MOBILE COMMUNICATIONS GROUP

The Mobile Communications Group (MCG) is aimed at developing new technologies for future standards in Mobile and Wireless Communications. The current activities of MCG are focused on four areas:

• 5G New Radio (5G-NR), with a frenetic activity in the definition of 5G for the next releases of NR standard.

• Multicast and Broadcast Services (MBMS) over 3GPP Networks, focused mainly in the research on new functionalities for the future releases of 5G (R.16 and following) to include Broadcast functions and native modes.

• Vehicular Communications, in which the MCG is working on cellular-assisted vehicular to anything (C-V2X) communications, in particular in topics of signalling for opportunistic usage of the different interfaces and advanced multi-antenna schemes. The final aim is guaranteeing the optimum operation of each vehicle and its interconnection in a 5G technology use scenario for increased levels of road safety.

• Body Area Communications (BAN), a relatively new domain in which the MCG is getting novel results on accurate characterization of UWB in-body propagation channels, design of in-body antennas for implanted and ingested devices, development of algorithms for the localization and tracking of in-body medical devices, human tissues measurement and modelling for research and diagnosis, and development of new full-spectrum phantom formulas tissues EM emulation. These tasks are currently undertaken with the support of the Hospital Universitario y Politécnico La Fe of Valencia, and the Centre for Biomaterials and Tissue Engineering at the UPV.

1.- PROJECT ACTIVITIES

1.1.- ONGOING PROJECTS

1. 5G-CARMEN

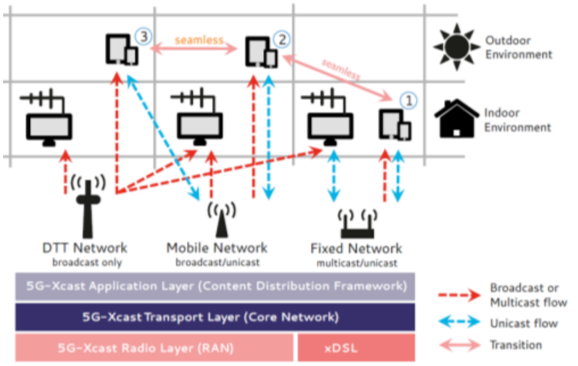
This project deals with the design and development of a 5G digital corridor for the connected and automated mobility of the future on European roads. Security, advanced management of emergencies, traffic sustainability, environment protection aspects: there are many challenges that await to be faced thanks to the most innovative technologies that will allow cars to be connected to each other and to land structures for a better management of vehicle traffic.

The "Munich-Bologna corridor", which covers 600 km of roads across three countries (Italy, Austria and Germany), is one of the most important corridors identified by the European Union for an initiative to improve the mobility of people and goods throughout Europe. As part of the 5G-CARMEN project, 5G technologies will be deployed along selected stretches of the motorway in the border regions.

This project has been funded by the European Commission.

2. Broadcast and Multicast Communication Enablers for the Fifth Generation of Wireless Systems (5G-Xcast)

5G-Xcast is a second phase 5G-PPP project focussed on devising, assessing and demonstrating a conceptually novel and forward-looking 5G network architecture for large scale immersive media delivery. The project objectives are to: (i) Develop broadcast and multicast point to multipoint (PTM) capabilities for 5G considering media, automotive, IoT and public warning use cases. (ii) Design a dynamically adaptable 5G network architecture with layer independent network interfaces to dynamically and seamlessly switch between unicast, multicast and broadcast modes or use them in parallel (iii) Develop proof-of-concept prototypes at Radio Access Network (RAN), core and content distribution level and experimentally demonstrate key innovations developed in the project for the media and public warning verticals. Dr. David Gomez-Barquero from MCG is the Project Manager. The MCG is also leading the 5G-Xcast radio air-interface task which is developing PTM capabilities for the standalone 5G New Radio, and participating in the 5G PPP IMT-2020 Evaluation Working Group that is one of the External Evaluations Group within ITU-R for the performance assessment of the 5G radio interface technology.



This project is funded by the European Commission.

3. LDM with MIMO and 3GPP NOMA techniques

This project is a collaboration with the Electronics and Communications Research Institute (ETRI) from Korea in the disruptive Non-Orthogonal Multiple Access (NOMA), known as Layered Division Multiplexing (LDM), adopted on the new U.S. DTT standard, ATSC 3.0. The project continues the studies initiated in regarding the joint transmission of LDM with co-located MIMO schemes. It also analyses the new NOMA technologies that are being considered in 3GPP.

This project is funded by ETRI Korea

4. Wireless In-Body Environment Communications (WIBEC)

https://www.ntnu.edu/wibec

This project is an Innovative Training Network that aims to train excellent researchers in the field of wireless communications inside the body. In particular, the two main application areas are Wireless Capsule Endoscopy (WCE) and pacemakers. WIBEC project will have a duration of 4 years during which 16 researchers will be trained in 8 European institutions, among them. WIBEC consortium is coordinated by Oslo University Hospital from Norway and is composed of 3 universities (Norges Teknisk-Naturvitenskapelige Universitet, Norway; Universitat Politècnica de València, Spain; and Technische Universität Dresden, Germany); 3 companies (Sorin CRM, France; Ovesco AG, Germany; and ValoTec, France); and 2 university hospitals (Hospital Universitario y Politécnico La Fe, Spain; and Oslo University Hospital, Norway).

This project is funded by the European Commission

5. ElectroMagnetic prObe for early Tumour dEtection (EMOTE)

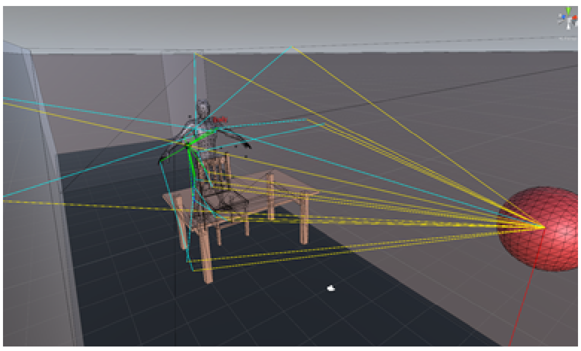
This is a joint collaborative project with Hospital La Fe, jointly funded by both public institutions. This project is devoted to the measurement of the dielectric properties of in vivo healthy and malignant colon tissues by using animal models (rats). In this way, it would be possible to evaluate whether the differences previously found for humans are also repeated at in in-vivo conditions. Furthermore, these tests will be used for verify and refine the methodology for the diagnosis of malignant body tissues based on the dielectric properties of both kind of tissues.

This project is funded by the Hospital Universitario y Politécnico La Fe and the Universitat Politècnica de València.

6. Millimetre Wave Communications in Built Environments (WaveComBE)

WaveComBE (www.wavecombe.eu) is an Industrial and Training Network of the Marie Sklodovska-Curie Action, dealing with the ultra-dense deployment of millimetre-wave (mmW) small-cells (SCs) in conjunction with massive multiple-input multiple output (MIMO) in 5G and beyond 5G (B5G) wireless networks. In WaveComBE the MCG is developing the simulation tools to analyse the human body blocking to millimetre wavelength radio frequencies, as well as efficient planning tools to deploy future access points in bands around and above 30GHz, as well as researching on beamforming techniques for the physical layer of mm-wave mobile communications.

This project is funded by the European Commission



2.1.- FEATURED PUBLICATIONS

1. Ultrawideband Technology for Medical In-Body Sensor Networks. An overview of the human body as a propagation medium, phantoms, and approaches for propagation

analysis. Concepción García-Pardo, Carlos Andreu, Alejandro Fornés-Leal, Sergio Castelló-Palacios, Sofia Perez-Simbor, Martina Barbi, Ana Vallés-Lluch, and Narcís Cardona. IEEE Antennas and Propagation Magazine, pp 19-32, 2018.

DOI: 10.1109/MAP.2018.2818458

An in-body sensor network is that in which at least one of the sensors is located inside the human body. Such wireless in-body sensors are used mainly in medical applications, collecting and monitoring important parameters for health and disease treatment. IEEE Standard 802.15.6-2012 for wireless body area networks (WBANs) considers in-body communications in the Medical Implant Communications Service (MICS) band. Nevertheless, high-data-rate communications are not feasible at the MICS band because of its narrow occupied bandwidth. In this framework, ultrawideband (UWB) systems have emerged as a potential solution for in-body highdata-rate communications because of their miniaturization capabilities and low power consumption. In recent years, various open issues have guided the research on in-body propagation. First, the propagation medium, i.e., human body tissues, is frequency dependent and exhibits a large attenuation at UWB frequencies. Second, the behavior of in-body antennas is strongly dominated by the surrounding tissues. Thus, the in-body channel characterization in UWB depends not only on the channel behavior itself but also on the characterization methodology. This article outlines the research performed in the field of UWB in-body radio-channel characterization, considering the propagation medium and the analysis methodology: software simulations, phantom measurements, and in vivo measurements. We provide an overall perspective on the current state of the art, the limitations of in-body propagation analysis, and future perspectives on UWB in-body channel analysis.

2. Frequency Dependence of UWB In-Body Radio Channel Characteristics. Carlos Andreu, Concepción García-Pardo, Sergio Castelló-Palacios, Ana Vallés-Lluch, and Narcís Cardona. IEEE Antennas and Propagation Magazine, pp 359-361, 2018.

DOI: 10.1109/LMWC.2018.2808427

In this letter, a research of ultra-wideband in-body channel by using a high accurate phantom is performed in order to evaluate the impact of frequency dependence of human tissues on the channel characteristics. Hence, a phantom-based measurement campaign from 3.1 to 5.1 GHz has been conducted. From postprocessing data, the path loss is assessed considering subbands of 500 MHz as well as the entire frequency range under test. In addition, the correlation in transmission is computed and discussed.

3. Experimental Assessment of Time Reversal for In-Body to In-Body UWB Communications. Carlos Andreu, Concepcion Garcia-Pardo, Sergio Castelló-Palacios, and Narcís Cardona. Wireless Communications and Mobile Computing, 12 pages, 2018.

DOI: 10.1155/2018/8927107

The standard of in-body communications is limited to the use of narrowband systems. These systems are far from the high data rate connections achieved by other wireless telecommunication services today in force. The UWB frequency band has been proposed as a possible candidate for future in-body networks. However, the attenuation of body tissues at gigahertz frequencies could be a serious drawback. Experimental measurements for channel modeling are not easy to carry out, while the use of humans is practically forbidden. Sophisticated simulation tools could provide inaccurate results since they are not able to reproduce all the in-body channel conditions. Chemical solutions known as phantoms could provide a fair approximation of body tissues' behavior. In this work, the Time Reversal technique is assessed to increase the channel performance of in-body communications. For this task, a large volume of experimental measurements is performed at the low part of UWB spectrum (3.1-5.1 GHz) by using a highly accurate phantom-based measurement setup. This experimental setup emulates an in-body to in-body scenario, where all the nodes are implanted inside the body. Moreover, the in-body channel characteristics such as the path loss, the correlation in transmission and reception, and the reciprocity of the channel are assessed and discussed.

4. Point-to-Multipoint Communication Enablers for the Fifth-Generation of Wireless Systems. David Gomez-Barquero, David Navratil, Steve Appleby, Matt Stagg. IEEE Communications Standards Magazine, special issue on ENABLING 5G VERTICALS & SERVICES THROUGH NETWORK SOFTWARIZATION AND SLICING, 2018.

DOI: 10.1109/MCOMSTD.2018.1700069

3GPP has enhanced the point-to-multipoint (PTM) communication capabilities of 4G LTE in all releases since the adoption of eMBMS (enhanced Multimedia Broadcast Multicast Service) in Release 9. Recent enhancements cover not only television services, but also critical, machine-type and vehicular communications, following the backwards-compatibility design philosophy of LTE. This paper discusses the opportunity in the design and standardization of 5G to break with the existing paradigm for PTM transmissions in 4G LTE, where broadcast PTM transmissions were initially conceived as an add-on and pre-positioned service. 5G brings the opportunity to incorporate PTM capabilities as built-in delivery features from the outset, integrating point-to-point (PTP) and PTM modes under one common framework and enabling a dynamic use of PTM to maximize network and spectrum efficiency. This approach will open a door to completely new levels of network management and delivery cost-efficiency. The paper also discusses the implications of PTM for network slicing, to customize and optimize network resources on a common 5G infrastructure to accommodate different use cases and services taking into account the user density.

5. Point-to-Multipoint Communication Enablers for the Fifth-Generation of Wireless Systems. Jordi J. Gimenez, David Gomez-Barquero, Javier Mogarde, Erik Stare, IEEE Communications Magazine, 2018.

DOI: 10.1109/MCOM.2018.1700675

Efficient and flexible use of spectrum will be inherent characteristics of 5G communication technologies with native support of wideband operation with frequency reuse 1 (i.e., all transmit sites use all available frequency resources). Although not in the very first 5G release of 3GPP, it is expected that broadcast/multicast technology components will later be added and fully integrated in the 5G system. The combination of both wideband and frequency reuse 1 may provide significant gains for broadcast transmissions in terms of energy efficiency, since it is more efficient to increase capacity by extending the bandwidth rather than increasing the transmit power over a given bandwidth. This breaks with the traditional concept of terrestrial broadcast frequency planning, and paves the way to new potential uses of UHF spectrum bands for 5G broadcasting. This article provides insight into the fundamental advantages in terms of capacity, coverage, as well as power saving of wideband broadcast operation. The role of network deployment, linked to frequency reuse in the UHF band, and its influence on the performance of a wideband broadcasting system are discussed. The technical requirements and features that would enable such a power-efficient solution are also addressed.

6. Study on the Optimum Co-Located MIMO Scheme for LDM in ATSC 3.0: Use Cases and Core Layer Performance. Eduardo Garro, Carlos Barjau, David Gomez-Barquero, Jeongchang Kim, Sung-Ik Park, Namho Hur, Proc. IEEE BMSB 2018.

DOI: 10.1109/BMSB.2018.8436920

In this paper, the joint transmission of ATSC 3.0 Layered Division Multiplexing (LDM) with co-located Multi-Antenna schemes (MIMO) is investigated for the mobile or Core Layer (CL). Previous works have already assessed the ergodic capacity of LDM plus MIMO, but the performance over realistic channels has not been performed yet. Four potential system models for the CL are compared, depending on the number of mobile receiving antennas and the use of Transmit Diversity Code Filter Sets (TDCFS). Mobile layer performance is evaluated by means of physical layer simulations. The main results obtained show that system models with one antenna receivers provide similar performance as more-complex implementations with two receiving antennas. The use of TDCFS is also recommended for mobile channels.

7. Distribution of Road Hazard Warning Messages to Distant Vehicles in Intelligent Transport Systems. Daniel Calabuig, David Martín-Sacristán, Jose F. Monserrat, Mladen Botsov, David Gozálvez. IEEE Transactions on Intelligent Transportation Systems (Volume: 19, Issue: 4 , April 2018).

DOI: 10.1109/TITS.2017.2718103

The efficient distribution of intelligent transport system (ITS) messages is fundamental for the deployment and acceptance of ITS applications by mobile network operators and the automotive industry. In particular, the distribution of road hazard warning (RHW) messages to distant vehicles requires special mechanisms. In this case, the combination of direct communication between vehicles and the wide area coverage provided by cellular networks might be crucial not only for reducing the data transmission costs but also for improving the timeliness of ITS information. Moreover, the application of clustering and cluster head selection mechanisms among vehicles can increase the efficiency of hybrid vehicular and cellular communication networks. This paper introduces a novel cluster head selection technique for the distribution of RHW messages, and proposes an implementation of another legacy technique that was originally intended for mobile ad-hoc networks (MANETs). This paper evaluates the performance of these techniques by the means of computer simulations in two scenarios with distinct congestion and propagation conditions. The simulation results show the potential benefit of hybrid networks compared with pure cellular transmissions, especially, if the novel cluster head selection technique is used.

2.3. AWARDS

1. Best Conference Paper award at the IEEE Conference on Standards for Communication and Networking (IEEE CSCN 2018) (Sofia Perez Simbor).

2. Best Student Paper award at the IEEE Broadband Multimedia Systems and Broadcasting (IEEE BMSB 2018) (Eduardo Garro)