Mobile Communications Group (MCG)

HEAD OF THE GROUP RESEARCH REPORT

The Mobile Communications Group (MCG), led by Narcís Cardona, 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 (5GNR), Multicast and Broadcast Services (MBMS) over 3GPP Networks, Vehicular Communications, and Body Area Communications (BAN). Currently, the MCG is composed of about 40 people between professors and researchers. The MCG researchers have a consolidated experience in 5G due to their involvement with several international projects related to 5G, most notably the METIS, METIS-II, and 5G-Xcast projects. It leads the H2020 European projects 5G-RECORDS, INGENIOUS, FUDGE-5G, WaveComBE, ITN-5VC and also participates in the 5G-CARMEN, 5G-SMART, 5G-TOURS. These researchers participate in the development of "vertical" 5G applications and some of them being in phases 2 and 3 of the 5G-PPP program, in addition to being involved in other of the ministry and autonomic projects such as PROMETEO 2020 (FEDER), Red.es 5G Pilots, etc.

The MCG has also achieved a contract with Huawei to create the iTEAM – Huawei Joint Research Center, which involves 7 projects, where the MCG participates in 4 of them. Furthermore, the MCG collaborates with companies in the sector such as the spin-off Fivecomm, among others, with which the UPV has signed agreements for the development of 5G technology applicable to industry 4.0, and in the transfer of knowledge referring to measures in 5G networks and their optimization.

Valencia 5G

During this period, the MCG members have been very active in the dissemination of the group's activities and achievements. An example of this is the event to present the results of the Valencia 5G agreement, which was signed in 2018 by the UPV, the Valencia City Council, the *Generalitat Valenciana,* and the *Universitat de València*. Thanks to this agreement, milestones such as the

Laser 5G demo at the MWC 2021

celebration of the EuCNC2019 & Global 5G Event and the implantation of the VLC-CAMPUS-5G in the UPV were possible. This has led to the Base 5G, a new public laboratory for experimentation and demonstration on pioneering 5G technologies in Spain located in the surroundings of La Marina and managed by the UPV and the City Council. The objective of Base5G is to allow small and medium-sized companies to test or demonstrate applications of 5G technology in different sectors, not only in industry, and thus facilitate the experimentation of new ideas and prototypes that can later be transferred to the Valencian business community.

Fruit of this success, the Valencia 5G (V5G) brand and platform (https://v5g.es/) has been created, in which all the information on the achievements of all the participating entities will be collected. Within the framework of this brand, the first edition of the V5G Day was held as a seed of a family of events to be organized yearly in Valencia. The V5G Day event was held on July 7th 2021, at the Valencia Conference Center, with the slogan "5G and the digitization of the Industry", it was organized by the MCG of iTEAM in collaboration with the UPV, *Generalitat Valenciana*, and the Valencia City Council. In this edition, the event was hybrid, with a limited presence of attendees at the venue, where demonstrations of live 5G technology were also carried out, applied to real use cases, specifically Remote Driving, Touch Internet, and Social Robot. At the same time, the event was broadcast live via

high-quality streaming. Throughout the day discussions and demonstrations were held on how 5G technology can become a catalyst for the modernization of our industry, and therefore the focus of presentations, round tables, and demonstrations were placed on representatives of various industrial sectors. Here, industry representatives could discuss in three round table sessions the possibilities that the 5G technology may provide to the local industry.

In addition, this year, the MCG group from iTEAM, together with Orange and ZTE, participated in the Mobile World Congress 2021. They showed the pioneering project "Laser 5G", an unmanned remote-controlled boat equipped with 360 ° cameras that was driven from Barcelona while sailing at La Marina of Valencia, thanks to the 5G technology. The project also involved the company Fivecomm and a team from the *Universidad Politécnica de Cartagena* (UPCT).

Laser 5G

1.- Project activities

1.1.- Ongoing projects

VLC-CAMPUS-5G (pilot testing field, development and demonstration of 5G mobile technologies)

VLC-CAMPUS-5G is the project to launch a 5G technology wireless communications platform on the campus of the Universitat Politècnica de València, which supports the testing of new 5G services and equipment and promotes Valencia as a 5G city. The VLC-CAMPUS-5G project is aligned with the evolution of mobile networks towards 5G, which will bring important developments and improvements not only in terms of capacity, latency, connection density, quality, and user experience, but also in terms of flexibility, efficiency, scalability, and openness of the networks, which will allow offering new services. There is currently a 5G network core emulator, as well as software-configured radio units, such as the Ettus USRPs B210 (3) and N321 (2) as well as various equipment and software licenses that together configure a network 5G laboratory. At this moment, it supports PROMETEO 2020 (FEDER), Red.es 5G Pilots, and H2020 projects, among others. Research projects and demonstrations of use cases of this technology are being carried out in the VLC-CAMPUS-5G, especially focused on the industry, and collaborates with companies in the energy and automotive sectors on projects for the sustainability and promotion of electric and connected vehicles.

This project is co-financed by the European Union through the operational program of the European regional (FEDER) development fund of the Comunitat Valenciana 2014-2020, with reference IDIFEDER/2018/030, duration 2018 - 2020 ext. to March 2021.

VLC-CAMPUS-5G II (Pilot Test Campus, Development and Demonstration of 5G Mobile Technologies for the Internet of Things and Connected Machines Applied to Logistics)

VLC-CAMPUS-5G II is the project to deploy an experimental field of 5G Mobile Technologies for the Internet of Things and Connected Machines that will use current infrastructure available by the Mobile Communications Group of the Institute of Telecommunications and Multimedia Applications (iTEAM) of the UPV, especially the equipment of the VLC-Campus-5G (pilot testing field, development and demonstration of 5G mobile technologies). The new equipment will be added that will allow pioneering tests of 5G-IoT connected machines related to the world of Logistics and Industry 4.0 in general, with practical use cases applied to process improvements in the port of Valencia. It should be noted that the VLC-Campus-5G has 5G Release-15 equipment (the first version of the standard), while the 5G equipment requested in this grant corresponds to the second version of the Release-16 standard,

which was completed in June 2020, and which includes the mMTC (massive-Machine-Type Communications) and URRLC (Ultra-Reliable-Low-Latency Communications) functionalities that are fundamental for the Internet of Things and the connection of machines. The construction of the 5G-IoT test campus requires different equipment that can be classified into the following categories:5G-IoT-mmW (5G-IoT Release-16 end-to-end connectivity equipment in the millimeter wave frequency band (26-28 GHz)); 5G-IoT-UHF (5G-IoT Release-16 end-to-end connectivity equipment in the frequency band below 6 GHz); 5G-IoT emulation (Core network, radio access network and 5G-IoT Release-16 devices emulation equipment.); and Automated mobile robotic system (Equipment with different types of mobile robots for indoor and outdoor industrial applications (mobile base, guided vehicle, collaborative robotic arm, automatic guided vehicle for warehouse transport and platform type)). https://vlc-campus5g.com/

This project is co-financed by the European Union through the operational program of the European Regional Development Fund (FEDER) of the Comunitat Valenciana 2021-2022, with reference IDIFEDER/2021/088, duration from January 2021 to December 2022.

WAVECOMBE (Millimetre Wave Communications in Built Environments)

WaveComBE is an Industrial and Training Network 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. This project is coordinated by UPV, in consortium with The University of Sheffield, University of Durham, University of Twente and companies Ranplan Wireless Network Design Ltd. and Televic Conference, Gapwaves AB together with the partner organizations, Axión Infraestructuras de Telecomunicaciones S.A.U, Telenor Group, and Nokia Bell Labs.

WaveComBE provides high-quality inter-disciplinary and cross-sector research training for a new generation of scientists. Specifically, 11 Early Stage Researchers have been involved in the project, two of them by the UPV. From the MCG has been developed simulation tools to analyse the human body blocking at millimetre-wave band, as well as efficient planning tools to deploy future access points in bands around and above 30GHz. Besides beamforming techniques have been investigated for the physical layer of millimetre-wave mobile communications.

This last year of the project, training, and dissemination activities have continued. In total, the project ends with 10 training activities organized by the consortium, up to 36 publications in conferences and journals, 5 contributions to the ITU, and 2 patent requests. The main outcome of WaveComBE MSCA-ITN-EID project is a group of excellent PhDs, with both technical and soft skills, that can lead future projects in the field of Telecommunications. https://wavecombe.eu/

This project has received funding from the European Union's Horizon 2020 research and innovation program under the Marie Sklodovska-Curie agreement No. 766231. Duration: 01/10/2017 - 30/09/2021.

5G-CARMEN (5G for Connected and Automated Road Mobility in the European union)

This project, funded by the European Commission, has progressed with relevant impact on research community, being declared the most active project on autonomous driving by the European Commission.

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 have been deployed along selected stretches of the motorway in the border regions. First demos were experienced in June 2021, being the fall 2021 a new opportunity for testing real autonomous cars along European motorways. https://5gcarmen.eu/

This project has received funding from the European Horizon 2020 Programme for research, technological development and demonstration under grant agreement no.: 825012. From November 2018 to July 2022.

5G-TOURS (SmarT mObility, media and e-health for toURists and citizenS)

5G-TOURS vision is to improve the life in the city for the citizens and tourists, making cities more attractive to visit, more efficient in terms of mobility and safer for everybody. 5G-TOURS builds on three themes: the touristic city (Turin), the mobility efficient city (Athens), and the safe city (Rennes). iTEAM is involved in the touristic city, where visitors of museums and

outdoor attractions are provided with 5G-based applications to enhance their experience while visiting the city. This includes VR/AR applications to complement the physical visit with additional content, involving interactive tactile communications. The experience of the visitors is also enhanced with robot-assisted services, telepresence to allow for remote visits, as well as live events enabled by mobile communications such as multi-party concerts. iTEAM is the leader of the broadcast use case. In this case of use, a 5G Broadcast network will be used to send high-quality multimedia content, which will be received by the visitors of Palazzo Madama. The UPV will contribute directly to the development of equipment compatible with 5G Broadcast specifications, based on Software Defined Radio (SDR), as well as the implementation of the multicast interfaces of the 5G Core. www.5gtours.eu

This project has received funding from the European Horizon 2020 under grant agreement no.: 856950, 36 months duration (June 2019 – May 2022).

5G-RECORDS (5G key technology enableRs for Emerging media COntent pRoDuction Services)

5G-RECORDS aims to explore the opportunities that new 5G technology components, including the core network (5GC), radio access network (RAN) and end devices, bring to the professional production of audiovisual content. The project targets the development, integration, validation, and demonstration of 5G components for professional content production, as part of an overall ecosystem integrating a subset of 5G network functions. The project is using 5G key enabling technologies, such as NPNs, network slicing, millimeter waves, network function virtualization, among others, to bring these new 5G components to emerging markets and new market actors, while also addressing recent emerging remote and distributed production workflows where cloud technologies work hand in hand with 5G. 5G-RECORDS is structured around three real-world content production use cases: live audio production, a multi-camera wireless studio and live immersive media production. The first use case focuses on deploying a 5G private local network using open-source software and general-purpose processors as part of the overall infrastructure. To meet the challenges of live audio production, i.e., stringent requirements in terms of latency, availability, and synchronization, ultra-reliable low-latency communications (URLLC) is key. The second use case aims to develop a complete production system that takes advantage of 5G technology to fit remote, distributed production and remote contribution scenarios. This use case involve video, audio, and auxiliary data processing with strict requirements in terms of quality, data rate, latency, reliability, and synchronization between devices. Its main goal is thus to equip media equipment with external codecs and 5G modems that feed the media signals into the 5G network. A project-developed media gateway on the other end translates the 5G-IP transport protocols to the desired ones in the final production network, such as SMPTE-2110. The media equipment is managed through an also project-developed control gateway through the 5G network via NMOS protocols. The third use case aims to enable real-time immersive capture of sporting and cultural events through cameras connected via 5G millimeter waves. Thanks to the enhanced bandwidth, it will be possible to broadcast content both live and in replays, with different perspectives and shots, so that the live program director can move the viewpoint of the image freely. www.5g-records.eu

iTEAM is leading this project, which has received funding from the European Union's Horizon 2020, under grant agreement no.: 957102, 24 months duration (September 2020 – August 2022).

FUDGE-5G (FUlly DisinteGrated private nEtworks for 5G verticals)

FUDGE-5G will make a leap forward in realizing the notion of cloud-native 5G private networks by developing a further enhanced Service-Based Architecture (eSBA) for both control plane and user plane with "decomposed" players of the ecosystem divided into: New Radio (NR) access network infrastructure provider, eSBA platform provider, mobile 5G Core (5GC) provider, vertical application orchestration provider and vertical service provider. The forward-looking FUDGE-5G architecture will also feature "all- Ethernet" 5GLAN (Local Area Network), 5G-TSN (Time- Sensitive Networking), 5G-Multicast and intelligent vertical application orchestration features. The proposed framework enables highly customized cloud-native deployment of private 5G networks that can be deployed anywhere as micro-services (i.e., edge, on premises and cloud), while the access network is hosted over 5G, WiFi or wired Ethernet links. iTEAM is the coordinator of the project, and the leader of the Concurrent Media Delivery use case, divided into two sub-scenarios: an uplink focused Remote News Gathering over 5G and a downlink intensive Media Showroom. iTEAM is also developing 5G-Multicast functions and hosting a node of the interconnected

private networks trials; which seek to emulate EDUROAM functionality over 5G networks. www.fudge-5g.eu

iTEAM is leading this project, which has received funding from the European Union's Horizon 2020, under grant agreement no.: 957242., 30 months duration (September 2020 – Feb. 2023).

INGENIOUS (Next-GENeration IoT sOlutions for the Universal Supply chain)

iNGENIOUS will exploit some of the most innovative and emerging technologies in line with the standardised trend, contributing to the Next-Generation IoT and proposing technical and business enablers to build a complete platform for supply chain management. iNGENIOUS embraces the 5G Infrastructure Association (5G IA) and Alliance for Internet of Things Innovation (AIOTI) vision for empowering smart manufacturing and smart mobility verticals. The iNGENIOUS network layer brings new smart 5G-based IoT functionalities, federated Multi-Access Edge Computing (MEC) nodes and smart orchestration, needed for enabling the projected real-time capable use cases of the supply chain. Security and data management are fully recognized as important features in the project. iNGENIOUS will create a holistic security architecture for next-generation IoT built on neuromorphic sensors with security governed by Artificial Intelligence (AI) algorithms and tilebased hardware architectures based on security by design and isolation by default. In the application layer, iNGENIOUS new AI mechanisms will allow more precise predictions than conventional systems. Project outcomes will be validated into 4 large-scale Proof of Concept demonstration, covering 1 factory, 2 ports, and 1 ship, encompassing 6 uses cases. iTEAM is the coordinator of the project, and it participates on three use cases. The first is Situational Understanding and Predictive Models in Smart Logistics Scenarios, where we work on the tracking of trucks inside the port and a dashboard to represent different sources of data. The second one is called Automated Robots with Heterogeneous Networks. Here we're deploying an open RAN network together with other partners to implement new capabilities and intelligence thanks to AI/ML. The last one is called Inter-modal Asset Tracking via IoT and Satellite, where we work on implementing new Non-Terrestrial Networks (NTN) channel models and link level simulations. www.ingenious-iot.eu

iTEAM is leading this project, which has received funding from the European Union's Horizon 2020, under grant agreement no.: 957216. 30 months duration (October 2020 – March 2023).

ITN-5VC (Integrated Telematics for Next Generation 5G Vehicular Communications)

ITN-5VC aims to investigate how multi-band multi-antenna communications, including mmWave, could be integrated together with radar heads and other wireless sensors into the same telematics unit, so that transmission chains and radiation systems were reused using the same spectrum in an opportunistic manner. This idea has important implications in the design of the vehicle and its communications that will also be addressed in the project. With this premise, the project aims to investigate the future C-V2X systems based on 5G NR and how to integrate them with autonomous driving sensor systems. https://itn5vc.eu/

This project has received funding from the European Union's Horizon 2020 research and innovation program under the Marie Skłodowska-Curie grant agreement No. 955629 Duration: 01/10/2020 - 30/09/2024.

5G-SMART (5G for smart manufacturing)

5G-SMART unlocks the value of 5G for smart manufacturing through demonstrating, validating and evaluating its potential in real manufacturing environments. 5G-SMART trials will test the most advanced 5G integrated manufacturing applications such as digital twin, industrial robotics and machine vision based remote operations. 5G-SMART will undertake the first ever evaluation of ElectroMagnetic Compatibility (EMC), channel measurements and co-existence between public and private industrial networks in real manufacturing environments easing the integration of 5G. The new 5G features, developed in 5G-SMART such as time synchronisation and positioning for manufacturing use cases represent a technological leap.

5G-SMART lead by Ericsson brings together a strong consortium of partners involved in every aspect of the manufacturing ecosystem. Prof. Jose F. Monserrat, member of the iTEAM, is the Innovation Manager of the Project. This project is funded by the European Commission. https://5gsmart.eu/

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement no.: 857008. From June 2021 to May 2022.

COLODEM (Colorectal Probe for Electromagnetic Tumour Detection)

COLODEM project is based on the development of a tool for colorectal cancer detection based on the reported difference in the electromagnetic properties of healthy and malignant colon tissues. Such tool will consist of three main parts: flexible coaxial probe to be integrated in the colonoscope, a software algorithm for measuring and identifying the malignant tissues, and a laboratory platform for testing. This platform will be based on the electromagnetic reproduction of a human colon with presence of malignant tissues and it will be used for both the development of the probe and the detection algorithm as well as the training of the physicians.

Regarding the platform, it was determined that artificial gels, specifically the PHEA hydrogel, was the most optimal gel for the requirements of the test platform to be developed. On the other hand, the most important limitations that can affect the three-dimensional production of the phantom to conform it to the size and shape of a real colon were determined, being especially relevant the polymerization initiator used.

Presentation Red.es 5G Pilots- Demo Robotics Remote control of AGVs.

Regarding the tests with the flexible probe and the detection algorithm, they have been performed both with the developed semi-solid phantoms and with data from other studies where measurements were already available. The results obtained showed that it is the cross section of the flexible probe is key to optimize the sensitivity of the measurement thus. In addition, calibration tests were performed taking into account the sterile conditions of the actual application environment. Finally, preliminary analyses of the difference in dielectric property values of healthy and tumor tissue showed that this methodology can provide good performance in the identification of colorectal cancer tissues, provided the realization of extensive clinical studies to refine the diagnostic algorithm.

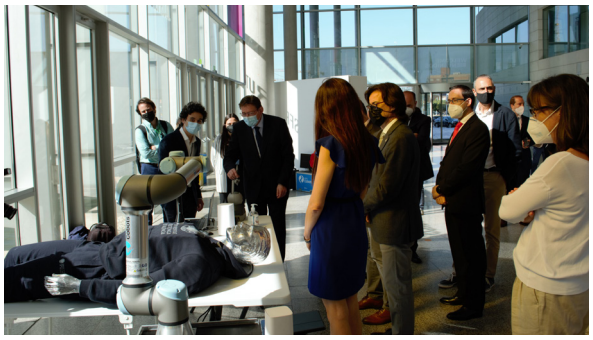
This Project has been funded by the Call for Grants for First Research Projects (PAID-06-18). Duration: 1/09/2019 to 28/02/2021.

CROFT (Cloud Robotics and factories Of The FuTure)

This project addresses the research required for the development of mobile robotics in the cloud based on 5th generation mobile networks for the future IoT revolution. Low latency, high capacity demands, and a large number of mobile wireless entities connected to the Internet will require a continuous Ultra Dense Network (UDN) that is likely to use mmW bands to support future factory wireless connectivity. The connection network must be multi-hop, with connectivity nodes moving throughout the factory, even with drones, to ensure line of sight conditions for successful mmW communication. The nodes can cooperate in the transmission/ reception of data in a centralized or distributed way. In addition, the design of the protocol, mainly speaking of the PHY and MAC procedures, will guarantee the minimum battery consumption of the communicating machines.

The objective of the project is to investigate and optimize the operation of RAN architectures for 5G standards beyond NR phase 2, and to design reliable and realistic PHY and MAC procedures adapted to this new communication model composed of mesh networks and mobile nodes. The ultimate goal is to achieve an improvement in the latency, reliability and capacity of the large number of robots, drones, droids and humans that will work together in the factory of the

V5G Day -Demo Social Robot



V5G Day -Demo Touch Internet

future. In this context, the new communication paradigm of mmW and continuous UDNs together with the use of multihop cellular communications play a transversal role. During the project, the performance of the systems will be evaluated: simulations, RF measurements, and experiments with a large number of devices will be performed to validate the design principles used. For this purpose, the VLC-CAMPUS-5G will be exploited. In addition, this project aims to attract the talent of women to the new job opportunities that 5G will generate.

During this first year of the project, the V5G Day event was held at the Conference Center, with the slogan "5G and the digitization of the industry". At the V5G Day event there were live demos, personalized information, collaboration, and co-working opportunities. Special emphasis was placed on the participation of female engineers specialized in 5G to promote the training and incorporation of women into the ICT sector, taking advantage of the great opportunity that opens with this technology. https://vlc-croft5g.com/

V5G Day Industry 5G round table

This project has been funded by the Prometeo 2020 grant (PROMETEO2020/040) from the Generalitat Valenciana to carry out R & D & I projects for research groups of excellence, 36 months duration (01/01/2020 - 30/12/2022).

AUDERE (Advanced Urban Delivery and Refuse Recovery)

AUDERE aims to design and develop an intelligent and innovative system for urban refuse collection and last mile delivery logistics. To fulfil this objective, a fleet of autonomous vehicles (autonomous mobile robots) are equipped with 5G connectivity to carry out last mile delivery and urban waste container recovery tasks. The AUDERE system will assess the technical, economic, social, and environmental viability in a range of use cases. Therefore, AUDERE will offer high-tech solutions to the growing forward and reverse logistics needs in our cities. Trials will be performed in two scenarios. The first one is the VLC-CAMPUS-5G of the Universitat Politècnica de València, which is equipped with the infrastructure of a private 5G mobile network that allows the validation of different use cases, such as logistics, automotive, industry, media, etc. In addition, among the main advantages of VLC-CAMPUS-5G we can mention that it is a closed and controlled environment, which could be considered as a small city due to its infrastructure, commercial and sports places, banks, parks and where more than 20,000 people move daily. The second scenario is the La Pinada District, which is an eco-district, the first in Spain, that will integrate the principles of sustainable urban development, creating an attractive environment for family living, work, and enjoyment of nature. The results of this project will define new technological products that can be deployed in Smart Cities or Smart Quarters. This year, the AUDERE project has been included as a use case within the 5G Pilots project in the Comunitat Valenciana where Orange participates as an infrastructure provider. The development of the AUDERE project is in its final stage of implementation, the intelligent system that automates the collection of urban waste, as well as the logistics in the delivery of goods and parcels through autonomous vehicles and 5G connectivity, were validated at the Universitat Politècnica de València at the end of November 2021.

The results of this project will define new technological products that can be deployed in Smart Cities or Smart Quarters. This project has been funded by The Agència Valenciana de la Innovació (AVI), 21 months duration (April 2020 – December 2021).

5G Valencia Pilots (5G Mobile Networks Pilot, Red.es Call 2019)

This is a project to validate the capabilities of 5G technology in Valencia, Spain, by testing 15 use cases that involve sectors of health, industry, energy, gaming, and tourism. In the 5G Valencia Pilots

participates Orange, Huawei, Arborea Intellbird, CFZ Cobots, Global Omnium Idrica, Etra Research and Development, Elewit (Grupo Red Eléctrica) and Robotnik. The project aims to contribute from three approaches: support the deployment of the first 5G networks in Spain; experiment with the network management techniques; and test the main capabilities of the technology: ultra-reliable and low-latency communications; mass machine-to-machine communications; and extremely high speed and capacity mobile broadband. ITEAM is involved in 5 out of 15 use cases, which are: (1) Robotic Remote diagnostic, (2) Fleet management: Robotics Remote control of AGVs, (3) Robotics-Remote inspection and maintenance, (4) 5G Digital Contents, and (5) Massive IoT for smart meters in supplies. The VLC-CAMPUS-5G of the Universitat Politècnica de València, has been chosen as one of the testing scenarios. Some of these 5G use cases demos, specifically in the field of telemedicine, remote inspection, and fleet management, were shown in front of senior officials from the national and local government, as well as managerial staff from Orange Spain, during the Red.es 5G pilots presentation event hosted by Orange Spain at the UPV on June 14th, 2021.

This project has been funded by Red.es through European Regional Development Fund, 18 months duration (July 2020 – December 2021).

6G Evaluation Methodologies

This project aims to do an exploratory research towards the definition of the 6G developing the required models and making a specific proposal of scenarios, assumptions and KPI. Considering that the frequency range will exceed the 100 GHz limit, and the propagation will be highly dependent on the details, new channel models are required, while a more accurate characterization of the obstacles is a must. In this way, the project is focused on the set up of an advanced E2E simulation platform in which new channels models light-oriented will be integrated. Accurate modelling of the channels and the obstacles will be included, while a first set of scenarios for simulation will be analysed as a prospective analysis.

This project is funded by Huawei as a part of our iTEAM – Huawei Joint Research Center, Duration 12 months, from 01/04/2021 to 30/03/2022.

Quantum Machine Learning for the AI Integration in 6G

The project is planned as exploratory and aims to use the advantages of quantum information theory to improve classical machine learning. Quantum machine learning met high expectations of providing a solution to the analysis of large volumes of data using the power of quantum computing "parallelism". Specifically, aims at meeting the Grover algorithm for the identification of matches in an exploratory search among big data. A clear example is to identify a face image pattern through the cameras and thus be able to locate the person among millions of images captured instantly. This could be used in a subsequent phase of the project to elaborate in a collaborative manner the hologram of a person for the holographic moving call.

This project is funded by iTEAM – Huawei Joint Research Center. Duration 12 months, from 01/04/2021 to 30/03/2022.

Customized materials for EM communications in the GHz and THz band

The project aims to develop full-spectrum phantoms, i.e., liquids and semisolids (gels) components with tailor-made electromagnetic properties fully adjustable in the range above 26GHz and up to 100MHz for a range of applications in 6G new devices and interfaces. This "custom EM materials" can be used in many areas like the physical interface between antennas and surfaces, the better impedance adaptation in wearables or implants, to develop "liquid" antennas, to build physical EM filters for certain bands, to improve human brain interfaces, and to explore the possibility of integrating these materials (in its gel configuration) in printed electronics or reconfigurable intelligent surfaces (RIS).

The scope of the project is to develop novel composite materials, on the basis of iTEAM's expertise, that can replicate the behavior of different human body tissues in an ultra-large frequency band.

Huawei as a part of our iTEAM – Huawei Joint Research Center funds this project. Duration: 18 months, from 01/04/2021 to 30/09/2022.

AI Video-Assisted Radio Communications

The project combines Artificial Intelligence video tracking algorithms with reconfigurable radiating systems, to improve beamforming performance and vehicle's location. Current systems rely on the detection of sensing radio signals and their quality. These solutions are reactive, meaning that the system responds to the radio channel behaviour and changes accordingly. Many scenarios in which the future communication systems will be deployed, or are deployed nowadays, can be assisted by video information, to feed the reconfiguration algorithms of the radio systems and even to anticipate such configuration on the basis of predictive video analytics.

The aim of this project is to develop a prototype of a video-assisted beamforming panel, as a first proof of concept of the AI applied to the Physical Layer of beyond 5G radio, as well as to explore the application to reinforce the location and tracking of moving objects in indoor (industrial) environments, to define a potential follow-up of the work on that direction.

Huawei as a part of our iTEAM – Huawei Joint Research Center funds this project. Duration: 12 months, from 01/04/2021 to 31/03/2022.

2.- Research results

2.1.- Featured publications

"Millimeter-wave Human Blockage Model Enhancements for Directional Antennas and Multiple Blocker."

D. Prado-Alvarez, Inca, D. Martín-Sacristán and J. F. Monserrat. IEEE Communications Letters, doi: 0.1109/LCOMM.2021.3095617

This manuscript targets a set of enhancement of the 3GPP body blockage model by proposing new criteria for: (i) the positioning of diffraction points over the body, (ii) the determination of the effective blockers from the set of potential blockers in a scenario taking into the account a blockage area determination concept, and (iii) the grouping of close blockers. Our approach is compared to real measurements at 30 GHz, showing a substantial decrease of the absolute error, while keeping the model simple.

"Limitations of ATSSS technology in ATSC 3.0 – 5G convergent systems" Carlos Barjau, David Gomez-Barquero, Hoiyoon Jung, Sung-Ik Park and Namho Hur. IEEE International Symposium on Broadband Multimedia Systems and Broadcasting 2021, doi: 10.1109/BMSB53066.2021.9547016

This paper explores the use of the 3GPP technology Access Traffic Steering, Switching and Splitting (ATSSS) to enable IP layer convergence between 5G and ATSC 3.0. ATSSS was first introduced in Release 16 and originally devised to integrate non-3GPP access networks such as WiFi and wireline into the 5G System; and is flexible enough to include IP-based broadcast standards like ATSC 3.0. The limitations of the ATSSS technology to enable this convergence are detailed in this paper. A proposal to overcome them with a high-level converged architecture between ATSC 3.0 and 5G, featuring ATSSS Release 17 characteristics, is additionally described. Presented at BMSB 2021, pending publication.

2.2.- Patents

"PROCEDIMIENTO DE ANÁLISIS DE LA COBERTURA EN ESPACIOS INTERIORES PARA REDES INALÁMBRICAS" (COVERAGE ANALYSIS PROCEDURE IN INTERIOR ENVIRONMENTS FOR WIRELESS NETWORKS)

Samuel Romero and Narcís Cardona. Ref. 202130290

"REFLECTOR PARA ONDAS MILIMÉTRICAS" (MILLIMITER WAVE REFLECTOR)

Samuel Romero and Narcís Cardona. Patent request P202130068