EMPOWER-PAWR Workshop:

Empowering Transatlantic Platforms for Advance Wireless Research; a look at Pan-European end-to-end site facilities and vertical trials for 5G and their collaboration with NSF PAWR platforms

EUCNC, 18/6/2019, Valencia

A full day workshop jointly organized from EMPOWER-PAWR within the EUCNC conference in Valencia, on 18/6/2019 (https://www.advancedwireless.eu/index.php/event/eucnc-workshop/). The joint workshop was a follow-up of the joint meeting organized in Paris on 19/4/2019.

The main objective of the joint workshop was to continue the dialogue between the three ICT-17-2018 projects and their NSF PAWR counterpart. IT was also extended to the ICT-19-2018 projects dealing with the verticals.

The first session of the workshop started with the presentation of Bernard Barani, the Deputy Head of Unit of Future Connectivity Systems at DG CONNECT who introduced the background for EU-USA collaboration. He presented the 5G activities steered by the European Commission as well as the potential future opportunities and collaborations with other regions in this specific sector.

Thyaga Nandagopal, the NSF Deputy Division Director of the CISE Directorate, gave the view of the National Science Foundation for 5G and beyond with focus on research and testing. The efforts are focused on yearly investments of roughly $50M in wireless and more than $150M/year in end-to-end research that assumes wireless to be an integral component, whilst there is a gap in between research and commercialization. He pointed out that open source can be considered as source of money, since we need open platforms to push innovation and took the recent examples of the Cloud. Cellular can learn from shared infrastructure, since we do not need isolated networks. Open issues to be further discussed include: What is softwarisation and the business models of 5G especially for shared platforms, why instead of looking for new frequencies we do not look at how to share the spectrum.

Serge Fdida, EMPOWER coordinator, targeting the new connectivity frontiers beyond 5G, acting as the catalyst for such collaboration and employing different tools to foster joint activities, such as organization of joint workshops, mobility of researchers, hackathons, etc. Serge pointed out that the current workshop is based on the results of the 1st joint meeting organized on 29/4/2019 in Paris. Main issues to be further discussed include: (1) sharing practices and solutions, (2) Exploring E2E system level, (3) The EMPOWER roadmap, (4) Data management and Reproducibility. Key to EMPOWER is to orchestrate and support the cross-Atlantic collaboration, and one target is to foster mutualization of software development and computing/networking resources. The aim to share tools and results, EMPOWER will take the task to coordinate deployments and PoC demos, as well as the creation of an evaluation activity.

Abhimanyu Gosain, Technical Program Director of PAWR Office, Northeastern University College of Engineering continued with the highlights of PAWR (Platforms for Advanced Wireless Research) as a US-based 5G research consortium funded by the National Science Foundation and the PAWR Industrial partners, which supports two PAWR nodes: COSMOS in New York City and POWDER-RENEW in Salt Lake City and Utah. These nodes are designated as innovation hubs and within the geographical area they can use licensed spectrum. It was pointed out that operators and municipalities are also part of the PAWR consortiums making the implementation easier. The architecture of the PAWR nodes were presented and discussed.

The workshop continued with the introduction of all participants that were more than 40. They introduced themselves and very shortly they presented their expectations from the workshop. It includes the discussion of issues such as spectrum, joint activities and experimentation between EU and US, following PAWR nodes and ICT-17 developments and evolution of 5G technologies, open source platforms and implementation, and many others.

A main issue of discussion was Open Source for experimentation, production and infrastructures:

- Radio platforms: use of OAI/O-RAN or other platforms for the developing of the RAN in an open reference platform.
- Core platforms: possible use of ONF/OMEC or other platforms for the development of the Core part of the open reference platform.
- The need of an NFV open framework to provide a relevant test framework and toolset to perform tests.

Manu pointed out OMEC (Open Mobile Evolved Core), which is a set of VNFs developing a vEPC and now OMEC is release 13 and it is based on containers and it can deploy ORAN on top. Discussion on the issue that most open source implementations are often several releases below commercial deployments. In addition, open source needs to focus on providing research tools working on white boxes. The discussion continues on how an open source core will be used by the industrial stakeholders. It was pointed out that additional work is needed on radio testing for open platforms.

Alain Mourad from Interdigital briefly presented the EMPOWER roadmap, which is undergoing and stakeholders invited to contribute accordingly. Active discussion on the future of the platforms and their technology evolution took place.

Raymond Knopp from EURECOM coordinated the discussion on Joint Collaboration Activities. Key aspect is the use of open platforms for academic research and push ideas towards the industry for building industry lead PoCs and research. The potential to use ICT-17/19/20 and the evolutions in Horizon Europe and PAWR nodes in order to bring forward the joint research and ideas via industry driven initiatives. There is a major opportunity for academic research to have more direct impact in pushing ideas to industry designs. There are several initiatives to be exploited such as Linux Foundation which federates software for Telecom Technology demonstrators; Telecom infrastructures projects, Small-cell forum and many others. There is a need for catalog of HW/SW tools and how to use them to build technology demonstrators and finally to promote 5G and beyond 5G technologies in industry driven venues and fora. Additional issues discussed include: (1) how to foster mutualisation of software development and computing/networking resources. One way is to lead to *common reference designs* between EU/USA teams (academia and industry); (2) how to coordinate proof-of-concept joint demonstrations at high-profile venues bringing together teams from EU and USA platforms and a solution is to *promote joint experimentation on multiple platforms*; (3) how to create of an evaluation activity for collecting and disseminating results and one answer is to generate joint scientific dissemination.

5G-PPP phase 3 projects (ICT-17 platforms) were presented, namely:

- **5G-EVE** (https://www.5g-eve.eu/), by Mauro Boldi, Telecom Italia. The 5G-EVE facility will enable experiments with: heterogeneous access, including NR, licensed/unlicensed spectrum, advanced spectrum management; Mobile Edge Computing, backhaul, core/service technologies; means for site-interworking and multi-site/domain/technology slicing/orchestration. The 5G-EVE end-to-end facility consists of the interconnection of four 5G-site-facilities (France, Spain, Italy, Greece), which have been selected because of their considerable previous work with vertical industries and standardisation bodies, on top of their 5G technology competences. 5G-EVE aims at creating synergies between a significant number of facilities that will ensure sustainability and impact in terms of exploitation.
- **5G-VINNI** (https://www.5g-vinni.eu/) by Pål Grønsund, Telenor. The 5G-VINNIaims to: Design an advanced and accessible 5G end to end facility; Build several interworking sites of the 5G-VINNI end to end facility; Provide user friendly zero-touch orchestration, operations and management systems for the 5G-VINNI facility; Validate the 5G KPIs and support the execution of E2E trial of vertical use cases to prove the 5G-VINNI capabilities; Develop a viable business and ecosystem model to support the life of the 5G-VINNI facility during and beyond the span of the project; Demonstrate the value of 5G solutions to the 5G community particularly to relevant standards and open source communities with a view to securing widespread adoption of these solutions. The main facility sites are Norway (Oslo, Kongsberg), UK (Martlesham), Spain (Madrid), Greece (Patras)
- **5G-GENESIS** (www.5GENESIS.eu) by Harilaos Koumaras, NCSR "Demokritos". Its main goal is to validate 5G KPIs for various 5G use cases, in both controlled setups and largescale events in order to realize an integrated End-to-end 5G Facility. The five platforms of the 5GENESIS Facility, and their main features/orientation, are: The Athens Platform: An edge-computing-enabled shared radio infrastructure (gNBs and small cells), with different ranges and overlapping coverage that are supported by an SDN/NFV enabled core, to showcase secure content delivery and low latency applications in large public-events; The Málaga Platform: Automated orchestration and management of different network slices over multiple

domains, on top of the 5G NR and fully virtualised core network to showcase mission critical services in the lab and in outdoor deployments; The Limassol Platform: Radio interfaces of different characteristics and capabilities, combining terrestrial and satellite communications, integrated to showcase service continuity and ubiquitous access in underserved areas; The Surrey Platform: Multiple radio access technologies that can support massive Machine Type Communications (mMTC), including 5G NR and NB-IoT, combined under a flexible Radio Resource Management (RRM) and spectrum sharing platform to showcase massive IoT services; The Berlin platform: Ultra dense areas covered by various network deployments, ranging from indoor nodes to nomadic outdoor clusters, coordinated via advanced backhauling technologies to showcase immersive service provisioning.

During the afternoon session, the ICT19 newly funded projects that are relevant to the experimentation on vertical sites were presented. The common issues are listed below: (1) Innovation on control plane;(2) All projects have a view on the control plane and basically a common dataplane; (3) AI access to data analytic and data for training; (4) Open source based orchestration and control vs pre-commercial orchestration; (5) APIs differences between ICT-17 and all projects are using more than one platform; (6) Non standard KPIs; (6) Spectrum.

5G-TOURS - 5G smar**T** m**O**bility, media and e-health for to**UR**ists and citizen**S (**http://5gtours.eu)**.** The vision of 5G-TOURS is to improve the involvement of citizens and tourists, making cities more attractive to visit, more efficient in terms of mobility and safer for everybody. The industry segments within this vision can greatly benefit from 5G technology and account for a very large fraction of Europe's economy. The goal of 5G-TOURS is to get the European 5G Vision of "5G empowering vertical industries" closer to commercial deployment with highly innovative use cases involving cross-industry partnerships. 5G-TOURS addresses technological and business validation of 5G technology from two perspectives: (1) within the set of requirements specific from one application domain, and (2) across all sets of heterogeneous requirements stemming from concurrent usages of network resources by different vertical domains.

5G-HEART - 5G HEalth AquacultuRe and Transport validation trials (http://5gheart.org/), presented by Haesik Kim – VTT. 5G-HEART will focus on these vital vertical use-cases of healthcare, transport and aquaculture. In the health area, 5G-HEART will validate pillcams for automatic detection in screening of colon cancer and vital-sign patches with advanced geo-localization as well as 5G AR/VR paramedic services. In the transport area, 5G-HEART will validate autonomous/assisted/remote driving and vehicle data services. Regarding food, focus will be on 5G-based transformation of aquaculture sector (worldwide importance for Norway, Greece, Ireland).

5G-SOLUTIONS – 5G Solutions for European Citizens (https://www.5gsolutionsproject.eu), presented by Andrea Di Giglio – Telecom Italia. 5G-SOLUTIONS aims to prove and validate that the 5G capabilities provide prominent industry verticals with ubiquitous access to a wide range of forward-looking services with orders of magnitude of improvement over 4G, thus bringing the 5G vision closer to realisation. The uses cases selected are related with *Factories of the Future, Smart Energy, Smart Cities, Smart Ports, Media & Entertainment.* The ICT-17 end-to-end facilities will be deployed are 5G-VINNI and 5G-EVE. The purpose is to validate and capture evidence through the relevant performance KPIs. To support network slice management, dynamic service lifecycle automation and enable automatic real-time and concurrent orchestration across the 5G-EVE and 5G-VINNI facilities, the CDSO based on NOKIA's CBND will be leveraged, to bind all 5G-related services to be piloted and to control their flows.

5G!Drones - Unmanned Aerial Vehicle Vertical Applications' Trials Leveraging Advanced 5G Facilities (https://5gdrones.eu), presented by Jussi Haapola (University of Oulu). The selected use case scenarios include UAV traffic management, Public safety / Saving lives, Connectivity during crowded events and situation awareness. It aims to drive the UAV verticals and 5G networks to a win-win position, on one hand by showing that 5G is able to guarantee UAV vertical KPIs, and on the other hand by demonstrating that 5G can support challenging use-cases that put pressure on network resources, such as low-latency and reliable communication, massive number of connections and high bandwidth requirements, simultaneously. 5G!Drones will build on top of the 5G facilities provided by the ICT-17 projects and a number of support sites, while identifying and developing the missing components to trial UAV use-cases. It will feature Network Slicing as the key component to simultaneously run the three types of UAV services on the same 5G infrastructure (including the RAN, back/fronthaul, Core), demonstrating that each UAV application runs independently and does not affect the performance of other UAV applications, while covering different 5G services.

5G-VICTORI - Vert**I**cal demos over **C**ommon large scale field **T**rials f**O**r **R**ail, energy and media **I**ndustries, presented by Jesús Gutiérrez, IHP GmbH. Its main goal is to conduct large scale trials for advanced use case verification in commercially relevant 5G environments. 5G-VICTORI will conduct large scale trials for advanced

vertical use case verification focusing on Transportation, Energy, Media and Factories of the Future and cross-vertical use cases. It leverages 5G network technologies developed in 5G-PPP phase 1 and 2 projects 5G-XHaul and 5GPICTURE and exploits extensively existing facilities interconnecting main sites of all ICT-17 infrastructures i.e. 5G-VINNI, 5GENESIS and 5G-EVE and the 5G UK test-bed in a Pan-European Infrastructure. It will provide enhancements of existing infrastructures towards integration of a large variety of vertical and cross-vertical use cases. 5G-VICTORI's platform aims to transform current closed, purposely developed and dedicated infrastructures into open environments where resources and functions are exposed to ICT and vertical industries through common vertical and non-vertical specific repositories. These functions can be accessed shared on demand and deployed to compose very diverse set of services in a large variety of ecosystems.

5Growth - 5G-enabled Growth in Vertical Industries (http://5growth.eu/), presented by Carlos J. Bernardos (UC3M). Its main objective is the technical and business validation of 5G technologies from the verticals' points of view, by performing field-trials on 4 vertical sites and the leverage on the results of 5G-PPP Phase 2 projects, mainly 5G-TRANSFORMER. 5Growth will deploy two ICT-17-2018 5G End-to-End platforms: 5G EVE and 5G-VINNI. 5Growth aims to perform real field trials involving customer sites of four vertical locations in Portugal, Spain & Italy, which requires the development, installation, validation and testing of pre-commercial 5G radio, transport and core technology in vertical sites, connected via the ICT-17 platforms. To empower vertical industries, such as Industry 4.0, Transportation, and Energy with an AI-driven Automated and Shareable 5G End-to-End Solution.

EuWireless: Design of the European mobile network operator for research (https://www.euwireless.eu), presented by Pedro Merino from Univ. of Malaga. EuWireless is a Design Study funded from Research Infrastructures aiming to design a pan-European infrastructure to support research in mobile communication networks using licensed spectrum. Its relevant technical contributions includes multi-domain with distributed peer-to-peer orchestration, recursive definition and implementation of slices to create the EuWireless slice on demand, uniform approach to expose resources from MNOs (spectrum, ..) and uniform approach to double authentication of users with SIM+Eduroam credentials.

5GINFIRE Platform: A facility for end-to-end 5G experimentation (https://5ginfire.eu), presented by Dr.-Ing. Halid Hrasnica from Eurescom GmbH. 5GINFIRE aims (1) to design and operate flexible 5G-NFV-based experimental facilities for exploring softwarized architectures of vertical industries and related applications and services through enabling end-to-end 5G experimentation and creating a playground for vertical industries and (2) to evolve FIRE arena into a 5G-oriented experimental playground for vertical industries. Initial experimental instances in 5GINFIRE driven by automotive and smart cities sectors. Design, integration, and operation of 5GINFIRE components and infrastructure along on-going standardization and open source activities (Open5G-NVF based) as well as 5G/5G PPP. Community involvement through additional infrastructures and functionalities and 5GINFIRE validation through experimentation and results.

Based on the two workshops outcome and the discussion that have taken place during this period, a first white paper will be issued with recommendations regarding the next phase and planning of activities.