



INTERACT

Valencia, Spain, 19-22 September 2022

SUBJECT | Annexes of the 3rd Management Committee Meeting of COST Action CA20120 “The Intelligence-Enabling Radio Communications for Seamless Inclusive Interactions (INTERACT)”

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Full name per Country

Name	Surname
Austria	
Golsa	Ghiaasi
Belgium	
Margot	Deruyck
Croatia	
Radovan	Zentner
Cyprus	
Konstantinos	Katzis
Czech Rep	
Jan	Sykora
Finland	
Konstantin	Mikhaylov
France	
Laurent Clavier	Clavier
Julien	Sarrazin
Guillaume Villemaud	Villemaud
Germany	
Andreas	Czylwik
Diego	Dupleich
Greece	
Periklis	Chatzimisios
Ireland	
Hamed	Ahmadi
Conor	Brennan
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Flaminia	Saratti
Marco	Skocaj
Francesca	Conserva
Paolo	Grazioso
Vittorio	Degli Esposti
Lithuania	
Rimvydas	Aleksiejūnas
Montenegro	
Milica	Pejanovic-Djurisic
Netherland	
Haibin	Zhang
Poland	
Slawomir	Ambroziak
Pawel	Kulakowski
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Krzysztof	Cichoń
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Vasile	Bota
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Jose-Maria	Molina-Garcia-Pardo
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Tamara	Skoric
Tomi	Mlinar

TD Number	TD Author	TD Title	TD Abstract	TD WG
TD(22)03002	Marek Simka, Ladislav Polak	On the RSSI-Based Indoor Localization Employing LoRa in the 2.4GHz ISM Band	Demand for systems and technologies ensuring indoor localization or tracking of an object with high and stable accuracy is continuously increasing. Nowadays, there are exist several wireless technologies, for instance Bluetooth or Wi-Fi, which can be employed for indoor positioning. In the future, Long Range (LoRa), originally developed for long range communication with high link budget, can extend the family of these technologies. This paper focuses on the LoRa technology and its employing in the licence free 2.4,GHz band for Received Signal Strength Indicator (RSSI) based indoor localization. To measure and collect the values of RSSI, a simple measurement setup is proposed. The RSSI values are used to calculate the position of an object according to the principle of trilateration. Measurements are conducted in three different indoor environments for different signal configurations of LoRa. The recorded dataset is available online for future research purposes. The results, analysed in terms of localization accuracy, revealed good performance of LoRa. However, this performance is highly depending on the signal configuration of LoRa and on the position of nodes.	WG1,WG2,HA1
TD(22)03003	Michał Sybis, Paweł Sroka, Adrian Kliks	Database Supported Successive Interference Cancellation Scheme for Intra-platoon Communications	High reliability of wireless communications is a rudimentary requirement for guaranteeing safe autonomous driving. This paper discusses the performance of communications between cars within autonomous platoons, with the application of a proposed database-supported successive interference cancellation (SIC) algorithm. By assumption, it utilizes the knowledge on other existing interfering transmissions (such as pre-entered information on digital television transmissions stored in the road-side database) to re-move the interfering signal at the receiver side. It is shown that this approach improves the bit error rate, and in turn - the reliability of intra-platoon transmission. The proposed solution is evaluated using link-level extensive computer simulations.	WG2,VT2
TD(22)03004	Mate Boban, Vittorio Degli Esposti, Diego Dupleich, Wei Fan, Marco Di Renzo, Joonas Kokkonieni	COST INTERACT Working Group 1 (Radio Channels): Key Challenges and Initial Directions	A comprehensive understanding of the radio channel is a prerequisite for designing efficient wireless communication systems. Next generation wireless systems are expected to include both new technologies -- e.g., reconfigurable intelligent surfaces (RIS), integrated sensing and communication -- and new frequency bands -- in particular, above 100 GHz. These new technologies and bands will require a paradigm shift in radio channel measurement and characterization. To that end, we explore the ongoing and planned activities that COST INTERACT Working Group 1 (WG1) has been carrying out. In particular, we describe the position of WG1 as originally mandated by COST INTERACT, elaborated further by the addition of sub-WGs on RIS and mmWave and THz sounding. Next, we identify the key challenges faced by WG1 and the two sub-WGs and describe the first steps taken in order to address those challenges. Finally, we give an outlook for the activities that need to be carried out in order to ensure the key output from WG1: definition of a comprehensive channel modeling framework that encompasses new scenarios and technologies that will be included in future wireless communications systems.	WG1

Growing intelligent transportation systems demand a vehicular communication technology that can satisfy high requirements in terms of data rates, latency, reliability and number of connected devices. To evaluate the performance of such communication technology, real-world measurements are required for various channel conditions. Since vehicular measurement campaigns are expensive and time-consuming, a high-mobility environment poses enormous challenges for performance measurements. Fortunately, using the existing method of time-stretching the transmit signals, such experiments can be emulated through measurements at a single lower velocity by inducing effects caused by higher velocities. Unfortunately, there is the problem of different channel estimation quality between the time-stretched and the original system. To ensure that the technique gives accurate results in practical systems, we adapt the pilot-based channel estimation scheme within the existing time-stretching technique.

Faruk Pasic,
Stefan Pratschner,
Markus Rupp
and Christoph F. Mecklenbräuker

Pilot-Aided Channel Estimation Scheme for NR-V2X Speed Emulation Technique

TD(22)03005

WG1,WG2,VT2

Wireless Communication with an implanted sensor represents a huge challenge, for three reasons: first, an implant is either injectable, ingestible or implantable, which means in any case it has to be physically small. This implies that the antenna used for the link has to be highly miniaturized. Second, biological tissues are very lossy, and will thus largely attenuate any wireless signal having to pass through them. Finally, as the implant is placed in a living host, levels of powers that may be used for a wireless link are heavily limited by regulations, in order to protect the host from exposure to electromagnetic fields. Thus, it is of paramount importance that such wireless links are designed in a way achieving the best possible efficiency in the transmission. To this aim, good propagation models for electromagnetic fields through biological tissues are required. They should be precise enough to enable a good link budget at the planning stage of a project, and simple enough to enable an easy use. One of the major difficulties in establishing such models is that in the case of wireless communication with a device located in a lossy medium, it is not always possible to decouple the channel (i.e. the propagation in the medium) from the antenna characteristics, as the near field generated by the antenna can couple to the medium through the losses. In this presentation, the coupling between antenna near-field and a lossy host body will be analyzed using a simple canonical host phantom. First approximate closed form expressions will be presented to account for these losses

A.K. Skrivervik,
M. Gao, Z. Sipus

In Body propagation: the influence of the antenna

TD(22)03006

WG1,VT1

The debate on electromagnetic field effects is not a new phenomenon, but it dates back to more than one century ago, when electricity began to be used. The advent of mobile radio networks a few decades ago further spurred this controversy, exacerbating it in some cases. Normally, citizens tend to complain about the installation of new base stations, especially when they are located close to their home, in spite of the absence of any scientific evidence of causal correlation between exposure levels respecting the limits in force and serious diseases such as cancer. The dispute recently reached new peaks, especially in the social media, with the deployment of 5G technology, adding to the traditional topics of dispute also new themes such as network densification and the use of millimetre wave frequencies. Network densification is a key factor for 5G networks development, but a widespread belief within the general public is that the increase in the number of base stations would imply a corresponding increase in field exposure in spite of the fact that several studies carried out in different countries show that network densification does not lead to an increase in exposure levels; on the contrary, the average field exposure does not change for the majority of population (about 90% in case of a uniform distribution of population on the territory), while exposure sharply decreases in locations close to the base stations when network density increases. As far as millimetre waves are concerned, numerical analyses show that fields at frequencies of 26 GHz and above don't penetrate deeply into body tissues. Unfortunately, for the time being there is not enough scientific literature about possible effects of millimetre wave fields, and this has been recognised as a cognitive gap to be filled as soon as possible. The work here presented performs an analysis of the state-of-the-art of knowledge about radiofrequency electromagnetic field effects, in particular with respect to new frequency bands (3.5 and 26 GHz) and to the new transmission techniques (adaptive antennas, beamforming); aim of this work is to investigate the correct communication means that should be adopted by the scientific community, by politicians and policy makers, and by media when informing citizens, and interacting with them, on a topic still characterised by a high risk perception.

TD(22)03009	Simona Valbonesi, Paolo Grazioso	Risk communication and risk perception in 5G and Beyond 5G scenarios		Sub-VT1
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TD(22)03010	Juan Pascual-García, Lorenzo Rubio, Vicent M. Rodrigo Peñarrocha, Leandro Juan-Llácer,, José-María Molina-García-Pardo, Concepción Sanchis-Borras, and Juan Reig	Wireless Channel Analysis between 25 and 40 GHz in an Intra-Wagon Environment for 5G using a Ray-Tracing tool	Metro and railway systems are one of the most used transportation systems for people in almost all countries. Nevertheless, the access to high throughput wireless services is still very limited inside the wagons (cars). A deep analysis of the wireless channel inside wagons is needed to deploy new efficient and high throughput networks as the ones provided by fifth-generation (5G) systems. Although several works have analyzed the intra-wagon channel, some limitations are usually present: only certain user equipment-access point situations were considered, the number of studied propagation mechanisms was limited, and only some channel parameters were extracted. For these reasons, in this work the wireless channel in an intra-wagon environment is thoroughly analyzed using simulations performed with a ray-tracing tool calibrated and validated with wideband measurements. Thanks to the accurate ray-tracing tool the main replicas are identified in different typical user equipment-access point positions; the contribution of each propagation mechanism to the total power is extracted; and the angular spread in azimuth and elevation for the direction of arrival and departure are obtained. This analysis is performed in the frequency range from 25 to 40 GHz, where spectrum for several 5G bands has been already allocated.	WG1
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The deployment of 5G technology using the 26 GHz band, and the foreseen usage of higher frequency bands in future releases of 5G and in future 6G networks, that will use frequencies above 100 GHz and up to 200 GHz and above, is causing widespread worries among citizens about possible adverse effects of electromagnetic fields on human health. The main reason for such an increased concern probably lies in the fact that these high frequencies have never been used before in terrestrial mobile communication networks. As a matter of fact, there are not many studies specifically targeting these frequency bands, and various international scientific bodies such as ICNIRP (International Commission on Non-Ionizing Radiation Protection), BEMS (Bioelectromagnetics Society) and SCENIHR (Scientific Committee on Emerging and Newly Identified Health Risks) identified the biological effects of millimetre wave electromagnetic fields as one of the cognitive gaps to focus on in the near future. In this paper we present a numerical analysis aimed at characterising various types of biological tissues from the electromagnetic point of view, addressing the modalities of propagation in layered tissues by means of geometrical optics rules on reflection and absorption in non-conductive materials. To this aim, we considered the structural characteristics of different tissues, that depend on cellular architectures, on the presence of membranes and, above all, on the water content. Therefore, the focus of the work here presented is on the evaluation of electrical fields in tissues within the cranial capsule as a function of the incident field frequency, taking into account transmission and reflection at the interface between tissue layers with different electromagnetic characteristics. The computation was performed in the parietal area of human skull, for both horizontal and vertical polarisations and for frequencies varying from 26 GHz to 100 GHz. Results show that even at 26 GHz a fraction of the electrical field ranging from 84% to 91% is blocked by the scalp, which constitutes the outer barrier against external agents; this fraction increases with the frequency and reaches values between 96% and 97% at 100 GHz, with remarkable differences between horizontal and vertical polarisation. The field that reaches the deep brain, after absorptions and reflections in the seven biological layers that cover it, is of the order of 10-11 V/m at 26 GHz and of 10-32 V/m at 100 GHz: such values are practically negligible in terms of heating effects. More in detail, the investigation here presented shows that at 26 GHz field is practically blocked by the tissues that precede the meninges (scalp, connective tissue, and two layers of bones, namely cortical bone and spongy bone), while at 100 GHz the field does not reach beyond the connective tissue located directly underlying the scalp. Therefore, as a conclusion we may state that some expressions recurring on media, such as “the 26 GHz field might cook one’s brain”, have no scientific basis.

TD(22)03011
 Simona Valbonesi and Paolo Grazioso
 Characterisation of millimetre wave field propagation in the cranial capsule

VT1,Sub-VT1

TD(22)03012
 Minseok Kim, Riku Takahashi, Kosuke Shibata, Anirban Ghosh
 Development and Verification of 300-GHz Double-Directional Channel Sounder

This paper describes the 300-GHz channel sounder developed for Beyond 5G radio access systems. It also presents the results of double-directional channel measurements in a conference room environment to validate the developed system. The measurement results show that several dominant multipath components existed, and the angles of departure and arrival (AoD and AoA) were also in good agreement with those obtained by the previous millimeter-wave measurements.

Sub-WG1

TD(22)03013	Yang Miao, François Quitin, Alister Burr, Ana Garcia Armada	Challenges in INTERACT WG2: Signal Processing and Localisation	This document is a summary of the main challenges being targeted and the first paths followed by the research activities of WG2. The goal of WG2 is to design novel physical layer technologies by combining the data information from statistical learning with the theoretical knowledge of the transmitted signal structure. Encoders for short block lengths, channel estimation schemes, beamforming and (massive) MIMO processing in sub-6-GHz and mmWave bands will be considered. The WG aims also at designing new positioning and localization techniques.	WG2
TD(22)03014	Alister Burr and Sumaila Mahama	Outage probability for physical-layer network coding	In previous work we considered a two-way relay network with overhearing for scenarios such as emergencies where base stations and other fixed infrastructure is unavailable, and evaluated average BERs in various forms of fading, using various forms of physical layer network coding (PNC). In this paper we evaluate outage probability for such a network, using analytical methods and approximations. This makes it easier to distinguish and compare the performance of different forms of PNC, and to evaluate the effect of different fading characteristics in the channel. We also consider the case where a relay fully decodes both sources, as a special case of PNC.	WG2
TD(22)03016	Vasile Bota, Mihaly Varga	Theoretical Performance Analysis of a HARQ Algorithm with Limited IR that Uses Rateless and FEC Coding	This paper presents a theoretical analysis of performance provided by a generic Incremental Redundancy (IR) HARQ algorithm which uses rateless and FEC coding to recover a message composed of m data blocks, each of them containing k bits. The limited IR is obtained by providing additional rateless symbols in q retransmissions at most, so that the total number of transmitted symbols would not exceed $2qm$. It derives the expressions of the performance metrics, namely the message non-recovery probability p_{NR} , the average number of rounds A_{avg} needed to ensure a target p_{NR-t} , the average spectral efficiency η and the average coding rates, in an OFDMA generic structure over a Rayleigh block-faded channel. The impacts of the algorithm's parameters, i.e., the number N_a of rateless symbols sent in the initial round, the maximum number of retransmissions and the FEC code's coding rate R_c , upon performance are evaluated by the numerical results. These results show that the algorithm could ensure small p_{NR-t} values at low SNRs with a small average number of attempts, by changing adaptively the algorithm's parameters according to the channel's current SNR.	WG2

TD(22)03017	<p>Yejian Lyu, Zhiqiang Yuan, Mengting Li, Allan Wainaina Mbugua, Pekka Kyösti, and Wei Fan</p> <p>Enabling Long-Range Large-Scale Channel Sounding at Sub-THz Bands: Virtual Array and Radio-Over-Fiber Concepts</p>	<p>Sub-Terahertz (sub-THz) (i.e., 100-300 GHz) communication is envisaged as one of the key building blocks for future communication systems due to its vast unexploited bandwidth. Knowledge of the radio channel characteristics is key to the design and development of new radio systems and air interfaces. Reliable channel sounding is essential to build accurate and realistic channel models. Virtual antenna array (VAA) has been a popular channel sounding strategy to obtain accurate directional characterization due to its low-cost and simple system implementation. However, this concept has not yet been realized for sub-THz bands in the state-of-the-art works due to the difficulty in accurate phase control. The measurement range has been rather limited at sub-THz due to significant signal loss compared to microwave or millimeter-wave frequencies. In this paper, we focus on vector network analyzer (VNA)-based channel sounders, highlighting frequency extension with sub-THz frequency extenders, measurement range extension with radio-over-fiber (RoF) schemes, and angular resolution improvement by VAA implementation with phase-compensation scheme. These techniques enable and enhance sub-THz channel characterization. The performance of the proposed long-range phase-compensated sounder is also experimentally demonstrated by the VAA-based channel measurements at 100 GHz in an indoor scenario.</p>	WG1,Sub-WG1
TD(22)03018	<p>Xuesong Cai, Meifang Zhu, Aleksii Fedorov, Fredrik Tufvesson</p> <p>Enhanced-EADF for the Characterization of Large- Scale Antenna Arrays</p>	<p>Massive multiple-input multiple-output (MIMO) is a key technique for fifth-generation (5G) and beyond communications. Therefore, accurately characterizing/calibrating the responses of the large-scale antenna arrays at an arbitrary direction is critical. The effective aperture distribution function (EADF) can provide an analytic description of an antenna array based on a full-sphere measurement of the array in an anechoic chamber. However, as the aperture of an array becomes significantly larger, application of the EADF requires very dense spatial samples, due to the large distance-offsets of the array elements to the reference point in the anechoic chamber. This will lead to a prohibitive measurement time and a high computational complexity of EADF. In this paper, we first present the EADF applied to large-scale arrays, followed by an analytical analysis of the issue caused by the large array aperture. To solve this issue, an enhanced EADF is proposed with a low complexity that is only relevant to the intrinsic characteristics of each array element rather than the aperture size of the array. Moreover, a measurement campaign conducted at the frequency band of 27-30GHz using a planar array is introduced, where the proposed enhanced-EADF is applied and validated.</p>	WG1,Sub-WG1
TD(22)03019	<p>Karol Zientarski, Mykyta Muravytskyi, Krzysztof Skoś, Kamil Chełminiak, and Pawel Kulakowski</p> <p>Minimising Network Detection Probability in MANETs Using Unmanned Vehicles</p>	<p>History shows that information is one of the key factors in military conflicts. Therefore there is a need to maintain communication channels on the battlefield. In this document, a simulator that allows to optimise the network to minimise the risk of detection by enemies was created. The simulator, using the Prim's algorithm and the fine-tuning shows how a mobile ad-hoc network between soldiers aided with unmanned vehicles can become undetectable for enemy units.</p>	VT2

TD(22)03020	<p>Jelena Crnogorac, Jovan Crnogorac, Enis Kočan, Milica Pejanović-Djurišić, Mališa Vučinić</p>	<p>Monitoring dense multi-channel multi-hop wireless sensor networks</p>	<p>Extensive implementation of wireless sensor networks (WSNs) in different areas makes the issue of their monitoring of great importance, not only in the phase of novel protocol development and network testing, but also in the regular operation phase of WSNs. This issue is particularly challenging in case of dense multi-channel multi-hop WSNs covering large areas, or implemented in harsh radio indoor environments. We propose a solution for defining number and position of sniffer devices, used for detecting network traffic in such WSNs, all with the goal to maximize the captured traffic. The proposed solution is based on searching minimal dominating set from graph theory and assumes known channel connectivity matrix, i.e. packet delivery ratio (PDR) on all channels and all links of a WSN. We evaluate the performance of the proposed method using the 6TiSCH Simulator with randomly generated topologies, as well as using the captured traces of network traffic on experimental FIT IoT-LAB testbed in Grenoble, with 50 nodes.</p>	VT4
TD(22)03021	<p>Armin Hadžiaganović, Raheeb Muzaffar, Hans-Peter Bernhard, Andreas Springer</p>	<p>Integration of openSAFETY in OMNeT++</p>	<p>Functional safety protocols provide automatic protection against system failures. Safety will be of critical importance for future industrial systems since they are undergoing automation and digital transformation under the Industry 4.0 revolution. However, functional safety depends on the underlying communication system employed in the manufacturing area. An extensive evaluation of the communication system and the functional safety protocol is needed before deploying it to the production environment. To facilitate the evaluation process of a fail-safe communication protocol, we integrate openSAFETY in the OMNeT++ simulation framework. We validate its integration by comparing the simulation results with an existing experimental work where the results show similar trends. Furthermore, we simulate an industrial closed-loop control use case with IEEE 802.11n being the communication technology. The results obtained in terms of safe-state duration and packet error rate demonstrate that 802.11n with its default configuration is not suitable for a high demanding industrial application.</p>	VT3
TD(22)03022	<p>Piotr Rajchowski, Olga Błaszkiwicz, Krzysztof K. Cwalina, Jarosław Magiera, Alicja Olejniczak, Jarosław Sadowski</p>	<p>Implementation of the Software-Defined NB-IoT Radio Interface</p>	<p>In the article the implementation of selected functional modules of the software-defined universal NB-IoT (Narrowband Internet of Things) radio interface was presented. The problem of time and frequency synchronization was pointed and the implementation the software modules realizing this synchronization process was discussed. Additionally, the sample results of performed functional tests aimed in verifying the ability of maintaining the synchronization of the terminal with the eNodeB station. The tests were realized by using the radio signals generated by the radiocommunication tester with an emulated radio channel influence to simulate various environmental conditions.</p>	WG2,VT4

TD(22)03023	Nopphon Keerativoranan and Jun-ichi Takada	Scenario-Based Radio Channel Modeling in Cyber-Physical Wireless Emulator	<p>Design, evaluation, and verification of a large-scale wireless system with high accuracy is essential prior to the implementation. Stochastic channel models are utilized for the link-level and system level simulations for the performance evaluation and the exhaustive drive-testing method is deployed for the validation. The former technique can be applicable for intra-system evaluation, but not suitable for inter-system interference in the realistic scenarios. The latter technique is time and cost inefficient. Concept of cyber physical wireless (CPW) emulator is introduced to overcome drawbacks of both of these approaches. It emulates the real-world wireless network scenario in real-time, not only within cyber space but also with real or prototype radios via physical interface. Hence, scenario-based radio channel modeling framework is necessary for the implementation of the cyber physical wireless emulator. Deterministic radio channel prediction such as ray tracing (RT) is typically preferable for the CPW emulator considering site-specific and high accuracy prediction. Therefore, spatial models such as 3D building map become essential part of the emulation. However, RT may not be practical in a large-scale environment due to spatial model complexity and computational cost. In such scenario, site-specific statistical models derived from field channel measurement are needed. Moreover, real-time computation is another challenge in such deterministic CPW emulator. In this paper, the overview of the scenario-based channel modelling will be discussed. The performance of the proposed channel emulation technique are comparatively investigated with RT simulation results.</p>	WG1
TD(22)03024	CRISTINEL GAVRILA, VLAD POPESCU, MARIAN ALEXANDRU, MAURIZIO MURRONI, CLAUDIO SACCHI, TITUS BALAN	An SDR-Based Satellite Gateway for Internet of Remote Things (IoRT) Applications	<p>Internet-of-Things (IoT) represents a breakthrough for the current ICT market. In many IoT applications, sensors and actuators are distributed over very wide areas, sometimes not reached by terrestrial networks. In such scenarios, the satellite plays a significant role. In this paper, a Software-Defined Radio (SDR) - based satellite gateway for Internet-of-Remote-Things (IoRT) is proposed. The use of SDR allows to decrease equipment cost and provides higher flexibility. The proposed architecture has been implemented by using a standalone SDR platform and Commercial Off-The-Shelf (COTS) modules for covering the main terrestrial IoT standards. Extensive proof-of-concept results are presented and discussed. Uplink and downlink tests showed the correct functionality implementation and transmitted signal generation, while the integration tests allowed to assess the reliability of the end-to-end information processing. Reconfigurability tests confirmed the capability of the gateway of dynamically updating in real-time its protocol settings. The overall test results showed the validity of the proposed SDR-based gateway for IoRT applications.</p>	WG3,VT4

TD(22)03025	Kamran Sayrafian, Brian Cloteaux, Vladimir Marbukh	On the Performance of Automatic Exposure Determination Using Bluetooth-based Proximity Estimation	<p>The proximity detection mechanism in current automatic exposure notification systems is typically based on the Bluetooth signal strength from the individual's mobile phone. However, there is an underlying error in this proximity detection methodology that could result in wrong exposure decisions i.e., false negatives and false positives. A false negative error happens if a truly exposed individual is mistakenly identified as not exposed. This misidentification could result in further spread of the virus by the exposed (yet undetected) individual. Likewise, when a non-exposed individual is incorrectly identified as exposed, a false positive error occurs. This could lead to unnecessary quarantine of the individual; and therefore, incurring further economic cost. In this paper, using a simulation platform and a notion of proximity detection error, we investigate the performance of the system in terms of false exposure determinations. Knowledge of how the Bluetooth-based proximity detection error impacts such false determinations and identification of methodologies that can reduce this impact will be helpful to enhance the effectiveness of an automatic contact tracing system. Our preliminary results indicate the substantial impact of the proximity estimation error on the exposure detection accuracy. The results also suggest how proper filtering of distance measurements may reduce this impact.</p>	VT1
TD(22)03026	Sara Cavallero, Kristi Qirjako, Chiara Buratti, Roberto Verdone	Industrial IoT at THz frequencies using a CSMA/CA MAC protocol	<p>This paper addresses the problem of enabling intra-machine communication in an Industrial Internet of Things (IIoT) scenario using Terahertz (THz) frequencies.</p> <p>To mitigate the path loss of such high frequencies, a tree-based topology is built: each automation machine of the factory is controlled by a Router that collects data measured by wireless sensor devices located on the machine and forwards them to a final Gateway (GW) for elaboration purposes. In this scenario, we study the applicability of a slotted Carrier Sense Multiple Access with Collision Avoidance (CSMA/CA) protocol via simulations, and we demonstrate its effectiveness when compared to Aloha. The performance of an uplink communication is evaluated in terms of packet success probability and network throughput. Results demonstrate that propagation delays cannot be neglected at THz frequencies, together with the impact of other parameters, like the sensing range of devices, the number of radiating elements at the Routers, the size and number of machines.</p>	VT3
TD(22)03027	Mohamed Abdulali, Amar Al-Jazri, Sana Salous	Millimeter-Wave Channel Characterization based on Directional Measurements at 39 GHz and 70 GHz in a Street Canyon Scenario	<p>This TD presents results of wideband channel measurements in a street canyon scenario for both line of sight (LoS) and non-line of sight (NLoS) scenarios at 39 GHz and 70 GHz using omnidirectional antenna at the transmitter (Tx) side and wide beam directional antenna at the receiver (RX) side. Measurements were carried out using Durham University's multi-band frequency modulated continuous wave channel sounder. The multipath component parameters (MPCs) including power delay profile (PDP), root mean square (RMS) delay spread (DS), angular spread (AS) and Path loss (PL) have been estimated at different angular orientations and compared for both frequency bands to characterize the measured channel.</p>	WG1

TD(22)03028	Anna-Malin Schiffarth, Thomas Kopacz, Jörg Pamp, Dirk Heberling	Influence of User Equipment's Position on Local Exposure to 5G	<p>This work addresses the influence of the position of a user equipment (UE) on frequency-selective exposure measurements at full load and on local downlink exposure at 5G NR base stations with beamforming antennas. Therefore, first, exposure measurements at five locations at a Huawei and an Ericsson base station showed that the emitted fields of the UE can overlap the 5G downlink of the base station while provoking a full load and can thus distort the measurement of the maximum possible exposure. Second, long-term measurements have demonstrated that the local exposure maximum in a 5G cell changes depending on the location of a moving UE. In contrast, a comparison with passive antennas of a 4G base station at the same location indicates that the local exposure in the cell is independent of the current location of the active UE.</p>	Sub-VT1
TD(22)03029	Sara Willhammar, Liesbet Van der Perre, Fredrik Tufvesson	Fading in reflective and heavily shadowed industrial environments with large arrays	<p>One of the use cases for 5G systems and beyond is ultra-reliability low-latency communication (URLLC), with applications within industrial automation. An enabling technology for URLLC is massive multiple-input multiple-output (MIMO), which has shown to increase reliability due to improved user separation, array gain and the channel hardening effect. Measurements have been performed in a real operating factory environment at 3.7~GHz with a co-located massive MIMO array and a unique randomly distributed array. For both arrays the channel hardening effect is quantified. Channel hardening can appear when the number of antennas is increased such that the variations of channel gain (small-scale fading) is decreased. The cumulative distribution function (CDF) of the channel gains then becomes steeper and its tail is reduced. This CDF is here modeled and the required fading margins are quantified. By deploying a distributed array, the large-scale power variations can also be reduced, further improving reliability. It can be seen that the large array in combination with the rich scattering environment, creates a more reliable channel as it approaches an independent identically distributed (i.i.d.) complex Gaussian channel, indicating that one can rethink the system design in terms of e.g. channel coding and re-transmission strategies. Overall, the conclusion is that massive MIMO is a highly interesting technology for reliable connectivity in reflective and heavily shadowed industrial environments.</p>	WG1,VT3
TD(22)03030	Tamara Skoric, Dragana Bajic	Reduction of Artifacts in Capacitive Electrocardiogram Signals of Driving Subjects	<p>The development of smart cars with e-health services allows monitoring of the health condition of the driver. Driver comfort is preserved by the use of capacitive electrodes, but the recorded signal is characterized by large artifacts. This paper proposes a method for reducing artifacts from the ECG signal recorded by capacitive electrodes (cECG) in moving subjects. Two dominant artifact types are coarse and slow-changing artifacts. Slow-changing artifacts removal by classical filtering is not feasible as the spectral bands of artifacts and cECG overlap, mostly in the band from 0.5 to 15 Hz. We developed a method for artifact removal, based on estimating the fluctuation around linear trend, for both artifact types, including a condition for determining the presence of coarse artifacts. The method was validated on cECG recorded while driving, with the artifacts predominantly due to the movements, as well as on cECG recorded while lying, where the movements were performed according to a predefined protocol. The proposed method eliminates 96% to 100% of the coarse artifacts, while the slow-changing artifacts are completely reduced for the recorded cECG signals larger than 0.3 V. The obtained results are in accordance with the opinion of medical experts. The method is intended for reliable extraction of cardiovascular parameters to monitor driver fatigue status.</p>	VT1

In light of events such as the recent pandemic and many potential applications in fields such as the social sciences, healthcare, and architecture, the detection of interactions or the proximity between people has become increasingly important. In this context, this paper investigates the limitations of a machine learning-based approach that detects the proximity of two devices based on the WiFi and BLE fingerprints of their radio environments. More specifically, (i) we compare the use of a rudimentary set of two features and an extended, more complex set of features, (ii) we investigate the use of separate classifiers that treat WiFi and BLE features separately, and (iii) we investigate whether using only one of the two communication technologies for detection could provide better results. In addition, we also try to use techniques such as undersampling and oversampling or their combination to deal with the highly imbalanced set of examples. Our results show that the use of a more complex set of features that can be subjected to further feature selection procedures can provide a performance benefit of about 4.6 percentage points. In terms of the communication technologies used, our results also show that using BLE alone always gives significantly worse results than using WiFi alone or WiFi and BLE together. On the other hand, there is no clear winner between using WiFi alone or combining WiFi and BLE, as both provide comparable results. Finally, our results also show that using under/oversampling helps in scenarios where the classification task is somewhat more complex, but not in those where the diversity between instances is low; thus, the classification problem is simpler.

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Smartphone Proximity Detection Using WiFi and BLE Fingerprinting

TD(22)03031

WG2

Recently, reconfigurable intelligent surface (RIS) has drawn much attention due to its capability of improving coverage and communication performance. The development of RIS-assisted communication technology relies on deep understanding of RIS channel characteristics. However, most of the existing investigations focus on the impact of RIS, ignoring the existence of local scatterers in the real propagation environment. The ideal propagation condition limits the accuracy and application of the developed channel model. In this paper, we aim to analyze the channel characteristics of RIS-assisted near-field communication by considering different conditions of local scatterers. Specifically, we propose a three-dimensional (3D) RIS-assisted multiple-input multiple-output (MIMO) channel model based on a three-dimensional cylinder model, which considers line-of-sight, single-bounced at RIS (SBR) and double-bounced (DB) modes where radio waves reflect from RIS and scatterers near receiver. Based on the proposed channel model, we investigate time-space correlation for SBR and DB propagation. From the simulation results, it is found that RIS element number, RIS locations, and movement of Rx have significant impacts on channel characteristics. These numerical results and observations can be used for design of RIS-assisted near-field communication systems.

A Geometry-Based Channel Model for Reconfigurable Intelligent Surface-Assisted Communication Systems
Guiqi Sun, Ruisi He, Bo Ai, Hang Mi, Yuan Yuan, Zhangdui Zhong

TD(22)03032

WG1

TD(22)03033	Yuan Yuan, Ruisi He, Bo Ai, Hang Mi, Guiqi Sun, Zhangdui Zhong	A Double-Spherical THz Channel Model for Ultra Massive MIMO Communications	<p>In this paper, a 3D geometry-based double-spherical terahertz (THz) channel model is proposed for ultra massive multiple-input multiple-output (MIMO) communications. To reflect real THz ultra massive MIMO communications, the characteristic of nano-material array antenna and the high loss of THz bands are considered in channel modeling. Based on the proposed geometry-based stochastic model (GBSM), space-time-frequency correlation function is derived and analyzed. Influences of channel parameters, namely, carrier frequency, Fermi energy, and number and location of clusters, on the correlation functions are investigated. The results indicate that number of clusters has significant impacts on channel correlation, and the decreasing of correlation function becomes slower when Fermi energy decreases. Moreover, location of clusters also affects the drop rate of correlation function. The proposed channel model and the corresponding statistical properties are insightful for designing and realizing THz ultra massive MIMO systems for 6G and beyond.</p>	WG1
TD(22)03034	Valentina Tlmcenko, Slavko Gajin	Machine Learning enhanced Entropy-Based Techniques for Network Anomaly Detection	<p>This research focuses on network behavior analysis and provides a comprehensive flow-based anomaly detection proposal, which is based on combined machine learning and entropy-based anomaly detection techniques. The entropy-based analysis can capture the behavior of the biggest contributors, and of a large number of minor appearances in the feature distribution, thus it can be applied for the needs of easier detection of rare traffic patterns. Then, the range of the machine learning algorithms can be applied to process the detected unusual traffic. The approach relies on the understanding of legitimate traffic behavior characteristics, which is further used to efficiently detect anomalous traffic patterns and deviations that could cause performance issues or indicate a breach. This way, it is possible to provide near real-time alerting and visibility of potential network security threats. This approach allows the detection of unknown threats, zero-day attacks, and suspicious behavior while providing performance optimization possibilities.</p>	WG3
TD(22)03035	Markus Hofer, David Löschenbrand, Stefan Zelenbaba, Gerhard Humer, Benjamin Rainer, Thomas Zemen	Massive MIMO Channel Measurements for a Railway Station Scenario	<p>In this paper we present massive MIMO channel measurements for a railway station scenario. The massive MIMO link shall provide an ultra-reliable low-latency communication link from the control center to the locomotive. In this measurement campaign the locomotive moves from line-of-sight to non line-of-sight. We present dual frequency band measurements, where the massive MIMO array at the base station has 24 receive antenna elements at 1890 MHz and 8 receive antenna elements at 748 MHz. The measurement bandwidth is 20 MHz and we use a repetition rate of 1 ms to acquire the time-variant channel frequency response of from the locomotive to all 32 antenna elements in parallel. In this paper, we provide a first analysis of the root mean square delay spread, the path loss coefficients and the channel hardening in both frequency bands.</p>	WG1,VT2

TD(22)03036	David Löschenbrand, Markus Hofer, Laura Bernadó, Stefan Zelenbaba, Thomas Zemen	Towards Cell-Free Massive MIMO: A Measurement-Based Analysis	Cell-free widely distributed massive multiple-input multiple-output (MIMO) systems utilize radio units spread out over a large geographical area. The radio signal of a user equipment (UE) is coherently detected by a subset of radio units (RUs) in the vicinity of the UE and processed jointly at the nearest baseband processing unit (BPU). This architecture promises two orders of magnitude less transmit power, spatial focusing at the UE position for high reliability, and consistent throughput over the coverage area. All these properties have been investigated so far from a theoretical point of view. To the best of our knowledge, this work presents the first empirical radio wave propagation measurements in the form of time-variant channel transfer functions for a linear, widely distributed antenna array with 32 single antenna RUs spread out over a range of 46.5 m. The large aperture allows for valuable insights into the propagation characteristics of cell-free systems. Three different co-located and widely distributed RU configurations and their properties in an urban environment are analyzed in terms of time-variant delay-spread, Doppler spread, path-loss, and the correlation of the local scattering function over space. For the development of 6G cell-free massive MIMO transceiver algorithms, we analyze properties such as channel hardening, channel aging as well as the signal to interference and noise ratio (SINR). Our empirical evidence supports the promising claims for widely distributed cell-free systems.	WG1
TD(22)03037	Robert Burczyk, Piotr Rajchowski, Jarosław Sadowski	Detection algorithm of hidden narrowband intersystem interference in LTE system	In the technical document, authors present the detection algorithm of narrowband intersystem interference in LTE system. The proposed interference detection algorithm is based on the analysis of received OFDM symbols phase variation in time. The technical document also contains the comparison of the interference detection effectiveness with the method known from the literature.	WG2
TD(22)03038	Raheeb Muzaffar, Ladislav Polák, Sara Cavallero, Irene Kilanioti, Golsa Ghiaasi	5G challenges for industrial automation	The industry 4.0 digital transformation is led by the automation of manufacturing processes. Industrial applications are quite heterogeneous and pose diverse requirements to the communication system. The transformation towards industry 5.0 has also been initiated recently, emphasizing the inclusion of humans into the increasingly automated physical processes. At the same time, the 5G cellular technology is evolving to support highly diverse and heterogeneous environments for various applications. In addition, edge computing and artificial intelligence with data-driven system design open novel dimensions for optimization of processes. All these technological advancements can be used to support industrial automation. This paper reviews essential 5G enabling technologies and available campus network deployment. With a view to practicability, we put particular emphasis on 5G non-public network variants, but also look at multi-access edge computing infrastructure and 5G integration with TSN (time-sensitive networking) and OPC UA (open platform communications unified architecture). A critical analysis of available results suggests that together these technologies can be effective enablers for ubiquitous wireless industrial communication, despite the stringent needs of industrial applications, including support of different QoS levels and security. Furthermore, we highlight existing challenges and open research questions that need further investigation before an actual rollout of the 5G system to the manufacturing industry can take place.	VT3

TD(22)03039	<p>Michał WYSOCKI, Robert NICPOŃ, Marta TRZASKA, Agnieszka CZAPIEWSKA</p> <p>Research of Accuracy of RSSI Fingerprint-Based Indoor Positioning BLE System</p>	<p>Radio localization in indoor environment is still a challenging task due to environment volatility. In the paper are compared achieved localization accuracies for RSSI-Fingerprinting method utilizing Bluetooth Low Energy (BLE) for two different environments: large empty hall and narrow corridor. Measurements were done by 6 different smartphones of 3 different producers, which makes those measurements unique as accuracies achieved by different devices can be compared.</p> <p style="text-align: right;">WG2</p>
TD(22)03042	<p>Peize Zhang, Pekka Kyösti, Mikkel Bengtson, Veikko Hovinen, Klaus Nevala, Joonas Kokkonen, and Aarno Pärssinen</p> <p>Experimental Characterization of D-Band Human Body Shadowing</p>	<p>Radio systems operating in upper millimeter-wave frequency band (100-300 GHz) are more likely to be deployed in real-world environments because the communication links are particularly susceptible to shadowing events, e.g., caused by the user's body. In this TD we present the results of D-band channel measurement campaign, which was conducted to characterize the impact of human blockage with a focus on the additional attenuation and deep fading duration. The attenuation by single human blockers with different physical characteristics was measured with human frontal and lateral crossing the line-of-sight link. Predicting results of two knife-edge diffraction models are compared with the measurement curves, which underestimate the attenuation levels due to the presence of human blockage, especially for the volunteer with larger size. Meanwhile, we quantify the degree of deep fading duration varying with fading depth, which helps to optimize the beam alignment strategy for maintaining sufficient signal-to-noise ratio when dominant path is heavily obstructed. More detailed analysis is ongoing with respect to different user cases in order to refine existing diffraction models for the characterization of human blockage effect.</p> <p style="text-align: right;">WG1,Sub-WG1</p>
TD(22)03043	<p>David Löschenbrand, Markus Hofer, Thomas Zemen</p> <p>Massive MIMO Channel Prediction and Channel Hardening for Mobile Users</p>	<p>We investigate the effects of user mobility on a single-cell massive multiple-input multiple-output (MIMO) system in terms of reliability. We derive a model for channel aging and multi-step channel prediction, given a general, stationary, temporal covariance matrix. Furthermore, we show that channel hardening, i.e., the capability of a massive MIMO system to eliminate small-scale fading and create quasi-deterministic effective channel gains, is independent of the channel state information (CSI) age. The asymptotic results show an improvement in signal to interference and noise ratio (SINR) of 20 dB and are confirmed by Monte-Carlo simulations, demonstrating an excellent match.</p> <p style="text-align: right;">WG1</p>

TD(22)03044	Yilin Ji and Wei Fan	Enabling High-fidelity Ultra-wideband Radio Channel Emulation: Band-stitching and Digital Pre-distortion Concepts	<p>Channel emulators are the key instrument in radio performance testing. The fidelity of the emulated channel with respect to the target channel models directly affects the credibility of the testing result. In practice, due to some non-idealities of the radio-frequency (RF) components of the emulator, its intrinsic frequency response, i.e., the response of the bypass mode, may not be flat over the frequency band of interest, which leads to an excessive distortion over the target channel models, and hence a less accurate emulated channel. This problem could be even more profound when the emulator engages the band-stitching process for a wider-bandwidth emulation, especially in the transition frequency band between adjacent sub-bands. To enable high-fidelity band-stitched or even ultra-wideband channel emulation, we propose a novel digital pre-distortion concept in this work, where we pre-distort the target channel models according to the measured intrinsic response of the emulator to compensate for its effect on the emulated channel. The proposed method is numerically assessed with measured intrinsic responses of a commercial emulator, and the magnitude and phase variations of the stitched channel reduce by one order of magnitude in comparison to that of the conventional method.</p>	WG1
TD(22)03045	Diego Dupleich, Alexander Ebert, Yanneck Völker-Schöneberg, Leon Löser, Mate Boban, and Reiner Thomä	Spatial/Temporal Characterization of Propagation and Blockage from Measurements at sub-THz in Industrial Machines	<p>In the present paper we introduce novel ultra-wideband dual-polarized double-directional measurements at sub-THz (300 GHz) in an access point to inside of machine application in an industrial scenario. The results show a sparse spatial/temporal channel with multiple paths from the different metallic objects and their influence on polarization. In addition, different LOS blockage situations were investigated, showing the presence of alternative paths for communications.</p>	WG1,Sub-WG1
TD(22)03046	Abdul Saboor, Evgenii Vinogradov, Zhuangzhuang Cui, Sofie Pollin	Probability of Line of Sight Evaluation in Urban Environments using 3D Simulator	<p>Unmanned Aerial Vehicles (UAV) communications offer various advantages over terrestrial communications due to mobility and high Probability of Line Of Sight (PLOS). Estimating the PLOS from UAV to ground users at a certain distance or inclination angle in different urban environments is essential for designing various applications. The existing PLOS models have limited applicability or cannot be generalized for any environment. Therefore, we present three-dimensional (3D) city simulator to estimate PLOS from UAV to ground users for arbitrary UAV height, user height, and distance. The simulator results can be generalized using built-up parameters for any city environment. Furthermore, we analyze the impact of different UAV locations on PLOS for street coverage. Lastly, we develop a lightweight geometry-based simulator using random user locations to validate the 3D simulator results. Index Terms—Unmanned Aerial Vehicles (UAV), Probability of Line Of Sight (PLOS), AerialBase Station (ABS).</p>	VT2,VT4

TD(22)03047	<p>Manuel M. Ferreira, Filipe D. Cardoso, Sławomir J. Ambroziak, Kenan Turbic, Mariella Särestöniemi, Luís M. Correia</p>	<p>Influence of User Mobility on System Loss and Depolarisation in a BAN Indoor Scenario</p>	<p>In this paper, an analysis of system loss and depolarisation in Body Area Networks for Body-to-Infrastructure communications based on a measurement campaign in an indoor environment is made, and a model for the standard deviation of the cross-polarisation discrimination ratio based on antenna visibility, link dynamics, user mobility and transmitter polarisation is proposed. Measurements were performed with a off-body antenna transmitting linear polarised signals and receiving antennas carried by the user on the body. The standard deviation of the cross-polarisation shows a clear dependence on user dynamics, with higher values in the walking scenarios, [0.99, 1.92] dB than the standing ones, [0.32, 0.74] dB. A Normal Distribution with a mean of 2.0 dB and a standard deviation of 4.3 dB is found to be the best fit for modelling the effects of cross-polarisation discrimination.</p>	WG1
TD(22)03048	<p>Alicja Olejniczak, Olga Błaszkiwicz, Krzysztof K. Cwalina, Piotr Rajchowski, Jarosław Sadowski</p>	<p>Software-Defined NB-IoT Framework</p>	<p>In the radiocommunication area, we may observe a rapid growth of new technology, such as 5G. Moreover, all the newly introduced radio interfaces, e.g., narrowband Internet of Things (NB-IoT), are strongly dependent on the software. In this paper, a software-defined NB-IoT framework in the field of design is presented, as well as its realization and potential use cases. The proposed realization is focused on the key elements in the physical layer of the NB-IoT interface used in the sensor devices. The proposed software-defined NB-IoT framework should be understood as an evaluational platform, where the signal processing functional blocks of the NB-IoT Rel. 13 and Rel. 14 standards are represented as a set of modules. It means that the design of the radio interface is completely modular, thus the adaptive form makes it possible to implement, execute, and test each part independently of the target platforms, testbeds, OTA stands, simulation environments, hardware–software stands with the FPGA support, or even distributed laboratory environments. Furthermore, the paper also highlights the need of the data processing optimization to minimize the power consumption and usage of the resources of the NB-IoT node during transmitting gathered telemetric data.</p>	WG2

Small, less than about 100 nodes, Mobile Ad-hoc Networks (MANETs) offer a number of advantages compare to infrastructure-based systems, especially for search and rescue and tactical applications where all nodes should be able to communicate to any other nodes. The flexibility of MANETs can be used to insure reliable communications among all nodes. Since the ideal fully meshed MANET topology cannot be insured in practice, nodes must be able to route packets and schedule the transmission to maximize the performance, throughput for example, despite the dynamic change of the topology. Throughput maximization can be achieved by providing more radio resources to the most used links, i.e., by scheduling more Tx slots to the most traversed nodes. In this contribution, we consider the case where the demand is characterized by short messages of equal size of 300B. Assuming that all pairs should be accommodated and given a topology, a set of shortest paths and an optimal TDMA schedule can be computed. An optimal schedule should last 3 to 6 seconds. However, realistic mobility scenarios like the open Anglova.net scenario changes every second. Suboptimal schedules are computed to use about 50 slots, i.e., less than 300ms, but providing more slots to the most traversed nodes as compared to a Round Robin schedule. Results are presented and discussed using the Optimized Link State Routing (OLSR) and the Omniscient Dijkstra Routing (ODR), with and without fading, with and without omniscient flow control allowing to avoid transmissions when no route is available and with/out slots reserved. The performance increased from 2kbps for the classical round robin schedule to 4kbps for the suboptimal ODR without fading using 1Mbps radio links. A Reinforcement Learning (RL) algorithm is investigated to propose more practical solutions to improve scheduling. Preliminary results on emulated radios present the performance of a so-called TDMA-Qs: a centralized RL agent based Q-Learning for slot allocation in MANETs. The TDMA-Qs agent identifies additional slots to provide to the nodes to keep a balance between the data to transmit and the slot allocation. The canonical 8-node 2-cluster topology is considered to evaluate the performance of the TDMA-Qs agent in static topology and fixed demand. The results show that the agent is able to provide slots to central nodes of the communications.

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Detailed analysis of optimal and feasible suboptimal MAC scheduling for realistic MANET scenarios

TD(22)03049

WG3

This paper considers a non-saturated IEEE 802.11ah-based network where stations are distributed around the Access Point (AP) and operate under a Rayleigh-fading channel with capture. We develop an analytical framework based on a two-level renewal process to model the contention within a group of stations and derive the Average Service Time (AST), presenting the proper size of the RAW slot that ensures successful delivery of all packets without extra waste of channel time. We also evaluate the Packet Delivery Ratio (PDR) and channel usage for a pre-allocated RAW slot in terms of designated stations to prove the effectiveness of our proposal. Our analytical framework is validated via extensive MATLAB simulations and can be applied to alternative communication technologies addressing dense scenarios and integrating periodic channel reservations.

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Adaptive Channel Allocation in non-Saturated Rayleigh Fading Wi-Fi HaLow Networks

TD(22)03050

WG3,VT3,VT4

Nowadays is not possible not to consider the coexistence and the fusion of different wireless technologies as completely separated entities. The ever-growing number of devices employing multi-RAT (Multiple Radio Access Technology) that require continuous wireless connectivity is posing great challenges. Furthermore, the requirements in terms of both throughput and latency originated by the use cases are pushing the current technologies to their limits, especially when considering dense deployments in indoor scenarios, which currently are mostly covered through WiFi. The IEEE 802.11 Working Group is currently tackling such challenges by working on a new amendment of the standard (namely 802.11be), which introduces, among other novelties, the Multi-Link Operation. Through this modality of operation, simultaneous transmission over multiple bands is performed to obtain massive throughputs up to 40 Gbps. Naturally, the introduction of a such new technology poses challenges on the coexistence with older, legacy devices in mixed networks. Therefore, the aim of this contribution is to explore and investigate how the coexistence of legacy IEEE 802.11 devices and new IEEE 802.11be devices operating in multi-link can be improved by using an appropriate static band assignment policy, and how the general network behaves in varying conditions (mainly the number of devices and the legacy/new nodes ratio). The experimental phase has been carried out by means of simulation for three different band allocation cases close to reality, and results in terms of aggregated, average throughput and fairness, for different conditions, are presented and discussed, altogether with further considerations on their exploitation.

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Investigating
inclusiveness and
backwards compatibility
for WLAN deployments
containing IEEE 802.11be
multi-link devices

TD(22)03051

WG3,VT4

With the increase in potential uses of terahertz technology, the need for terahertz transceivers with application-oriented adaptive radiation patterns has emerged. Reconfigurable reflectarrays consisting of actuated sub-wavelength reflectors have been successfully used for terahertz beam steering and beamforming. They do not require a complex feeding network and associated electronics, enabling a compact and power-efficient terahertz beam steering system. However, the current reflectarray-based beam steering is accomplished by forming the reflectarray as a grating structure, which is accompanied by the problems such as grating lobes, limited steering range, and discrete steering angles. Here, we configure a MEMS-based reflectarray with the genetic algorithm to eliminate the grating lobes and open up the possibility of customizing its radiation pattern. We used single- and multi-objective optimization to find the optimal height profile of the reflectarray and verified the results by full-wave electromagnetic simulations. We measured the radiation patterns of four reflectarray phantoms, i.e. reflectarrays without the MEMS actuation systems. The measurement results agree well with the calculated ones, with the main beam deviating at most 2 degrees from the target direction. Our work demonstrates how a genetic algorithm is used to shape a reconfigurable terahertz reflectarray to eliminate the grating lobes and tailor some specific features in its radiation pattern.

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Terahertz beam steering
using a MEMS-based
reflectarray configured
by a genetic algorithm

TD(22)03052

WG1,Sub-WG1

TD(22)03053	<p>Anja Dakić, Benjamin Rainer, Markus Hofer, Stefan Zelenbaba, Stefan Teschl, Guo Nan, Peter Priller, Xiaochun Ye, Thomas Zemen</p>	<p>Hardware-in-the-Loop Framework for Testing Wireless V2X Communication</p>	<p>In this paper we present a hardware-in-the-loop (HiL) framework for testing wireless vehicle-to-everything (V2X) communication hardware, i.e., modems under realistic channel conditions. The framework includes a wireless channel emulator, which is capable of emulating non-stationary wireless channels in real-time. We validate the HiL framework by comparing the frame error rate (FER) obtained via emulation with data obtained during a V2X measurement campaign using the same IEEE 802.11p based modems. To do this we acquire measured time-variant channel transfer function and FER measurements simultaneously. The results show that our HiL approach is feasible and that we can obtain FER measurements in the laboratory that closely match the measurement results obtained on the road.</p>	WG1,VT2
TD(22)03054	<p>Marjolijn Kleijer, Gerhard Steinböck, Bengt-Erik Olsson, Martin Johansson, Bart Smolders</p>	<p>Impact of Façade Details on Radio Propagation at 28 GHz</p>	<p>Channel modeling tools, such as ray-tracers, require geometrical information of the environment. Usually, this geometrical information consists of smooth 3D models. These models are obtained by extruding building footprints from commercially available digital maps. However, with the evolution of mobile networks and the use of higher frequencies, small-scale geometric details are becoming increasingly important. This contribution investigates if the typically used diffuse scattering models are sufficient to mimic these small-scale geometric variations or if more detailed geometrical models are needed. A ray-tracer based on geometrical optics and radio wave propagation theory is used to simulate a model with various levels of details. Comparison between the simulations and corresponding measurements leads to the conclusion that the typically used diffuse scattering models may not mimic scattering from façades well. More details, such as windows, should be included in the 3D models or an improved façade scattering model is required to more realistically modeling the scattering observed from a façade.</p>	WG1
TD(22)03055	<p>Enrico M.Vitucci, Nicolò Cenni, Franco Fuschini, Vittorio Degli- Esposti</p>	<p>A Reciprocal Heuristic Model for Diffuse Scattering from Walls and Surfaces</p>	<p>Diffuse scattering of electromagnetic waves from natural and artificial surfaces has been extensively studied in various disciplines, including radio wave propagation, and several diffuse scattering models based on different approaches have been proposed over the years, two of the most popular ones being Kirchhoff Theory and the so-called Effective Roughness heuristic model. The latter, although less rigorous than the former, is more flexible and applicable to a wider range of real-world cases, including non-Gaussian surfaces, surfaces with electrically small correlation lengths and scattering from material inhomogeneities that are often present under the surface. Unfortunately, the Effective Roughness model, with the exception of its Lambertian version, does not satisfy reciprocity, which is an important physical-soundness requirement for any propagation model. In the present work, without compromising on its effectiveness and its simple and yet sound power-balance approach, we propose a reciprocal version of the Effective Roughness model, which can be easily implemented and replaced to the old version in ray-based propagation models. The new model is analyzed and compared to the old one and to other popular models in the present paper. Once properly calibrated, the new model is shown to yield similar - if not better - performance with respect to the old one when checked vs. measurements.</p>	WG1

TD(22)03056	Olga Błaszkiwicz, Piotr Rajchowski, Jarosław Sadowski	Synchronization methods analysis in NB-IoT	In the article a survey of frequency-time synchronization methods and analysis were made. Three different methods of synchronization were implemented. Analysis and comparison of the results were based on real NB-IoT signals generated by radiocommunication tester in confined and emulated propagation environment.	WG2
TD(22)03057	Mohammed Mallik, Angesom Ataklity Tesfay, Joe Wiart, Davy Gaillot, and Laurent Clavier	EMF Exposure measurement in Métropole Européenne de Lille	With the fifth-generation (5G) deployment, electromagnetic field exposure has become a critical concern. However, measurements are scarce, and accurate electromagnetic field reconstruction in a geographic region remains challenging. This paper presents the drive-test electromagnetic field measurement of the European metropolis of Lille. The main objective is to use the drive-test measurement data to train a machine learning-based electromagnetic field exposure mapping model and reconstruct the exposure from a few sensors located in an outdoor urban environment. Additionally, the drive-test data is compared with the drive-test performed by Métropole Européenne de Lille in 2017.	Sub-VT1
TD(22)03058	Wim Kotterman	Deriving beam dynamics in FR2 derived from V2I channel measurements in FR1	The dynamics of transmit beams in FR2 for vehicular scenarios can be measured directly, but at high costs. Here, measurements in FR1 are used to emulate the channel conditions in FR2. The idea behind this is that the large scattering objects that are likely to transport the power on the channel in NLoS, are present in both FR1 and FR2, be it of course with some differences in scattering strength and directivity. We take the scattering in FR1 as possibly more stable than in FR2, in this way giving a lower limit on the speed of change in beam visibility at the receiver. The sounding measurements were originally intended for emulating low-altitude satellite MIMO transmissions to mobile users, that is from a high base station position, in urban Berlin, Germany. The data are fully-polarimetric @ 2.53 GHz.	WG1,Sub-WG1
TD(22)03059	Michael Döbereiner, Gerd Sommerkorn, Wim Kotterman	Proposal for structured storage and access of data and meta data in HDF5 format. Example: the datapool contribution from TU Ilmenau.	The INTERACT data pool is under construction. At the moment, data is stored locally in proprietary formats. One of the worst jobs in processing measurement campaign data is combining the measured data with corresponding meta data, directly followed by structured access of specific items in the data. For such tasks in large to very large data sets, the hierarchical Data Format has been developed, of which HDF5 is the current version. We show some of the advantages this data format has for storing and accessing very diverse sets of data as well as sets of very diverse data. As an example, we demonstrate this by explaining the data format of the channel sounding data supplied to the INTERACT data pool by TU Ilmenau. We hope that adopting such a format for pool data leads to more homogeneous access of data in the pool.	WG1,HA1

TD(22)03060	Gerd Sommerkorn, Michael Döbereiner, Wim Kotterman	Contribution to the data pool by TU Ilmenau: Full-polarimetric V2I MIMO channel sounding data sets @2.53GHz in urban environment, together with pertinent antenna array characteristics	Seven measurement runs, selected from a measurement campaign in Bonn, Germany, are offered to the data pool. The environment is urban, the context is V2I from an elevated base station, the set-up is fully polarimetric MIMO with an 8 dual-pol element linear Tx array and a 24 dual-pol element Rx array, configured as four circular rings of 6 elements each. The frequency is 2.53 GHz, the bandwidth 20 MHz. For easy access of relevant quantities, data as well as meta data are stored jointly in HDF5 format. For aiding interpretation of the data, full Tx and Rx array characteristics are included.	WG1,VT2,HA1
TD(22)03061	Mohammed Mallik, Joe Wiart, Davy P. Gaillot, Laurent Clavier	A GAN and LSTM model Based Spatio-Temporal Electromagnetic Field Exposure Prediction Method	With the fifth-generation (5G) deployment, electromagnetic field exposure has become a critical concern. However, measurements are scarce, and accurate spatial and temporal sequence of electromagnetic field reconstruction in a geographic region remains challenging. In this work, a Generative Adversarial Network and long-term and short-term memory neural networks are proposed to address this issue. The main objective is to reconstruct the electromagnetic field exposure map accurately from a few sensors located in an outdoor urban environment and then use these predictions to capture the temporal behavior of the fields. The model is trained to learn and predict the propagation characteristics of the electromagnetic field. The reconstructed fields are then used to predict electromagnetic fields for the next hour using long-term and short-term memory neural networks (LSTM). Results show that the proposed method produces accurate estimates and is a promising solution for spatiotemporal exposure map reconstruction.	Sub-VT1
TD(22)03062	Ahmed Boujnoui, J. J. Camacho Escoto, Javier Gomez, Luis Orozco Barbosa, and Abdelkrim Haqiq	Energy Analysis of a Broadcast MAC protocol for IEEE 802.11bc Enhanced Broadcast Services	In this paper, we conduct an energy consumption analysis of a broadcast access mechanism over IEEE 802.11 networks. By assuming non-saturated conditions, we provide a statistical model of the energy consumed during one cycle period defined as the duration between two successful broadcast transmissions. The model includes a characterization of the medium access transmission mechanism. Our results show that the broadcast protocol is a good candidate to be included in future amendments of the IEEE 802.11 standard.	WG3

TD(22)03063	Guoda Tian, Ilayda Yaman, Xuesong Cai, Liang Liu, Fredrik Tufvesson	Indoor Wireless Positioning with sub- centimeter accuracy using real Massive MIMO Testbed	<p>High-precision localization technology as well as Artificial intelligence (AI) play an important role on the next generation cellular communication system. In this paper, we evaluate the potentials of applying AI technique to solve indoor positioning tasks with high accuracy requirements. We propose a novel processing pipeline for solving localization tasks utilizing massive MIMO antenna array. The proposed pipeline considers a narrow band uplink system, where UE transmits narrowband sounding signals which are captured by an antenna array at base station side. The pipeline contains a pre-processing algorithm which extracts information embedded in spatial domain, by calculating received channel covariance matrices which embed the spatial correlation information among all antennas. Those matrices are fed into a fully-connected neural network to estimate positions of users. To further improve the positioning accuracy, ensemble learning algorithms are applied, which first divide the large array into few sub-arrays. At next step, we calculate the covariance matrices regarding to those sub-arrays and feed those matrices into several independent neural networks. The outputs of those networks are combined to further improve the positioning results. In addition, we propose a novel method to determine the necessary training samples by applying Nyquist theorem. To evaluate our proposed algorithms, we conduct indoor measurement campaign using a robot as UE and Lund university massive MIMO testbed as base-station. We show that we can reach sub-centimeter accuracy level by applying our proposed processing pipeline.</p>	WG1,WG2
TD(22)03064	Conchi Garcia- Pardo, Alberto Nájera, Álvaro Villaescusa, Sergio Castelló- Palacios, Jesús Gonzalez Rubio, Narcis Cardona	5G EMF Exposure Assesment Methods: Theoretical Maximum vs Total Exposure in the City of Valencia	<p>The 5G roll-out is aimed to bring new services and applications along with new model businesses. Nevertheless, it exists social concern about the implications on health of 5G EMF human exposure. Besides, the novelties of 5G in the radio interface make it necessary to review and update the methodologies for the assessment of exposure in 5G technology. Thus, the development of proper assessment methodologies will impact the adequate deployment of 5G systems as well as assuring the safe operation of devices for people. This work aims at comparing the results of total exposure and the theoretical maximum exposure in commercial 5G networks already deployed in the city of Valencia. These are the first 5G measurements performed for commercial networks in Spain and aim at setting the basis of 5G EMF exposure considering the state of the art of 5G measurements available so far.</p>	Sub-VT1

TD(22)03065	<p>Francesca Conserva, Roberto Verdone</p> <p>Mathematical Description of User Satisfaction for UAV-Aided Vehicular Networks</p>	<p>Future mobile radio networks require a degree of flexibility that technologies Unmanned Aerial Vehicles (UAVs) (a.k.a. drones) carrying Base Stations (BS) can provide. In particular, UAVs acting as flying BSs create what we can refer to as the 3D Networks paradigm. In this perspective, we foresee the employment of UABSs to enable indirect Vehicle-to-Vehicle (V2V) communications via drones. In this way, the vehicular users can enhance the perception of their surroundings beyond what their own sensors can detect, running augmented sensing applications.</p> <p>The objective of this work is to extend a mathematical framework that aims at providing the assessment of some theoretical limits regarding a UAV-Aided Vehicular Network. The mathematical model, that relies on stochastic geometry, provides an expression of the Vehicular User Access Probability, which is the probability that the ground user is both covered by one UABS beam and it is assigned enough resources to successfully transmit in uplink its traffic demand. In particular, the Access Probability is expressed as a function of both the UABS' height and the antenna system's aperture angle. Numerical results show optimal couples of both these values allowing to reach the desired level of user satisfaction.</p>	WG3
TD(22)03066	<p>Francisco Muro, Eduardo Baena, Sergio Fortes, Lars Nielsen, Raquel Barco</p> <p>A novel approach for Noisy Neighbour identification and handling for virtualized 5G Core</p>	<p>The evolution of the new generation of mobile networks towards virtualization involves the emergence of new problems to deal with. The sharing of the underlying infrastructure between multiple virtual units as well as any other processes can trigger a competition for the dynamic allocation of the resources, leading to a decrease in network performance and impacting service quality and users' experience. In this context, a renewal to the management procedures applied to the predecessor networks as well as the consideration of new variables that were previously ignored (e.g, computational capacity) is determined as crucial. The present work introduces a novel framework with multiple coexistent computational processes, where a "Noisy Neighbour" (NN) is identified as an entity that uses most of the underlying resources while other virtual units suffer a lack of them. The present work proposes a baseline for NN handling through a novel lifecycle management flow. In this way, it is analysed and assessed the NN problem in 5G Core scenarios, as well as the degradation that KPIs suffer in the network when a NN appears. For this purpose, several ML models have been tested for the identification of this malicious entity based on the metrics obtained from the network, proving the validity of the approach. In addition, ML is also applied to performance forecasting, along with a model for the prediction of the CPU resources that the network may demand at any given conditions, supporting the proposed management flow.</p>	WG3
TD(22)03067	<p>Alicja Olejniczak, Krzysztof K. Cwalina, Jaroslaw Sadowski, Jacek Stefanski</p> <p>EFFICIENCY ANALYSIS OF THE DEEP LEARNING-BASED MODELS FOR GMSK SIGNAL DETECTION</p>	<p>Artificial intelligence dynamically enters the realm of radiocommunication not only in the scientific context but also regarding commercial market. The paper presents evaluation of the deep learning (DL) models for Gaussian Minimum Shift Keying (GMSK) signal demodulation in AWGN channel. The proposed DL methods were compared with optimal Maximum Likelihood Sequence Estimation (MLSE) detector based on Bit Error Rate (BER) metric.</p>	WG2

TD(22)03068	Thomas Blazek, Adrian Kliks	Challenges and achievements in transportation - VT2	It this paper, the achievement made so far as well as all identified challenges within VT2 are summarized. They go across all INTERACT workpackages and cover the vast spectrum of research topics such as channel sounding, application of edge Intelligence and the role of 6G in transportation.	VT2
TD(22)03069	Fred Wagen and Yann Maret	On Physical Layer Abstraction for realistic real time emulations: do we need an INTERACTION between WG1 and WG3 ?	In WG1, accurate modeling of the radio propagation and of the radios Tx/Rx characteristics are of major interest. In WG3, accurate multiusers system simulations and emulations is increasingly important to quantify the benefits and the limitations of new schemes in advanced communications systems from WiFi to 6G to V2x. An abstracted PHY based on Packet Error Rate-vs-Signal to Interference+Noise Ratio (PER-vs-SNR) curves does not need to generate or decode waveforms. The abstracted PHY allows simulations to run in minutes instead of hours and real time emulation became feasible but at the cost of accuracy. How accurate the WG3 and WG1 communities needs to be ? Although somewhat equivalent, changing the PER-SINR curves according to the environment, the MCS and the Packet Size is favored to, as an example, adding a Gaussian Random variable G(3,5)dB to the pre-computed pathloss. Some non-exhaustive thoughts, reviews, measurements, simulation results are presented.	WG1, WG3
TD(22)03070	Konstantinos Katzis, Irene Kilanioti, Sławomir J. Ambroziak, Kamran Sayrafian	Technical Challenges in Vertical Team 1: Health & Well-Being	This document captures the general technical challenges that are under discussion and research by Vertical Team 1 (VT1) on Health and Well-being. The Technical Documents (TDs) that have already been presented by the participants in the past two meetings of COST CA20120 are addressing some of the issues under these challenges. The technical topics in vertical team 1 cover a wide spectrum of subjects; therefore, the challenges presented in this document is not meant to be an exhaustive list. Consequently, in the future, the content of this TD is expected to evolve as more VT1 participants contribute their research ideas and results to the action and possibly new challenge areas are identified. In the following, a summary of the current challenges is presented.	VT1

Valencia, September 20-22, 2022

	Day One	Day Two	Day Three
Start time	08:30	Welcome	Welcome
Room	Auditorium	Auditorium	Auditorium
Sessions	PLENARY	WG1-MIMO	WG1 - Models
TD or other	09:00	09:00	09:00
TD or other	MC meeting	36	23
TD or other	9:00 Welcome Prof. Héctor Esteban (Dir. of Telecom. Faculty)	18	33
TD or other	09:25 General information	43	
TD or other		29	51
TD or other		6	62
TD or other		11	
TD or other		28	
TD or other		47	
TD or other		24	
TD or other		65	
TD or other		CHAL	
TD or other		Disc WG3	
Break	10:30	10:30	10:30
Room	Coffee break	Tea break	Friendly break
Sessions	Auditorium	Auditorium	Auditorium
TD or other	PLENARY	VT2+WG1	PLENARY
TD or other	11:00	11:00	11:00
TD or other	DATABASE Short word	5	MC meeting
TD or other	59	25	Summary of WG activities
TD or other	9	30	
TD or other	63	70	
TD or other		68	
TD or other		Disc VT1	
TD or other		22	
TD or other		46	
TD or other		20	
TD or other		CHAL	
TD or other		Disc VT4	
Lunch	13:00	13:00	13:00
Room	Lunch	Lunch	Lunch
Sessions	Auditorium	Auditorium	
TD or other	WG1 - Scattering	WG1 - Measures	
TD or other	14:00	14:00	
TD or other	10	27	
TD or other	54	60	
TD or other	55	35	
TD or other	69	4	
TD or other		Disc WG1	
TD or other		57	
TD or other		61	
TD or other		64	
TD or other		Disc EMF	
TD or other		49	
TD or other		26	
TD or other		38	
TD or other		Disc VT3	
Break	15:30	15:30	
Room	Orange juice break	Water break	
Sessions	Auditorium	Auditorium	
TD or other	WG1 - RIS	sub-WG1 THz	
TD or other	16:00	16:00	
TD or other	32	45	
TD or other	52	12	
TD or other	14	42	
TD or other	16	Sana Salous	
TD or other	48	Disc SWG1	
TD or other		37	
TD or other		67	
TD or other		Disc ISAC	
TD or other		13	
TD or other		Disc WG2	
End time	17:30	17:30	
		Newsletter meeting	



INTERACT

Valencia, Spain, 20-22 September 2022

SUBJECT: WG Contributions at the 3rd Management Committee Meeting and 3rd Technical Meeting of COST Action CA20120 “The Intelligence-Enabling Radio Communications for Seamless Inclusive Interactions (INTERACT)”.

WG Contributions

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WG Contributions

WG1 - Radio Channels

We had 6 WG1 sessions, 1 of which was a joint session with VT2, for a total of 20 papers. In addition, there was 1 sub-WG1 THz session with 3 papers, 1 report from Sana Salous and discussion: I rely on Diego for a more complete sub-WG1 THz report.

Main lines of research that emerged from the sessions are:

- studies on diffuse scattering, including measurement and modelling at various frequencies (3-4 papers)
- Antenna, propagation and channel modeling for MIMO, massive MIMO and cell-free, distributed MIMO, with specific focus on channel hardening, channel estimation and channel aging (4-5 papers)
- Propagation and channel modeling for Vehicular applications, including channel sounding and emulation (4 papers)
- Channel measurements and modeling for indoor and in-cabin environment. Interesting combinations of measurements and ray tracing prediction are proposed for channel simulation (3-4 papers)
- Hardware testbed and propagation/system studies for reconfigurable intelligent surfaces (2 papers).

We had a discussion on the new sub-working group "Scattering and propagation models for reconfigurable intelligent surfaces" (sWG1 "RIS") that resulted in the official Kick-off of the sWG and the election of the two co-Chairs.

I recalled previous steps and I asked again everybody - both in presence and online - if somebody else, besides Joonas Kokkonen and Marco Di Renzo was available to run as a co-Chair of the sWG. Nobody showed up.

Therefore, Mate and I, as co-Chairs of the session, declared the sWG1 "RIS" finally activated with Marco and Joonas as co-Chairs. Then I asked Joonas and Marco to briefly present themselves. A brief discussion followed with the purpose of stimulating work and future TD submissions on the sWG topic.

Finally we had a discussion on the future Challenges, that were also presented in TD(22)03004 "COST INTERACT Working Group1: Key Challenges and Initial Directions", and on the future "White Paper" on Propagation/Channel modelling, that will have to be written in 2023. Discussion touched the following points:



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- Identify the directions of interest by the participants of WG1 (Narcis, Luis) that will then be worked out for the rest of the action. Proposal by Narcis: channel modeling for ISAC.
- It should include Issues to be solved and challenges to be addressed
- Specify the Whitepaper ToC based on input by people. Topics should be participant-driven, e.g: including body area networks and body scattering for gesture recognition, if of interest. Include directions, not only challenges.
- Use the deliverable on challenges and maybe the introduction of the White Paper of the EurAAP WG Propagation, that is being written by the EurAAP Propagation Board.
- Given the tight schedule and the necessity of another meeting for discussion, the WP deadline should be moved to June 2023

SubWG - THz

Regarding the sWG1 in THz, we had three TDs ranging from set-ups for measurements at sub-THz to proper measurements of novel scenarios: industrial machines, human shadowing, and also conference room with the comparison to previous mmWave measurements in the same scenario.

- TD(22)03012: this TD from the Niigata University in Japan is related to the development of a channel sounder at 300 GHz and measurements in a conference room. Previously, in the same scenario, measurements at mmWave were conducted. The results showed high similarities between the bands in terms of the dominant multi-path components.
- TD(22)03045 is related to double-directional and dual-polarized measurements at 300 GHz in industrial scenarios, more specifically, inside of machines. LOS and different blockage scenarios were measured and characterized.
- TD(22)03042 from Oulu presents novel human shadowing measurements at 300 GHz with the comparison to models widely used in the literature, showing the need to adapt the models considering system components, as the antenna patterns, to obtain results closer to the measurements.

In general, more measurement results for characterization of propagation with modeling implications in different scenarios are expected to be received in the future, showing the relevance of the topic in the current time.



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WG2 - Signal Processing and Localisation

WG2 had three sessions and one TD was presented in the plenary. In total, 10 TDs were presented in WG2: four about localisation and positioning; three about coding, demodulation schemes and evaluation of their performance; two about signal detection; and one about implementation of communication transceivers. Two chairs were selected for the SWG on ISAC, namely, Yang Miao and Carsten Smeenk. Additionally, after thanking the editors and contributors, there was a discussion on the Challenges TD. Some topics to be added to the current version were identified, such as cell-free massive MIMO and network coding. Besides, there was interest to organise some joint sessions with WG1 in topics related to cell-free massive MIMO. Some new data-sets to be added to those already available were identified.

WG3 - Network Architectures and Protocols

Three papers were presented during the Tuesday session and focused on boosting network safety by using ML to mitigate the attacks, using UAV repeaters to minimize eavesdropping chances for critical and military applications, and introducing and investigating functional safety in industrial wireless communications. Also, the challenge TD have been discussed and brainstormed, and the follow-up activities have been planned. We thank the ones who have already either provided input or promised to provide some input during the past two days and wish to remind the others interested in getting in touch with the group chairs or Gianluca Rizzo.

On Wednesday, in the WG3 section, we had two papers presenting a design of ground GW for satellite IoT and analytic work discussing the performance of UAV-aided vehicular networks. Also, there was a joint session with VT4 on Wednesday, and VT3 today. In the WG3 session, we discussed some of the upcoming events, new funding opportunities, the open publication of data sets and SW/models (including brainstorming the ways to boost the number of contributions from WG3; the discussion involved the chair of HA1 Marco Skocaj), and, again, the deliverable.

On Thursday's session, three papers were presented, dealing with resources assignment in multilink and multi-RAT communication and efficient broadcasting techniques.



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VT1 - Health and Well-Being

During the INTERACT 3rd MC and 3rd Technical Meeting the VT1: Health and Well-Being held two sessions with 6 TDs. In total there were 38 onsite attendees and 8 online attendees. A summary of the presentations and discussions is provided in the following.

I. September 21st (09:00-10:30)

This was a joint session with SWG EMF. During this session three TDs (no. 6, 11 and 47) related to VT1 were presented. In the first TD (no. 6) the coupling between antenna near-field and a lossy host body with a use of a simple canonical host phantom was analysed. A method allowing the easy computation of the reference distance i.e., the distance at which propagation models are independent on the antenna was presented. A closed form equation enabling the computation of the losses within this reference distance was proposed. The second TD (no. 11) presented a numerical analysis aimed at characterising various types of biological tissues from the electromagnetic point of view, addressing the modalities of propagation in layered tissues by means of geometrical optics rules on reflection and absorption in non-conductive materials. The focus of the work is on the evaluation of electrical fields in tissues within the cranial capsule as a function of the incident field frequency. The analysis takes into account transmission and reflection at the interface between tissue layers with different electromagnetic characteristics. The computation was performed in the parietal area of human skull, for both horizontal and vertical polarisations and for frequencies varying from 26 GHz to 100 GHz. The authors of the last TD (no. 47) performed an analysis of the system loss and depolarisation in Body Area Networks for Body-to-Infrastructure communications based on a measurement campaign in an indoor environment. Measurements were performed with an off-body antenna transmitting linearly polarised signals and receiving antennas carried by the user on the body. A Normal Distribution was found to be the best fit for modelling the cross-polarisation discrimination. The average correlation between the signals received by the orthogonally polarised antennas is below 0.5, indicating that polarisation diversity can be used to enhance communication quality.

II. September 21st (11:00-13:00)

During this session three TDs (no. 25, 30 and 70) were presented. The first TD (no. 25) reported initial results on the effect of the underlying error in Bluetooth proximity estimation on the accuracy of the exposure decisions in an automatic contact tracing system. An agent-based simulation platform which allows for evaluation of a wide range of scenarios with a large number of agents has been developed. Preliminary results indicated that the proximity estimation error using



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BLE may have substantive effect on the number of false exposure determinations. The authors of the second TD (no. 30) proposed a method for reducing artifacts from the ECG signal recorded by capacitive electrodes (cECG) in moving subjects. A method for artifact removal based on estimating the fluctuation around linear trend (for both artifact types) including a condition for determining the presence of coarse artifacts has been developed. The method was validated on cECG data recorded while driving. Artifacts are predominantly due to the movements. The last TD (no. 70) discussed some of the technical challenges under consideration in Vertical Team 1: Health & Well-Being. Five technical challenges have been identified. They are “Advanced Communications for Medical Implants, Wearables and Ingestible Implants”, “Advanced Telemedicine including Remote Health and activity monitoring for diagnosis or rehabilitation”, “Next Generation Technologies for Public Health and Emergencies”, “Enhanced Privacy and Security in Health Data and patient safety”, and “Nano-Networks”. These challenges are used as general technical topics for future VT1 activities as well as areas of collaboration inside or outside the INTERACT community. A VT1 discussion was held after the session. The summary of the discussed topics is provided in the following.

1. Challenges

The challenges have been defined in TD(22)03070 “Technical Challenges in Vertical Team 1: Health & Well-Being.” Five technical challenges have been identified as the baseline for VT1:

- Advanced Communications for Medical Implants, Wearables and Ingestible Implants,
- Advanced Telemedicine including Remote Health and activity monitoring for diagnosis or rehabilitation,
- Next Generation Technologies for Public Health and Emergencies,
- Enhanced Privacy and Security in Health Data and patient safety,
- Nano-Networks.

This list captures the general technical challenges that are under discussion and research by VT1. The TDs that have already been presented by the participants in the past meetings of COST CA20120 are addressing some of the issues under these challenges. The technical topics in VT1 cover a wide spectrum of subjects; therefore, the challenges presented in this document is not meant to be an exhaustive list. Consequently, in the future, the content of this list is expected to evolve as more VT1 participants contribute their research ideas and results to the action and possibly new challenge areas are identified.

2. Training schools

a) *Executed*



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- None.
- b) *Planned*
- None.

VT1 members were asked to send information on planned or executed training schools to the VT1 Chairs.

3. Short Term Scientific Missions among participant institutions

a) *Executed*

- None.
- b) *Planned*
- 26-30.09.2022, **UPV@PG**: “Measurements of the materials’ properties (reflection and transmission losses) in classroom and meeting room environments at 26-65 GHz.”

VT1 members were asked to send information on planned or executed STSMs to the VT1 Chairs.

4. Joint workshops and special sessions

a) *Executed*

- None.
- b) *Planned*
- *IoT-Health 2023: 5th International Workshop on IoT Enabling Technologies in Healthcare* at IEEE International Conference on Communications, 28 May - 01 June 2023, Rome, Italy; Organizers: Kamran Sayrafian (NIST), Hamed Ahmadi (UOY), Konstantinos Katzis (EUC), Slawomir Ambroziak (PG);
- *COST CA20120 INTERACT: Measurement & Modelling of Radio Waves Propagation for Indoor Communications*, XXXVth General Assembly and Scientific Symposium of the International Union of Radio Science (URSI GASS 2023), August 19 - 26 2023, Sapporo, Japan; Organizers: Slawomir Ambroziak (PG), Kamran Sayrafian (NIST).

VT1 members were asked to send information on planned or executed joint workshops and special sessions to the VT1 Chairs.

5. Collaboration

a) *Ongoing*

- **IST, PG, IPS, RWTH and OULU**: “Off-Body and Body-to-Body Radio Channel Modelling at UWB and mmWaves Bands”;
- **PG and UPV**: “Measurements of the Channel Impulse Response at mmWaves for Conference Networks”.



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- **EUC and NIST:** “Remote Monitoring of Physiological Signals using LoRa”.
- c) *Planned*
- None.

VT1 members were asked to send information on planned or ongoing collaboration to the VT1 Chairs.

6. Joint papers (with acknowledgements to INTERACT)

a) *Published*

- Ferreira M.M., Cardoso F.D., Ambroziak S.J., Turbic K., Correia L.M., *Mobility's Influence on System Loss in Off-Body BAN Scenarios*, Joint European Conference on Networks and Communications & 6G Summit (EuCNC/6G Summit), 7-10 June, Grenoble, France, 2022;
- Ambroziak S.J., Cwalina K.K., Rajchowski P., Cardoso F.D., Ferreira M.M., Correia L.M., *A Cross-Polarisation Discrimination Analysis of Off-Body Channels in Passenger Ferryboat Environments*, IEEE Access, Vol. 10, pp. 55627-55637, DOI:10.1109/ACCESS.2022.3175009, 2022;
- Ferreira M. M., Cardoso F. D., Ambroziak S.J., Correia L.M., *Influence of User Mobility and Antenna Placement on System Loss in B2B Networks*, IEEE Access. Vol. 10, pp. 37039-37049, DOI: 10.1109/ACCESS.2022.3163859, 2022.
- Ambroziak S.J., Cardoso F.D., Kosz P., Ferreira M.M., Correia L.M., *Analiza zaników szybkozmiennych w radiowych sieciach BAN pracujących w rewerberacyjnym środowisku propagacyjnym*, Przegląd Telekomunikacyjny i Wiadomości Telekomunikacyjne, No. 4/2022, pp. 505-510, DOI 10.15199/59.2022.4.91, 2022 (in Polish).

b) *Planned*

- Ferreira M.M., Cardoso F.D., Ambroziak S.J., Särestöniemi M., Turbic K., Correia L.M., *Influence of User Mobility on System Loss and Depolarisation in a BAN Indoor Scenario*;
- Ambroziak S.J., Drozdowska M., Cwalina K.K., Rajchowski P., Cardona N., *Channel Impulse Response Measurements at mmWave Bands in Offices and Conference Rooms*, URSI GASS 2023, Sapporo, Japan, 2023.

VT1 members were asked to send information on accepted and/or published joint papers to the VT1 Chairs.

7. Liaisons

- IEEE P2933: *Standard for Clinical Internet of Things (IoT) Data and Device Interoperability with TIPPSS - Trust, Identity, Privacy, Protection, Safety, Security* (Konstantinos Katzis, Irene Kilanioti);



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- IEEE 802.15 TG6ma: *Dependable Body Area Networks* (Kamran Sayrafian);
- URSI Commission C: *Radiocommunication Systems and Signal Processing* (Krzysztof Cwalina);
- EurAAP: *Working Group on Propagation* (Krzysztof Cwalina).

8. White papers

a) *Published*

- *None.*

b) *Planned*

- *None.*

VT1 members were asked to send information on planned and/or published white papers to the VT1 Chairs.

9. Datasets (HA1):

- “System Loss in Body-to-Body BAN in Indoor and Outdoor at 2.45 GHz” – **PG & IST.**
- “System Loss in Off-Body BAN in Indoor at 2.45 GHz” – **PG & IST.**
- “Two-layer Phantom-Based UWB Channel Measurements for IB2OB Scenarios” – **UPV.**

During discussion there was a proposal to use the gathered data as a training dataset for Machine Learning tools.

10. Dissemination

During IRACON a LinkedIn group (*IoT - Health Working Group*) has been created. This group is still active and has 72 members. It can be used as a venue to disseminate VT1 activities.

11. Number of TDs submitted so far: 15

- Feb. 2022, Bologna, Italy: 5 TDs
- Jun. 2022, Lyon, France: 4 TDs
- Sept. 2022, Valencia, Spain: 6 TDs

12. A possible Special issue on health and well-being

Dragana Bajić proposed to initiate a series of Special Issues under the following MDPI journals:

- Entropy, <https://www.mdpi.com/journal/entropy>
- Sensors, <https://www.mdpi.com/journal/sensors>
- Healthcare, <https://www.mdpi.com/journal/healthcare>



INTERACT

- Machine Learning and Knowledge Extraction, <https://www.mdpi.com/journal/make>

The proposed topic title is “Communications Challenges in Health and Well-being” with the following sub-topics:

- RF Propagation in Body Area Networks;
- Application of machine learning and artificial intelligence in Health Data Processing;
- Remote Health Monitoring (applications for both humans and animals);
- Nano-Networks;
- Technologies for Public Health and Emergencies;
- Activity Monitoring for Diagnosis or Rehabilitation;
- Privacy and Security in Health Data Transmission or Processing;
- Crowdsensing/crowdsourcing;
- Information Theory Aspects of Biomedical Signals;
- Medical-technical human interface.

VT1 Members interested to be a co-editor of a Special issue were asked to contact Dragana Bajić.

SubWG - EMF

SWG EMF had 1 plenary talk and 2 technical sessions during the Valencia meeting. On one hand, the plenary talk provided by Paolo Grazioso was about the communication of risk and dissemination to general public of issues related to exposure. On the other hand, regarding the two technical sessions, there was one joint session with VT1 with TDs about measurements considering the influence of user equipment's position on local exposure to 5G and another about dielectric characterisation of millimetre wave field propagation in the cranial capsule. Considering the second session, the TDs presented were about field measurements in the city of Lille and a AI-based method to predict the measured values. Following, a TD about methodology for the extrapolation to the theoretical maximum exposure in 5G was presented. In general, a nice discussion among attendees was held about measurement methodologies and open technical challenges related to EMF exposure. To conclude the session, chairs asked for planned organized joint activities or STSM, but they are still ongoing.

VT2 - Transportation

Many of the TDs submitted to the Valencia meeting have been related to the topics covered by the VT2. Finally, four separate submissions have been allocated



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to the VT2 session, which was chaired by Arian Kliks, VT2 group chair. Approximately almost half of all participants attended this session, which led to nice and vivid technical discussions. One of the VT2 papers discusses the problem of expanding the measurements and results achieved for low velocities to very high speeds. Such an approach is necessary, as performing real measurements at velocities around 300 kmh generates many problems. Another paper presents the results of the experiment, where the concept of hardware-in-the-middle was evaluated to approximate the real behavior of the V2X channels. The achieved results proved an almost perfect match between the simulation and the true, real-life measurements. Finally, the third technical paper discusses the ways of extrapolating the measurements and tests done in low-frequency bands to the higher-frequency bands. The whole discussion was complemented by the summary TD, where all the achievements made in VT2 in Interact have been gathered together.

VT3 – Industrial Automation

During the Valencia meeting, three TDs were presented in the dedicated VT3 (industrial IoT) session. **[TD(22)03049]** titled “Detailed analysis of optimal and feasible suboptimal MAC scheduling for realistic MANET scenarios” was presented by Yann Maret from Edge Hill University, Ormskirk, UK. This work investigates use of reinforcement learning to optimize scheduling for maximizing throughput in MANET scenarios. Results show improved performance, however, further investigation with increased user traffic is targeted. **[TD(22)03026]** titled “Industrial IoT at THz frequencies using a slotted CSMA/CA MAC protocol” was presented by Sara Cavallero from DEI, University of Bologna, Italy. This work addresses the problem of enabling intra-machine communication in an Industrial Internet of Things scenario using Terahertz frequencies. The applicability of CSMA/CA protocols to THz communications in an Industrial IoT scenarios is studied. Results demonstrate that propagation delays cannot be neglected at THz frequencies whereby impact from other parameters also come into play. Lastly, **[TD(22)03038]** titled 5G “challenges for industrial automation” was presented by Raheeb Muzaffar from Silicon Austria Labs. This work gives a background on existing developments in 5G to support industrial networks and identifies gaps that need further attention before a roll-out of 5G takes place at the manufacturing sites. A discussion session followed these presentations, and it was suggested to join hands for a joint journal publication.

VT4 - Smart Buildings and Cities

In the VT4/WG3 session, three TDs were presented, followed by an extended period of discussion about the first paths followed in VT4, its position and underlying challenges. TDs 22, 46 and 20 were on the development of a time and



INTERACT

frequency synchronization module for NB-IoT, the development of a comprehensive 3D simulator for examining the probability of Line of Sight in urban environments that use built-up parameters to create different city environments, and proposal of using sniffers for monitoring dense multi-channel multi-hop IEEE 802.15.4 wireless sensor networks, respectively. In the discussion phase, after a presentation on the 5G Advanced smart cities and buildings, aspects of spectrum management within Cloud RAN architectures, coexistence, use cases, among many other topics, were discussed, followed by the 6G challenges, in mobile and wireless networks. Researchers enthusiastically participated in the discussion of aspects of RF Energy Harvesting (Guillaume Villemaud, INSA), challenges on cybersecurity and privacy (Valentina Timcenko, IMP, and Titus Constantin Balan, from TUB), as well as contributions on IEEE 802.11 for Broadcast Services and IoT (Luis Orozco-Barbosa, UCLM). A draft document has been circulated and is being edited by all the contributing members of VT4, until October 7th, 2022, followed by the final editing tasks until mid-October.

HA1 – Datasets

HA1 discussion in plenary room in Valencia discussed the status of the datasets collection and the joint submission of datasets to a special issue of communications magazine:

<https://www.comsoc.org/publications/magazines/ieee-communications-magazine/cfp/data-sets-machine-learning-wireless>.

Women in Radio Science

URSI

Women in URSI

- Two initiatives were started by the late Pat Doherty

1. **WIRS**: across the 10 commissions of URSI

Electromagnetic Metrology, Fields and waves, Radiocommunication Systems and Signal Processing, Electronics and Photonics, Electromagnetic Environment and Interference, Wave Propagation and Remote Sensing, Ionospheric Radio and Propagation, Waves in Plasmas, Radio Astronomy, Electromagnetics in Biology and Medicine

2. **URSI awards**

National Committees of WIRS

- USA
- Czechia,
- Egypt,
- Japan
- Poland

European WIRS

- Critical mass to conduct activities
- Interested to join: please contact Golsa Ghiaasi golsa.ghiaasi@silicon-austria.com
- Interested to lead: please contact Sana Salous: sana.Salous@durham.ac.uk
- URSI will provide 500 Euros to support activity of the chapter
- Possible activities can be in:
 1. COST action
 2. Sessions in the URSI GASS 2023, Japan

URSI Awards

- Nominations for URSI awards

There are seven awards: <https://www.ursi.org/awards.php>

Two awards by the president of URSI

Tuesday morning (plenary)

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- 8. Database**
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Tuesday - Thursday

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Thursday end of the morning (plenary)

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Main updates:

- 1 new dataset coming soon: MIMO ...
- Joint paper submissions to SI on IEEE Communications Magazine

CONTEXT AWARE 60 GHZ INDOOR MOBILE CHANNEL MEASUREMENTS

Authors: *R.Sun et Al., NIST*

Short description: 60 GHz, 8×16 MIMO channel sounder. It employs a pseudorandom bit sequence with a bandwidth of 4 GHz. The sounder can precisely measure radio propagation channel characteristics such as path loss, small-scale fading, delay dispersion, absolute delay, angle-of-arrival (AoA), angle-of-departure (AoD), and Doppler power spectrum.

Possible use of the data: AI-based localization, Multipath component tracking, Channel Modeling.

[Conferences](#) > [2017 11th European Conference...](#) 

Design and calibration of a double-directional 60 GHz channel sounder for multipath component tracking

Publisher: IEEE

[Cite This](#)

[PDF](#)

[Ruoyu Sun](#) ; [Peter B. Papazian](#) ; [Jelena Senic](#) ; [Yeh Lo](#) ; [Jae-Kark Choi](#) ; [Kate A. Remley](#) ; [Camillo Gentile](#) **All Authors**

IEEE COMMAG SI

Data Sets for Machine Learning in Wireless Communications and Networks

Publication Date

**First Quarter/Second Quarter
2023**

Manuscript Submission Deadline

31 October 2022

- Datasets that have been already peer-reviewed
- Description of the testbed and steps for reproducibility
- Novel use-cases

IEEE COMMAG SI

2 dataset (at most) per submission

Select topics from HA1 datasets:

- Vehicular/High Speed Channel Measurements
- Indoor MIMO Measurements
- Human Sensing

COST Interact - Massive MIMO Datasets for Machine Learning-based Localization and Channel Modeling

TBD

I. INTRODUCTION

~ 600 words; MS, NDC

II. INTRODUCTION

- General introduction to the topic of localization and channel modeling with MIMO CSI
- Introduction to ML-based localization and/or channel modeling
- Short introduction of the two datasets: common applications, shortly mention the small differences (i.e. frequency range, data format), and relevance to the community.

~ 600 words; MS, NDC

III. TESTBED DESIGN AND IMPLEMENTATION

For every of the two datasets:

- How the measurements were conducted: focus on the description of the experimental setup. Necessary lab equipment and the steps for performing a physical experiment.

A. Dataset A

~ 400 words; Authors A

B. Dataset B

~ 400 words; Authors B

V. USE OF THE DATA AND POSSIBLE RESEARCH DIRECTIONS

- Datasets hindsight
 - Potential applications and use cases of interest
 - Technical details about possible ML algorithms ([...])
- N: some ideas...
- Localization: multi-output regression problem (x and y)
- Supervised Learning problem: ground truth x and y are available
 - Feature distillation as per the original paper and use of a multi-output regression algorithm (e.g., XGBoost, CatBoost) optimizing the average RMSE loss along all outputs
 - End-to-end learning by feeding directly the CSI matrix



IEEE COMMAG SI

- Experiment.
- Practical information and specification of the measurements.
- General considerations (i.e., "good practices"), that have to be taken into account for the design and implementation of the testbed.

A good reference example for this section and referenced by the SI editors can be found at this link: <https://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=8924625>

A. Dataset A

~ 1000 words; Authors A

B. Dataset B

~ 1000 words; Authors B

IV. DATASET

Provide a concise but detailed description of the dataset format (e.g. tabular/cloud point data, the format of the file (e.g., .csv), feature space, name of the columns, etc...)

- Data set organization and data format
- Some example measurements.

- End-to-end learning by feeding directly the CSI matrix through a neural network. To exploit spatial information, one can use a ConvNet. As the CSI input is complex, one can have a two-channel input where one separates real/imaginary, or magnitude/phase. Again, we optimize average RMSE loss over the two x and y outputs.
- Incorporating CSI positions to build a graph and place it into a framework of graph representation learning, instead of a CNN
- Possibly mention prediction uncertainty via approximate Bayesian inference (e.g., MC Dropout) to compute confidence intervals for each predictions.
- Probabilistic models (soft localization). Train independently regressors on features such as AoA, etc. and adopt something like "soft voting".

Channel modelling via generative models

- Can be unsupervised, ground truth may be not available
- Goal is to build a statistic model of the channel (the CSI matrices) that can be sampled from
- The generative model may be conditioned by position x and y, i.e., sample the channel from a user that is located in position (x, y)
- As before, we can use ConvNets, as the input can be conveniently structured as an image
- Can mention VAEs, GANs and Diffusion Models

3rd Scientific & Technical Meeting

Valencia, Spain, 20-22 September 2022



Chiara BURATTI
University of Bologna

Laurent CLAVIER
IMT Nord Europe



Tuesday morning
(plenary)

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7. Women in Radio science
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Thursday end of the morning (plenary)

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Funded by the European Union



UNIVERSITAT
POLITÈCNICA
DE VALÈNCIA

Valencia, Spain 19 - 22 September 2022



COST INTERACT

3rd MCM and Technical Meeting

Tuesday morning
(plenary)

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Any change to the agenda ?

ATTENDANCE LISTS (for people on site)

Please sign the attendance list for **the day(s) you are present**

AND

ONE attendance list for **EACH** WG/VT you attend

No reimbursement of travel expenses (for those entitled to) if attendance lists are not duly signed

AP	WHAT	WHO	WHOM	WHEN
1	Submit reimbursement forms	Those entitled to	e-cost	Before 02/10

Tuesday morning
(plenary)

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Number of signatory countries



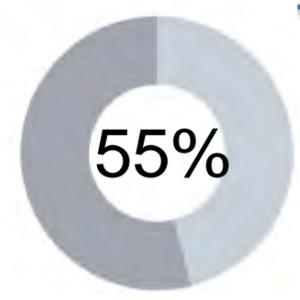
43 (34 out of 40 COST full members, including 18 ITC)

Number of WG members registered on the website



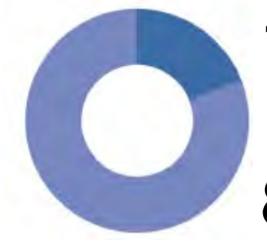
463

Young Researchers



55%

Gender balance



19% F

81% M

From ITC 25%

Number of MC Members



64 (+1 pending)
46 attending the meeting
(37 on site)
(including substitutes)

People attending the meeting



93 on site
51 remote

Number of TDs



66



4 votes organized, all proposals unanimously approved

- New Sub-Working Groups proposal
RIS (by WG1) and ISAC (by WG2) Sub-Working Groups shall be instituted / co-chairs elections are planned during the meeting
- Minutes of the 2nd MC Meeting and 1st Technical Meeting, Bologna
The minutes of the 2nd MC Meeting and 1st Technical Meeting in Bologna shall be approved
- Local Organiser Support for 2nd Technical Meeting, Lyon
For the 2nd Technical Meeting in Lyon (June 13-15, 2022), the Local Organiser requested a LOS (Local Organiser Support) of 5.000 EUR
- Grant Holder Scientific Representative's temporary replacement (Aug 1st 2022 to Dec 31st 2022)
The GH Scientific Representative Prof Chiara Buratti shall be temporarily replaced by Prof Roberto Verdone



Month 12	Deliverable 1 (HA1) - H1: Database structure and content requirements. Deliverable 2 (All) - D1: State-of-the-art and key challenges	Mid October 2022
Month 16	Deliverable 3 (WG1) - White paper on radio channel modelling and prediction to support environment-aware communications	Mid February 2023
Month 32	Deliverable 4 (WG2) - White paper on novel physical layer technologies and localization algorithms for future wireless networks	Mid June 2024
Month 36	Deliverable 5 (All WGs and verticals) - Disciplinary solutions to the research challenges (<i>preliminary draft of the final report</i>)	Mid October 2024
Month 48	Deliverable 6 (HA1) - H2: Database with data sets available. Deliverable 7 (WG3) - White paper on novel network architectures and protocols for future wireless networks Deliverable 8 (All) - FR: Final report (open-access book) including all research outcomes of the different disciplinary and interdisciplinary work.	Mid October 2025



Month 12 Deliverable 1 (HA1) - H1: Database structure and content requirements.

Mid October 2022

This is on-going work with HA1... Good progress

Deliverable 2 (All) - D1: State-of-the-art and key challenges

TD discussion during this meeting

Month 16 Deliverable 3 (WG1) - **White paper** on radio channel modelling and prediction to support environment-aware communications

Mid February 2023

A little bit more time but not that much. Is it feasible? Who can lead?

Tuesday morning
(plenary)

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Budget Y1:

Work and Budget Plan	Planned (WBP)	Spent	Remaining	Re-allocated
A. COST Networking Tools EUR				
(1) Meetings	90.000,00	40.999,42	49.000,58	56.201,16
(2) Training Schools	8.000,00	5.833,16	2.166,84	0,00
(3) Short Term Scientific Missions (STSM)	4.400,00	1.700,00	2.700,00	0,00
(4) ITC Conference Grant	500	0,00	500,00	0,00
(5) COST Action Dissemination	4.695,00	3.961,26	733,74	0,00
(6) Other Expenses Related to Scientific Activities (OERSA)	1.100,00	0,00	1.100,00	0,00
B. Total Science Expenditure (sum of (1) to (6))	108.695,00	52.493,84	56.201,16	56.201,16
C. Financial and Scientific Administration and Coordination (FSAC) (max. of 15% of B)	16.304,25	0,00	0,00	0,00
Total Grant (B+C)	124.999,25			

Budget Y1:

Work and Budget Plan	Re-allocated	Expected	Remaining
A. COST Networking Tools EUR			
(1) Meetings	56.201,16	56.400,00	-198,84
(2) Training Schools	0,00	0,00	0,00
(3) Short Term Scientific Missions (STSM)	0,00	0,00	0,00
(4) ITC Conference Grant	0,00	0,00	0,00
(5) COST Action Dissemination	0,00	0,00	0,00
(6) Other Expenses Related to Scientific Activities (OERSA)	0,00	0,00	0,00
B. Total Science Expenditure (sum of (1) to (6))	56.201,16	55.400,00	-198,84

**50.400
Reimbursement
MCM/WGC**

6.000 LOS

Budget Y2: 176 000 €

Work and Budget Plan	Planned
A. COST Networking Tools EUR	
(1) Meetings	129.000,00
(2) Training Schools	14.500,00
(3) Short Term Scientific Missions (STSM)	7.200,00
(4) ITC Conference Grant	1.350,00
(5) COST Action Dissemination	0,00
(6) Other Expenses Related to Scientific Activities (OERSA)	993,00
B. Total Science Expenditure (sum of (1) to (6))	153.043,00
C. Financial and Scientific Administration and Coordination (FSAC) (max. of 15% of B)	22.956,45
Total Grant (B+C)	175.999,45

Tuesday morning
(plenary)

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1st Training School / ESoA course: *Mobile Radio Propagation for 5G and Beyond*

- Dates: 2022 June 20th - 24th
- Location: Louvain-la-Neuve, BE
- Organiser: Claude Oestges (ICTEAM UCLouvain)
- Duration: 36 hours training
- Format: in-person
- Speakers: 6 (5 academia + 1 I&D&I centre + 0 industry)
- Grants: 5 awarded, but only 4 taken
- Attendance: 15 (15 in-person + 0 remote),
(13 students + 2 researchers)
9 countries (9 EMEA, 0 Amers., 0 As/Pac)





2nd Training School: *Open-RAN Networks: from Theory to Implementation*

- Dates: 2022 July 5th - 7th
- Location: Poznań, PL
- Organiser: Adrian Kliks (Poznan Uni. Tech., Rimedolabs)
- Duration: 18 hours training
- Format: hybrid (in-person + remote)
- Speakers: 12 (5 academia + 0 I&D&I centre + 7 industry)
- Grants: 7 awarded, but only 5 taken
- Attendance: 69 (16 in-person + 53 remote),
(24 students + 45 researchers)
27 countries (17 EMEA, 3 Amers., 6 As/Pac)





Training Days:

- the Call will be launched 3 months prior to the meeting;
- the deadline for proposals is 2 months prior to the meeting;
- meetings will start on Tuesday or Wednesday, so that Training Days can be held on a weekday.

Training School:

- the Call will be launched in January of each year;
- the deadline for proposals is by mid February;
- the evaluation result will be announced by early March.

Training Schools

TRAINING EVENTS

Dissemination is a key component of the Action, given its R&D dimension, together with the development of basic technology and the training of researchers. INTERACT addresses this matter by carrying out a number of initiatives, open to the community at large, namely Training Schools and Training Days, which are as follows:

- **Training Day:**
 - a training event with a duration of half or full day, to be held the day prior to a Management Committee Meeting or a Technical Meeting;
 - organised by INTERACT;
 - with lecturers from INTERACT;
 - there is no financial support to these events (neither to trainers nor to trainees);
 - the application and organisation of these event should follow the [Guidelines](#);
 - the programme should follow the [Programme Template](#) and speakers should provide information according to the [Speaker Template](#);
- **Training School:**
 - a training event with a duration of 3 to 5 days, to be held autonomously;
 - organised by INTERACT or jointly with other Actions, projects or scientific entities;
 - with lecturers not only from INTERACT but also from other entities external to the Action;
 - there is usually financial support to these events, to both trainers and trainees (rules are given below);
 - the application and organisation of these event should follow the [Guidelines](#);
 - the programme should follow the [Programme Template](#) and speakers should provide information according to the [Speaker Template](#);

FINANCIAL SUPPORT

TRAINEES

CA20120-INTERACT offers a limited financial support to Trainees (eligible INTERACT's members, as defined in the [Annotated Rules for COST Actions](#), i.e. only from Members or from Near Neighbour Countries) to attend Training Schools. The selection will be based on applications and on the following priorities:

1. Ph.D. students (one grant per Country);
2. while grants available, Young Researchers (one grant per Country);
3. while grants available, other applicants.

In any of the above steps, ICT countries and gender balance will be taken for resolving equality.

Applicants should use the [Trainee Application Form](#). Details (e.g. deadlines) will be provided for each School.

Trainees will be granted an amount based on a daily allowance, which is defined according to the host country and the School duration. Prior to the Training School, each Trainee granted financial support must register at e-COST, <https://e-services.cost.eu>, namely by creating a profile that includes the details of a bank account for payment.

For each Training School, specific information will be provided.

TRAINERS

CA20120-INTERACT offers a limited financial support to Trainers to lecture at Training Schools.

The following items can be reimbursed: travel, accommodation and meal expenses, in line with the eligibility rules specified in [Annotated Rules for COST Actions](#); no lecture fees or honoraria will be paid. Each Trainer granted financial support must register at e-COST, <https://e-services.cost.eu>, namely by creating a profile that includes the details of a bank account for payment.

TEMPLATES & USEFUL DOCUMENTS

- Training Day_Programme
- Training Day_Lecturer
- Training School_Programme

<https://interactca20120.org/meetings-events/training-schools>

And what else?

- 2022 Oct. 14th: submit a proposal for a Training Day at the 2023 Jan. meeting,
- 2023 Feb. 17th: submit a proposal for one of the two 2023 Training Schools

But still:

- Consider organising a Training School in collaboration with another Action, Project, ...
- Let us know what topics you would be interested in having in a Training Event.

Tuesday morning
(plenary)

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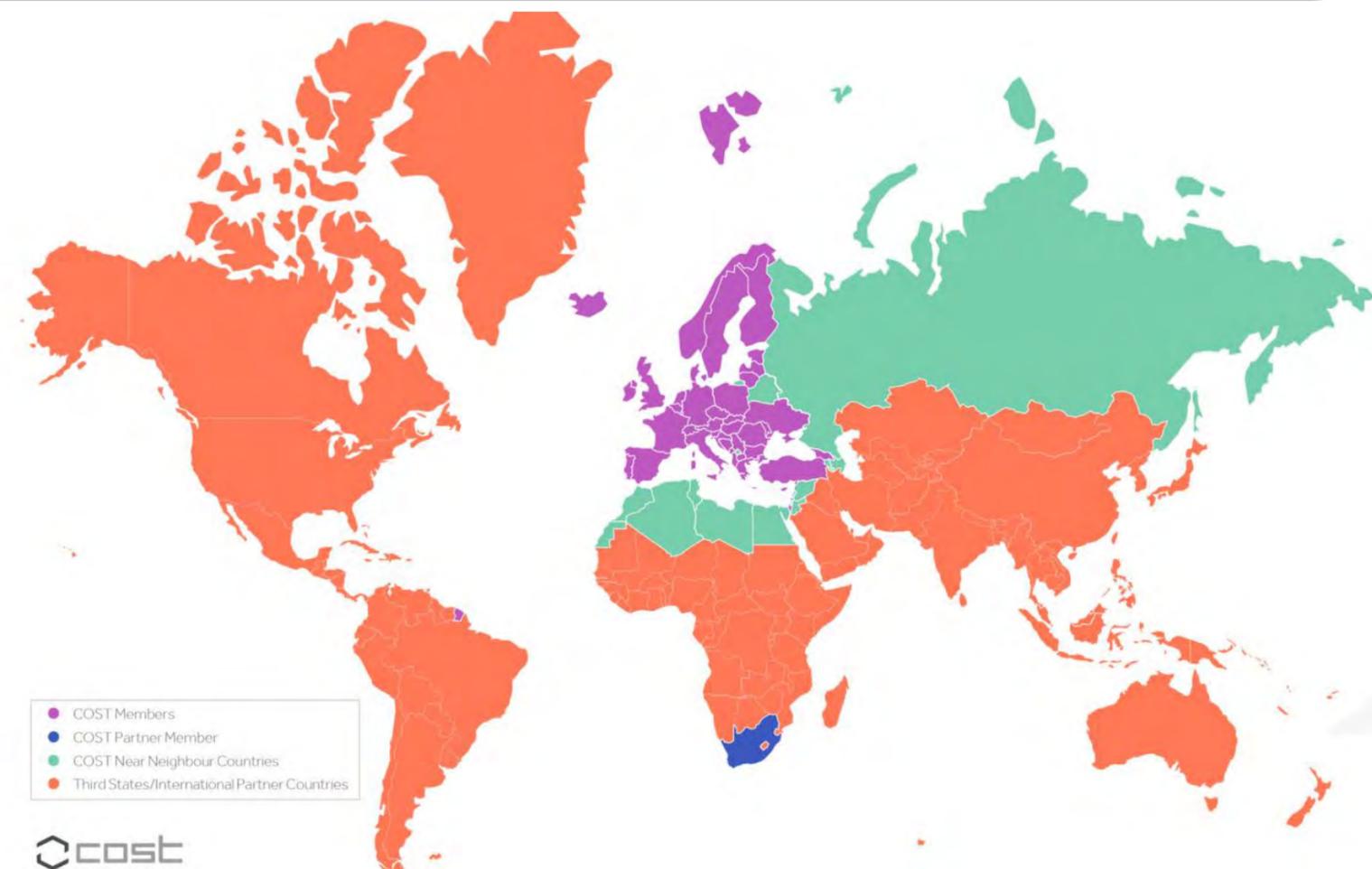
Thursday end of the morning (plenary)

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STSMs are **exchange visits** aimed at supporting **individual mobility, strengthening existing networks** and **fostering collaboration** between researchers. The aim [...] is to **contribute to the scientific objectives** of a COST Action [...] by allowing scientists to go to an **institution or lab in another COST country** to foster collaboration, to learn a **new technique** or to **take measurements** using instruments and/ or **methods not available** in their own institution/ lab.

- BOTH the home and host institutions MUST be INTERACT partners (easy fix)
- Home: COST full members, cooperating member, or Near Neighbouring Countries (NNC).
- Details: <https://interactca20120.org/grants/stsm/>



The aim of ITC **Conference** Grants is to **support PhD students** and **Early Career Investigators** (ECI) from **INTERACT institutions** located in **Inclusive Target Countries** (ITC) to attend **international science and technology-related conferences** not specifically organized by the COST Action.

- Inclusive Target Countries (as of March'22): Albania, Bosnia and Herzegovina, Bulgaria, Cyprus, Czech Republic, Estonia, Croatia, Greece, Hungary, Lithuania, Latvia, Malta, Moldova, Montenegro, Poland, Portugal, Romania, Slovenia, Slovakia, Republic of North Macedonia, Republic of Serbia and Turkey.
- Max. funding per grant: 500 euro (partial funding).
- Virtual or physical attendance (annotated rules).
- Details: <https://interactca20120.org/grants/itc-conference-grants/>



- Short-term Scientific missions (STSMs):
 - Raised interest in the community: **good number of applications** received.
 - **All grants available for RP1** (Reporting Period 1) already **awarded**.
 - **Awardees**: François Rottenberg (KU Leuven), Vukan Ninkovic (U. Novi Sad), Mohammed Mallik (U. Lille), and Monika Drozdowska (U. Politècnica València).
 - **One STSM completed** (F. Rottenberg); three to take place in the coming weeks/months.
 - **New applications** to be considered **for RP2**: Nov. 1, 2022 – Oct. 31, 2023.
 - If interested, please, **apply soon**.
 - Likely to run out of STSM grants for RP2 in a very short time
- ITC Grants:
 - **One ITC Grant** still **available for RP1**.
 - If interested, please, **apply soon**. Contact carles.anton@cttc.es for any question/clarification.

Tuesday morning
(plenary)

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INTERACT NEWSLETTER

INTELLIGENCE-ENABLING RADIO COMMUNICATIONS FOR SEAMLESS INCLUSIVE INTERACTIONS

Newsletter

Number 2, August 2022

Newsletter Editor
Francesca Conserva, University of Bologna, Italy

COST INTERACT Chairman
Laurent Clavier, IMT Nord Europe, France

Editorial Board
Vittorio Degli Esposti, Mate Boban, Diego Dupleich, Wei Fan, Ana Garcia Amada, Alister Burr, Hamed Hamadi, Konstantin Mikhaylov, Kamran Sayrafian, Slawomir Ambroziak, Luis M. Correia, Conchi Garcia-Pardo, Thomas Blazek, Adrian Kliks, Golsa Ghiaasi, Raheeb Muzaffar, Periklis Chatzimisios, Fernando José Velez, Marco Skocaj, Margot Deruyck, Krzysztof Cichoń, Laurent Clavier, Chiara Buratti, Carles Anton-Haro

COST CA20120 ACTION

IN THIS ISSUE:

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

<https://bit.ly/3QBRCFa>



CHAIRMAN'S ADDRESS

"THE CONTROL LOOP"

Laurent Clavier



INTERVIEW WITH A SENIOR RESEARCHER: STEFANO MORO



INTERVIEW WITH A SENIOR RESEARCHER: ANA GARCIA ARMADA



PROFESSOR UNIVERSIDAD CARLOS III DE MADRID (UC3M)

Visiting scholar at Stanford University, Bell Labs and University of Southampton.

More than 200 contributions in journals and conferences and holds 5 patents.

Awards of Excellence and for Best Teaching Practices from UC3M.

Third place Bell Labs Prize 2014, the Outstanding Service Award from the SPCE TC of the IEEE Communications Society and the Outstanding Service Award from the Women in Communications Engineering committee.

ESoA Course and INTERACT Training School: "Mobile Radio Propagation for 5G and Beyond"

The joint ESoA Course and COST INTERACT Training School. Local organizer: Glauco Destro.

COST-INTERACT Summer School: "Open-RAN networks: from theory to implementation"

The key focus of the school was on Open RAN, which is a recent and vibrant trend in the telecommunications market, especially in the 5G area, aiming at the realization of various challenging objectives.

Main activities across the three days: theoretic background related to the Open RAN domain; opportunities and challenges of the Open RAN approach; industry-oriented discussion, implementation perspectives from O-DU side; introduction on kits and dockers.

The overall event was highly successful. As School Leaders, we would like to thank all the persons involved for their positive attitude and vivid involvement in the event, which made it highly successful. We would also like to thank our event partner, COST CA20120 INTERACT, for the support and the opportunity to organize it!



All in-person attendees together.

Local organizers: Thomas Kluge, Vittorio Degli Esposti, Glauco Destro.

Organized by: European University of Technology (EUT) and COST CA20120 (ARS) 20-24 July 2022



Teachers on the building's rooftop during the Air-to-Ground Demo.

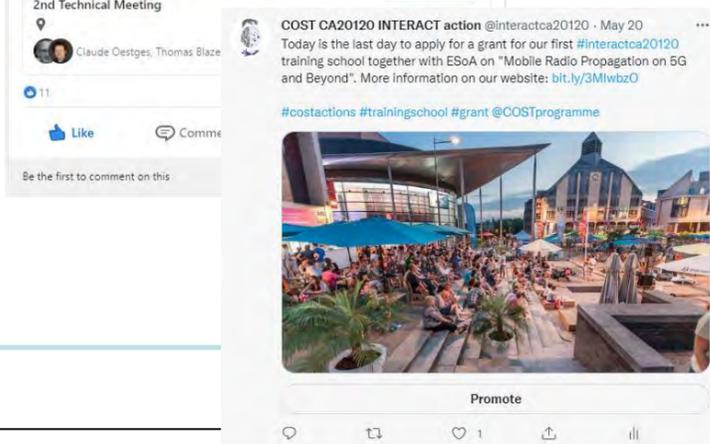
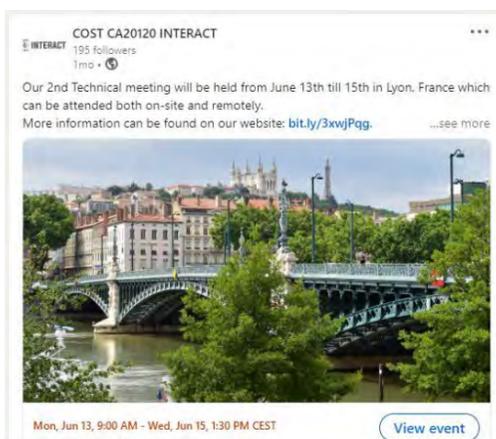
...AND MUCH MORE!



- LinkedIn (<https://www.linkedin.com/company/interactca20120>): 274 followers
- Twitter (<https://twitter.com/interactca20120>): 19 followers

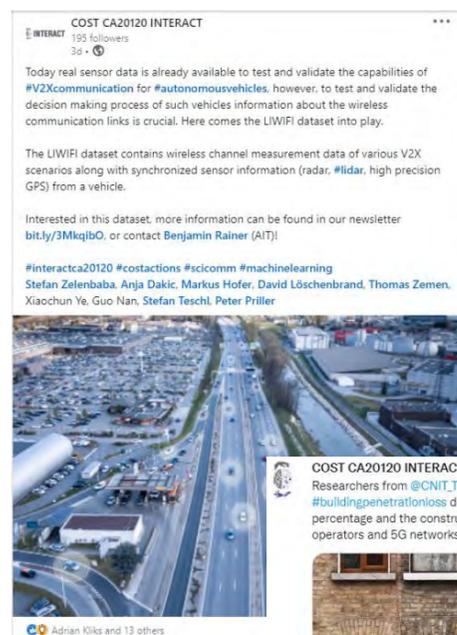
EVENT-BASED

- Announcements/reminder meetings, TTSs, etc.
- Call for STSMs, TTSs, grants, etc.
- Newsletters, leaflet



SCIENCE COMM WEEKLY

- Selected TDs from WGs
- White papers
- Joint papers



DATASETS WEEKLY

- Short description of dataset, link to paper, contacting author
- Starting week 27/28



TESTIMONIALS

- STSMs
- TTSs: participants w/ grant



- Available on various platforms:
 - YouTube: <https://youtu.be/7n7t1IWxkV0>
 - Anchor: <https://bit.ly/3DrIVJO>
 - Spotify: <https://spoti.fi/3QKrpU3>
- Host: Prof. Adrian Kliks (Poznan University of Technology)
- First episode: our chairman!





Science Communication Plan – COST Action CA20120 “Intelligence-Enabling Radio Communications for Seamless Inclusive Interactions” (INTERACT)

Strategy and implementation on dissemination of the Action results

The table below mentions all the communication and dissemination activities that were foreseen in the MoU of our Action, along with the status of the implementation.

Activity	Status
Organisation of Training Schools by INTERACT lectures and jointly with other EU projects and COST actions which will be open for all	<p>Ongoing https://interactca20120.org/training-schools/</p> <p>In the first year, INTERACT has organized two training schools:</p> <ul style="list-style-type: none"> • Joint training school with ESoA on “Mobile Radio propagation for 5G and beyond” (June 2022) • Training school on “Open-RAN networks: from theory to implementation” (July 2022) <p>A yearly call for training schools will be launched in the beginning of each year.</p>
Organisation of topical workshops, special sessions and tutorials in top tier	Ongoing

Science Communication Plan

- Communication, dissemination and valorization strategy, incl. a plan to implement this strategy
- Updated on a yearly basis
- All MC members received a copy last week
- Approved?

Tuesday morning
(plenary)

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INTERACT

Tuesday morning
(plenary)

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Core group meeting 04/10 – 14:00 CET.



Upcoming Meetings

- **Fourth MC meeting and technical meeting**

Last week of Jan. 2023 – Dubrovnik (Croatia)

- **Then**

May-Jun. 2023 – Not possible in Roma due to the lack of room availability

Greece (Thessalonic) ?

Sep. 2023 – Not possible in Ghent

Jan./Feb. 2024 (special one) – Lisboa

To be discussed within the working groups and vertical teams

- CHALLENGES – deliverable – Discuss the TDs about the challenges in your WG/VT ; Identify in any missing points.
 - What will be our contribution?
 - How to proceed? What are the next steps?
- DELIVERABLE on Channel models
- DATA BASE – discuss how to use them? Young Researchers could start data-base games?
- Joint workshops / sessions in conferences
- Training Schools / STSMs / liaisons

Tuesday morning (plenary)

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Main updates:

- 1 new dataset coming soon: MIMO ...
- Joint paper submissions to SI on IEEE Communications Magazine

CONTEXT AWARE 60 GHZ INDOOR MOBILE CHANNEL MEASUREMENTS

Authors: *R.Sun et Al., NIST*

Short description: 60 GHz, 8×16 MIMO channel sounder. It employs a pseudorandom bit sequence with a bandwidth of 4 GHz. The sounder can precisely measure radio propagation channel characteristics such as path loss, small-scale fading, delay dispersion, absolute delay, angle-of-arrival (AoA), angle-of-departure (AoD), and Doppler power spectrum.

Possible use of the data: AI-based localization, Multipath component tracking, Channel Modeling.

[Conferences](#) > [2017 11th European Conference...](#) 

Design and calibration of a double-directional 60 GHz channel sounder for multipath component tracking

Publisher: IEEE

[Cite This](#)

[PDF](#)

[Ruoyu Sun](#) ; [Peter B. Papazian](#) ; [Jelena Senic](#) ; [Yeh Lo](#) ; [Jae-Kark Choi](#) ; [Kate A. Remley](#) ; [Camillo Gentile](#) **All Authors**

IEEE COMMAG SI

Data Sets for Machine Learning in Wireless Communications and Networks

Publication Date

**First Quarter/Second Quarter
2023**

Manuscript Submission Deadline

31 October 2022

- Datasets that have been already peer-reviewed
- Description of the testbed and steps for reproducibility
- Novel use-cases

IEEE COMMAG SI

2 dataset (at most) per submission

Select topics from HA1 datasets:

- Vehicular/High Speed Channel Measurements
- Indoor MIMO Measurements
- Human Sensing

COST Interact - Massive MIMO Datasets for Machine Learning-based Localization and Channel Modeling

TBD

I. INTRODUCTION

~ 600 words; MS, NDC

II. INTRODUCTION

- General introduction to the topic of localization and channel modeling with MIMO CSI
- Introduction to ML-based localization and/or channel modeling
- Short introduction of the two datasets: common applications, shortly mention the small differences (i.e. frequency range, data format), and relevance to the community.

~ 600 words; MS, NDC

III. TESTBED DESIGN AND IMPLEMENTATION

For every of the two datasets:

- How the measurements were conducted: focus on the description of the experimental setup. Necessary lab equipment and the steps for performing a physical experiment.

A. Dataset A

~ 400 words; Authors A

B. Dataset B

~ 400 words; Authors B

V. USE OF THE DATA AND POSSIBLE RESEARCH DIRECTIONS

- Datasets hindsight
- Potential applications and use cases of interest
- Technical details about possible ML algorithms ([...])

N: some ideas...

Localization: multi-output regression problem (x and y)

- Supervised Learning problem: ground truth x and y are available
- Feature distillation as per the original paper and use of a multi-output regression algorithm (e.g., XGBoost, CatBoost) optimizing the average RMSE loss along all outputs
- End-to-end learning by feeding directly the CSI matrix



IEEE COMMAG SI

- Experiment.
- Practical information and specification of the measurements.
- General considerations (i.e., "good practices"), that have to be taken into account for the design and implementation of the testbed.

A good reference example for this section and referenced by the SI editors can be found at this link: <https://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=8924625>

A. Dataset A

~ 1000 words; Authors A

B. Dataset B

~ 1000 words; Authors B

IV. DATASET

Provide a concise but detailed description of the dataset format (e.g. tabular/cloud point data, the format of the file (e.g., .csv), feature space, name of the columns, etc...)

- Data set organization and data format
- Some example measurements.

- End-to-end learning by feeding directly the CSI matrix through a neural network. To exploit spatial information, one can use a ConvNet. As the CSI input is complex, one can have a two-channel input where one separates real/imaginary, or magnitude/phase. Again, we optimize average RMSE loss over the two x and y outputs.
- Incorporating CSI positions to build a graph and place it into a framework of graph representation learning, instead of a CNN
- Possibly mention prediction uncertainty via approximate Bayesian inference (e.g., MC Dropout) to compute confidence intervals for each predictions.
- Probabilistic models (soft localization). Train independently regressors on features such as AoA, etc. and adopt something like "soft voting".

Channel modelling via generative models

- Can be unsupervised, ground truth may be not available
- Goal is to build a statistic model of the channel (the CSI matrices) that can be sampled from
- The generative model may be conditioned by position x and y, i.e., sample the channel from a user that is located in position (x, y)
- As before, we can use ConvNets, as the input can be conveniently structured as an image
- Can mention VAEs, GANs and Diffusion Models

Tuesday morning
(plenary)

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Plenary resumes on
Thursday at **11:00 am** after the *early morning session*

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(plenary)

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- WG1 Vittorio Degli-Esposti, Mate Boban
SWG mmW and THz channel sounding Wei Fan, Diego Dupleich
- WG2 Ana Garcia Amada, Alister Burr
- WG3 Hamed Hamadi, Konstantin Mikhaylov
- VT1 Kamran Sayrafian, Slawomir Ambroziak
SVT1 EMF exposure Luis Correia, Conchi Garcia Pardo
- VT2 Thomas Blazek, Adrian Kliks
- VT3 Golsa Ghiaasi, Raheeb Muzaffar
- VT4 Periklis Chatzimisios, Fernando Velez

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(plenary)

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- H2020 Reindeer – Fredrik Tufvesson
- EU-ITN MINTS – Fredrik Tufvesson
- 5G DU-Volution – Alister Burr
- 6G-IA (SNS) – Carles Anton

Any other Business?



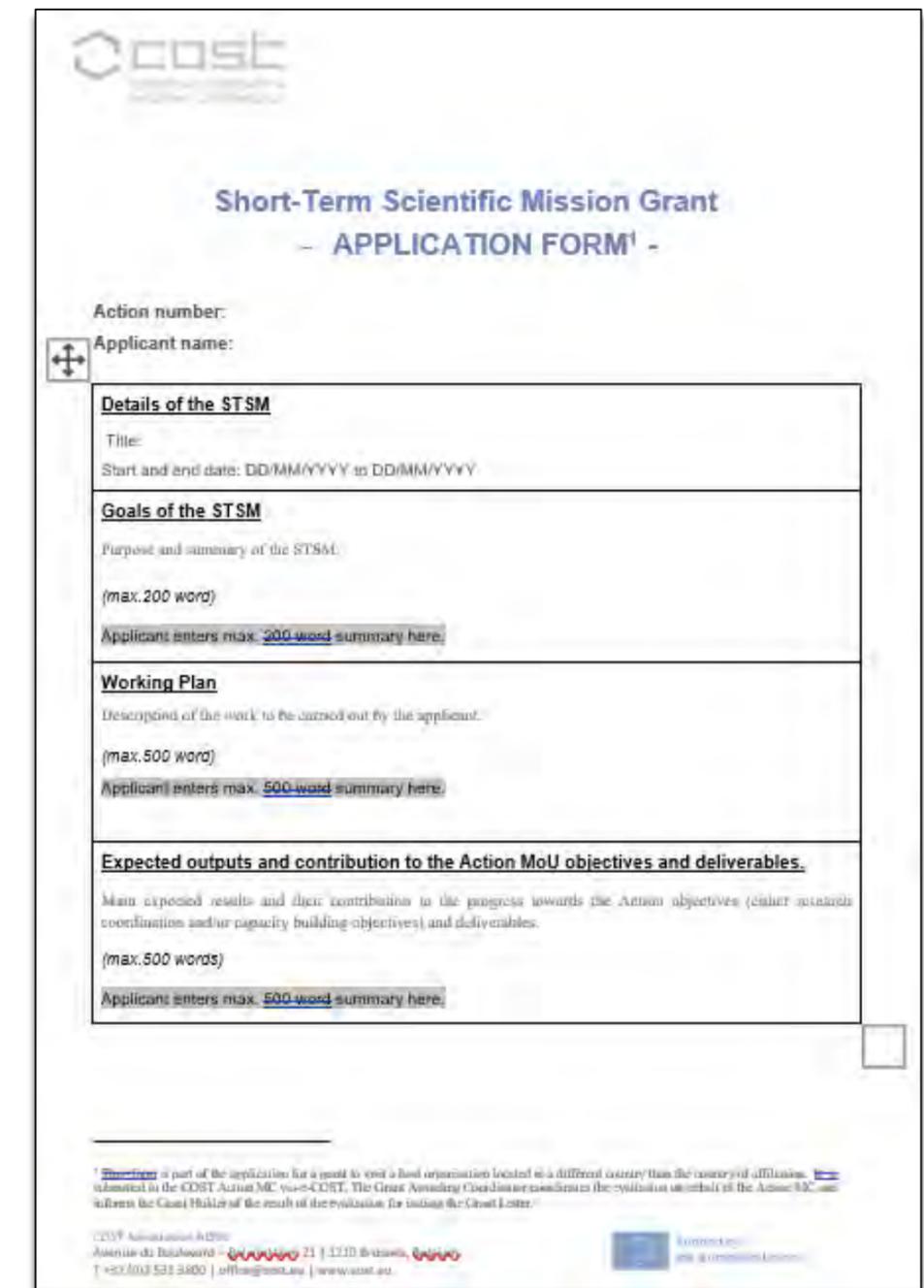
AP	WHAT	WHO	WHOM	WHEN
1	Submit reimbursement forms	Those entitled to	e-cost	Before 02/10
2	Send Minutes of Group Meetings	Group Chairs	Chair + Secretary	Before 09/10
3	Send STSM Applic.	Those interested	e-cost + Training Chair	Open call
4	CORE Group meeting	SC members + Working group chairs	Remote meeting	04/10, 2pm CET

Thank you !

See you in Dubrovnik

BACKUP SLIDES

- STSM request handled via the e-COST platform:
<http://www.cost.eu/STSM>
- You only need:
 - Grant application (what)
 - Invitation Letter (host)
 - Letter of Support (home)
 - Motivation Letter (why)
 - Applicant's CV (who)
- Applications: submit at least 1 month before mission starts.
- Activities: entirety within a single Grant Period (up to Oct 31).
- Grants:
 - Up to 1.200 euro / grant, according to duration & budget availability.
 - 4 grants for Grant Period 1 (1 awarded so far).



The image shows a screenshot of the 'Short-Term Scientific Mission Grant - APPLICATION FORM' on the e-COST platform. The form includes the following sections:

- Action number:** [Field]
- Applicant name:** [Field]
- Details of the STSM:**
 - Title: [Field]
 - Start and end date: DD/MM/YYYY to DD/MM/YYYY [Field]
- Goals of the STSM:**
 - Purpose and summary of the STSM: [Field]
 - (max. 200 word)
 - Applicant enters max. 200 word summary here: [Text area]
- Working Plan:**
 - Description of the work to be carried out by the applicant: [Field]
 - (max. 500 word)
 - Applicant enters max. 500 word summary here: [Text area]
- Expected outputs and contribution to the Action MoU objectives and deliverables:**
 - Main expected results and their contribution to the progress towards the Action objectives (either research coordination and/or capacity building objectives) and deliverables: [Field]
 - (max. 500 words)
 - Applicant enters max. 500 word summary here: [Text area]

At the bottom, there is a small note: 'If beneficiary is part of the application for a grant to visit a host organisation located in a different country than the country of affiliation, the beneficiary must be approved by the COST Action MC (via e-COST). The Grant Awarding Coordinator coordinates the evaluation on behalf of the Action MC and informs the Grant Holder of the result of the evaluation for issuing the Grant Letter.'

Contact information for COST is provided at the bottom right.



- **CV of the Applicant:**
 - Applications of ECIs and PhD students are given priority.
- **Workplan & Schedule:**
 - Is the **workplan well defined** and structured?
 - Is the **schedule** of activities **realistic**?
- **Expected outcome**
 - Which **WGs/VTs/HAs** of INTERACT are potentially **interested in the results** of this STSM?
 - Is the STSM focused on a specific **scientific objective(s)** of INTERACT?
 - What are the **expected outcomes** of the STSM (**publications, generation of *datasets*, ...**)?
- **Scientific Networking**
 - What is the **support offered by the Host** Institution to the applicant?
 - Could the work described in the STSM be **performed without researcher mobility**?
 - Is it expected that the STSM **provides new networking activities among the Home and Host** Institutions (e.g. exchanges, setup/joint participation in other collaborative projects)?
- **Financial Plan**
 - Consider an average of **60 to 80 EUR per night reasonable**, in addition to travel costs. If above this amount, an explanation/justification should be provided.
- **COST Policies:**
 - Is the **applicant** from an **Inclusive Target Country (ITC)**?
 - Is the **host** from an **Inclusive Target Country (ITC)**?
 - Is the **applicant** a **female** researcher?