coupling a Classifier Chain (CC) with a Gradient Boosting Decision Tree (GBDT), namely, the LightGBM algorithm. For benchmarking, we consider two classical adaptation learning schemes: Multi-Label k-Nearest Neighbours (MLKNN) and Multi-Label Twin Support Vector Machines (MLTSVM); as well as other naive approaches. Computer simulation results reveal that, for a number of base learners in the 104 – 105 range, the sum-rate and Hamming losses of LightGBM can be minimized while avoiding a rapid increase of CPU time. The proposed CC-LightGBM scheme clearly outperforms all the benchmarks and naive strategies for the whole range of the number of active users. For 12 users in particular, the sum-rate loss is one order of magnitude/15 times lower than that of the ML-kNN/ML-TSVM algorithms, respectively. Moreover, the gain with respect to random user clustering is tremendous. With respect to the case without user presorting, the CC mechanism achieves a 7% extra gain. The training complexity of CC-LightGBM grows linearly in the size of the training dataset.

C. BEN ISSAID, C. ANTÓN-HARO, X. MESTRE, M.S. ALOUINI

As for the test phase, its complexity is potentially higher than that of ML-KNN and MLTSVM. However, the actual CPU time is also affected by the fact that the basic operation in CC-LightGBM is less computationally intensive than those of the benchmarks.



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SELECTED SCIENTIFIC TOPIC:

LIWIFE - V2V, V2I AND V2P WIRELESS CHANNEL DATASET ENRICHED WITH SENSOR DATA FROM A VEHICLE



The LiWi dataset is a freely available and open dataset, released under the Creative Commons license CC BY-SA 3.0, containing vehicle-to-vehicle (V2V), vehicle-to-infrastructure (V2I) and vehicle-to-pedestrian (V2P) OFDM-based wireless channel measurement data including synchronized sensor data such as radar, LiDAR, and high precision GPS. The measurement scenarios focus on safety critical use cases where wireless communication can substantially contribute to road safety. The wireless channel measurement is conducted at the carrier frequencies of 3.2 GHz and 5.81 GHz with a bandwidth of 150 MHz which are the most promising frequency bands in which future V2X communication systems will operate.

BENJAMIN RAINER, STEFAN ZELENBABA, ANJA DAKIC, MARKUS HOFER, DAVID LOSCHENBRAND, THOMAS ZEMEN, XIAOCHUN YE, GUO NAN, STEFAN TESCHL, PETER PRILLER

SELECTED SCIENTIFIC TOPIC:

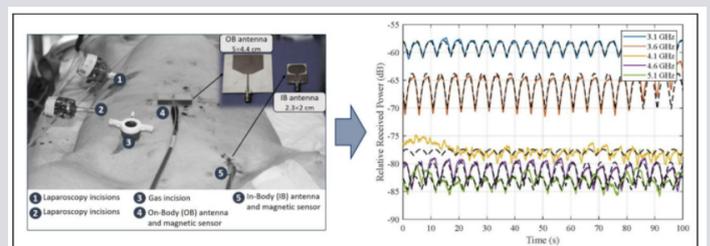
EFFECT OF BREATHING ON UWB PROPAGATION CHARACTERISTICS FOR INGESTIBLE AND IMPLANTABLE DEVICES

Wireless in-body devices are those in which a medical sensor is introduced –implanted or ingested– inside the human body and communicates with a remote node. Some in-body applications demand high data rates are necessary, so Ultra-Wideband (UWB) spectrum has been proposed as a good candidate because of its large bandwidth available. In addition, breathing can lead to internal movement of the torso and consequently, of devices installed in this area. Thus, the radio channel performance can be affected by such movement leading to a malfunction of the radio interface. This work aimed at analyzing the effect of breathing on the propagation channel by means of in vivo measurements in living animal models. Continuous wave (CW) measurements were carried out for five single frequencies in the 3.1-5.1 GHz band, and the effects of breathing on the relative received power (module and phase), at in vivo conditions in a porcine animal model. Results showed that the relative received power and its phase (derived from the time-varying transfer function) exhibit an oscillatory process with time, which can be modelled by an absolute value of the cosine function.

The dataset contains the wireless channel measurement data of various V2X scenarios along with synchronized sensor information from a vehicle. In addition to the wireless channel measurement data, the dataset also includes frame error rate measurements from an IEEE 802.11p based communication system, synchronized to the other measurement data. The vehicles and the mounted measurement equipment are shown in the figure above.

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Such oscillatory behavior was more pronounced when the in-body antenna was nearer the thoracic cage. Model parameters were reported for two different cases. Further research is needed in order to know the internal physiological and ElectroMagnetic phenomena that give rise to these variations in the received power.



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CONCEPCION GARCIA-PARDO, ALEJANDRO FORNES-LEAL, MATTEO FRASSON, VICENTE PONS-BELTRÁN, NARCIS CARDONA

COST-INTERACT Summer School:

"Open-RAN networks: from theory to implementation"



Organized by:
Poznan University of Technology with the cooperation of RIMEDO LABS

3 days-long school
5-7 of July, 2022

More information and registration at <https://interactca20120.org/meetings-events/training-schools/>

The school will give the opportunity to deepen the knowledge in various domains of Open RAN, including the discourse on the evolution of the cellular network architecture from regular to virtualized and open one and the discussion on Open-RAN architecture. Moreover, opportunities and challenges of the Open RAN approach will be presented together with the analysis of the ongoing trials and implementations.

The virtual participation via ZOOM or another tool will also be possible.

ESoA Course and INTERACT Training School:

"Mobile Radio Propagation for 5G and Beyond"



Local organizer: Claude Oestges
Course coordinators: Thomas Kürner, Vittorio Degli-Esposti, Claude Oestges

UCLouvain
June 20 - 24, 2022.

More information and registration at <https://bit.ly/3NzUFfW>

This training school will cover propagation aspects for 5G and beyond cellular and vehicular communications. Starting with the basics of propagation, modern methods used in cellular network planning as well as aspects relevant for future 5G networks, e.g. MIMO, multi-link aspects, localization, car2X and railway communications, drones, are taught. It includes also computer-based exercise.

Registration deadline: June 6th, 2022

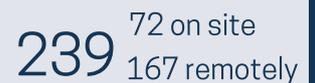
FACTS & FIGURES



INTERACT Action's Members



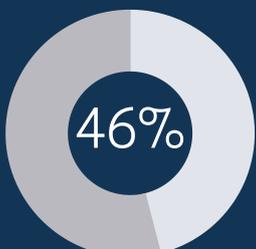
Participating per meeting



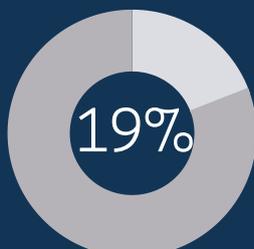
Training School/Day planned



Young Researchers



Women



Presented TDs



Meetings per year

