HORIZON 2020
ICT - Information and Communication Technologies

Deliverable D4.4
Report on organisation of events and engagement activities

Project Acronym:	**EMPOWER**
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Executive Summary

This document reports on the organisation of EMPOWER events and engagement activities within the first 18 months of the project. During this period, the different activities for engaging the community were planned and discussed within the EMPOWER group. The tools includes site visits, short and medium mobility and hackathons and tutorials.

Within the reporting period, the following EMPOWER events were organised:

- EMPOWER-PAWR meeting, Paris (FR), 29 April 2019 (co-located with INFOCOM 2019);
- EMPOWER-PAWR workshop, during EuCNC 2019, Valencia (ES), 18 June 2019;
- EMPOWER booth at EuCNC 2019 conference, jointly with PAWR, and the activities of both initiatives demonstrated;
- EMPOWER-PAWR workshop that took place during the GEFI 2019 conference held in Coimbra (PT) on 7-8 November 2019.
- US-EU visits that took place the first week of March. US delegates visited Madrid (ES) and Sophia-Antipolis (FR) sites. In addition, a visit has also been scheduled in Oslo (NO), but it has been finally cancelled due to the burst of COVID-19 outreach. The output of these first site visits was positive and useful for the US delegation. The main objective of those visits will be to allow the EMPOWER community to learn more about 5G and B5G platforms on both sides of the Atlantic. The site visits in the USA will be rescheduled, when the global situation will allow safe travel.

In addition, EMPOWER contributed/participated in several relevant international events, such as INFOCOM 2019 (EMPOWER-PAWR joint panel), the Mobile World Congress in Barcelona, the IEEE-ICC in Shanghai, the 6G Wireless Summit in Finland, etc. The detailed list is included. Finally, the EMPOWER strategy for future events is initially presented.

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1. Introduction

EMPOWER has the ambition to accelerate the joint development between the EU and the US of advanced wireless platforms targeting the new connectivity frontiers beyond 5G. The overarching aim of EMPOWER is to reinforce the cooperation between the EU and the US towards establishing a collaborative transatlantic community on the new connectivity frontiers beyond 5G with the ambition to accelerate the joint development of the associated advanced wireless platforms.

EMPOWER acts as a catalyst for promoting EU-USA technology and test platforms in industry-driven events such as ONS, OPNFV Summit, TIP Summit, MWC as well as high profile IEEE and ACM conferences. Specifically, it will coordinate the preparation of selected demonstration targets for these events with the technical teams from its companion projects.

This document reports on the organisation of EMPOWER events and engagement activities within the first 18 months of the project.

EMPOWER engagement activities and events are affected by the recent restrictions applied in travel and physical presentation by the COVID-19 outbreak. The organisation of events are facing some limitation in EMPOWER team. Solutions and alternative methods for engaging the community are discussed and planned, such as the virtual organisation of events and meetings. The document presents the strategy for the organisation of the future events, especially during the COVID-19 situation.

1. EMPOWER Events

EMPOWER community building tools have been defined and the following workshops and event took place during the reporting period:

- A workshop was co-organised with PAWR in parallel to INFOCOM, on 29th April in Paris.
- A workshop was co-organised with PAWR on 18th June, during EuCNC 2019, Valencia.
- EMPOWER-PAWR joint booth within EUCNC 2019, where the PAWR nodes presented their work and results.
- The GEFI2019 workshop, co-organised by EMPOWER and PAWR on 7-8th of November 2019, in Coimbra.

1.1 EMPOWER-PAWR joint meeting – Paris, 29th April 2019

Summary: This first joint meeting between the EMPOWER project and the US-based PAWR program took place in Paris, in parallel with IEEE International Conference on Computer Communications (IEEE INFOCOM).

Figure 1 - EMPOWER-PAWR joint meeting

The main objective of the joint meeting was liaised key persons in Europe and USA to share information and start discussing possible joint activities related to advanced wireless platforms at both sides of the Atlantic towards 5G and beyond 5G technologies. In addition, the ongoing work of the three ICT-17-2018 projects (5G-EVE, 5G-VINNI, 5G-GENESIS) and the ongoing NSF PAWR projects (COSMOS, RENEW, POWDER) were presented. Each of these projects shortly highlighted the services provided by their projects, the infrastructure available at this stage and their roadmap.

Those presentations were followed by two sessions aim at exploring potential lines of joint activities. The first one, "Joint collaborative activities", was focused on Software component store, Open Source Domain Analysis and Joint and Cross-Platform Experimentation; and the potential to use ICT-17/19/20 (and beyond) and PAWR nodes in order to bring forward the joint research and ideas via industry driven initiatives The second one dedicated to EMPOWER Advanced Roadmap was the opportunity to exchange about future technical areas on the path of 5G evolution and the associated experimental challenges.

Figure 2 - EMPOWER-PAWR Panel – INFOCOM 2019

Extensive discussions followed, demonstrating joint interest, even if ICT17 and PAWR have different approaches and objectives. EMPOWER's mission is also to liaise US and EU on advanced wireless platforms reaching out to a broader community (e.g. not restricted to ICT17 and PAWR invited to this first event).

In addition to this joint meeting, EMPOWER and PAWR also chaired a panel during the INFOCOM conference, titled "Panel B: Experimentation Meets Platforms: A Survey of Macro Trends in Mobile Communication Research and Its Impact on Future Testbed Development".

Outputs: This first joint meeting was the opportunity for the participants to know each other and to better understand the goals, the characteristics and the services provided by the different infrastructures. Among the lessons learnt, it came up that the PAWR and ICT-17 platforms have different targets and missions but they all shown some potential common interests. Indeed, PAWR focuses in pure research and the first PAWR nodes are oriented beyond 5G while ICT-17 platforms are demonstrating 5G and the focus is mostly deployment. ICT-19 addresses verticals landing on ICT17 infrastructures. Regarding the two new PAWR platforms (phase 2), they are driven by

applications providing a big potential for deployment, which means that are closer to vertical sectors. In this context, the EMPOWER's role of catalyst is essential to promote joint experimentations, facilitating the exchange of detailed and practical information between both sides, and facilitate the exchange of knowledge in order to reinforce the commonalities between PAWR projects and ICT-17/19.

Based on the above-mentioned outputs, it has been agreed to explore two complementary activities:

1. *Sharing practices and solutions:* EMPOWER/PAWR are willing to propose **site visits** to US and EU delegates with the objective to go into more details and therefore, be in a position to better identify potential opportunities for cooperation.
2. *Exploring E2E system level:* This part aims at questioning how to set-up and E2E open reference architecture. This might be a concern of mutual interest as it goes beyond the wireless specific hardware components and target the issue related to the E2E architecture that should be encountered by most projects.

The main topics of the following joint workshop (Radio OAI/O-RAN, ONF/OMEC Edge, NFV open framework) have been also defined at this occasion.

1.2 EuCNC workshop – Valencia, 18th June 2019

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

Summary: Following the joint work started in the meeting, collocated with INFOCOM 2019, this workshop started by a session focused on exploring E2E system level, as agreed in Paris' meeting. The big question would be how to set-up an E2E open reference architecture, considering this might be a concern of mutual interest for Europe and the USA as it goes beyond the wireless specific hardware components and target the issue related to the E2E architecture that should be encountered by most projects. In this context, the workshop participants brainstormed and exchanged on the role of Open Source for experimentation, production and infrastructures, paying special attention to radio platforms (use of OAI/O-RAN or other platform), core platforms (possible use of ONF/OMEC) and the need of a NFV open framework to provide a relevant test framework and toolset to perform tests. One of the round tables was dedicated to the challenges for Beyond 5G wireless Technologies, with the participation of representatives of ICT-17, NSF PAWR projects and other stakeholders, who discussed on the future of the platforms and their technology evolution. Followed by the presentation of several platforms, the workshop ended with an open discussion on how to best address the vertical experimentation and requirements. Here is the list of platforms and projects presented during this workshop: 5G-EVE, 5G-VINNI, 5GENESIS, 5Growth, 5G-Tours, 5G-Solutions, 5G-HEART, 5GINFIRE, 5G!Drones, 5G-VICTORI and EuWireless**.**

Figure 3 - EMPOWER-PAWR EuCNC workshop

Outputs: The discussions of this second EMPOWER workshop were fruitful and confirmed the common interest of both EU and US projects to collaborate in the field of Advanced Wireless Platforms in 5G and beyond 5G technologies. The main output of this workshop was the publication of a White Paper prepared by EMPOWER's partners and peer-review by the members of the Advisory Board. The aim of this document is to propose recommendations regarding the next phase and planning of activities.

1.3 GEFI workshop

Following the two first workshops organised in Paris and Valencia, a third workshops took place on 7th and 8th November, 2019, in Coimbra (PT). This joint event was organised in collaboration with the PAWR office, in the framework on the Global Experimentation for Future Internet (GEFI).

Figure 4 - View of the workshop

As defined on the conference website[1], "the Global Experimentation for Future Internet (GEFI) community connects researchers and research sponsors in the EU, US, Japan, Korea, and Brazil to advance international collaboration for experimental research in future networks. GEFI 2019 is the third workshop in the GEFI series, which expands on several previous bilateral and regional international collaborations. Potential participants in GEFI 2019 are invited to submit position statements and proposed session topics".

Figure 5 - Abhimanyu Gosain (PAWR office) presenting PAWR initiative

Inviting stakeholders from the US and EU to GEFI, not only to the workshop itself but also to present a position statement, was a significant opportunity to go further into the discussions.

This event took place in a nice environment and was the perfect opportunity to present and discuss about the first results of the project (i.e. White Paper) not only the EU and US but also to participants from Brazil, Japan and Korea. Generally speaking, this workshop was a real success and its outputs are fruitful for EMPOWER project.

Moreover, GEFI conference was also the scenario for the ICE-T's meeting which took place in parallel to the EMPOWER's one. Promoted by the NSF and DG CONNECT, ICE-T[2] project is another EU-US initiative which aims to enable US and EU researchers to collaborate to address compelling research challenges in NGI and AWN. To do so, ICE-T program provides support to the researchers thanks to three types of awards: Research Collaboration; Research Collaboration Initiation; Research Fellowships.

1.4 Events that EMPOWER participated and disseminated its activities and results

In the following table the events that EMPOWER participated and disseminated its activities and results are listed.

Table 1 - List of events

EVENT NAME	RELATION TO EMPOWER	DATES	PLACE	OUTPUTS
PAST EVENTS				
IRACON Cost Action meeting	EMPOWER presentation by Per H. Lehne, Telenor Research.	16-18 Jan. 2019	Dublin, Ireland	During this meeting, EMPOWER was presented and the interest of the consortium to collaborate with IRACON was stressed. This collaboration would be particularly fruitful for the activities

[1] https://indico.rnp.br/event/1/, visited on 10th October 2019.

[2] US-EU Internet Core & Edge Technologies (ICE-T), https://nsf.gov/funding/pgm_summ.jsp?pims_id=505516, visited on 7th November 2019.

				carried in WP2, about technology roadmap. The COST meeting was preceded by a joint workshop with the MSCA Action "WaveCombe", which focusses on mm-wave communications. In the WG-group sessions of IRACON, almost 90 presentations ("TD") were held. Two issues, of potential interest for EMPOWER, were discussed: 1. Possible collaboration in order to create a vision "Beyond 5G", and address technology challenges in this domain. This would be particularly interesting for the research roadmap. 2. Organisation of a joint workshop between IRACON and EMPOWER. The discussions around both issues are still ongoing and no decision has been taken so far.
MWC19 Barcelona	EMPOWER represented in 3 panels.	25-28 Feb. 2019	Barcelona, Spain	Attended yearly by more than 100k attendees, the Mobile World Congress is the biggest worldwide mobile fair. During the last edition, EMPOWER project was represented by some of the project partners, in 3 panels titled: 1. How Will Open Source Play a Role in the Evolving 5G Ecosystem? 2. Beyond 5G: What is Coming Next? 3. How Far Can Edge Computing Take Us to a New Network Architecture? Abhimanyu Gosain, from PAWR office, also attended two of the panels mentioned above, demonstrating the common interest of EMPOWER and PAWR in taking part to international discussions on 5G and beyond 5G technologies. The potential impact of the participation of MWC19, in term of visibility for EMPOWER, is high.
IEEE – 6G Wireless Summit	EMPOWER presentation by Alain Mourad, InterDigital.	24-26 Mar. 2019	Levi, Finland	With around 300 attendees, from 29 different countries, "*the first 6G Wireless Summit launched the process of identifying the key drivers, research requirements, challenges and essential research questions related to 6G*"[3]. Alain Mourad's presentation focused on showing the whole vision about EMPOWER. What the projects looks for and how could EMPOWER procure the purpose of broad relation collaborations from other entities and testbeds. In addition to this presentation, Alain Mourad took this opportunity to do networking and tied a new link with the 6G community. For instance, the 6Genesis initiative is particularly interested in aligning its activities with EMPOWER roadmap: the first step to reach that was to

[3] Latva-aho, Matti and Leppänen, Kari, *Key drivers and research challenges for 6G ubiquitous wireless intelligence*, Oulun yliopisto, September 2019.

				invite them to the INFOCOM joint meeting and panel. In parallel, a contact was established with the joint TEKES-NSF programme Wireless Finland-US (Wi-FIUS), whose goals are similar and aligned with to EU-US EMPOWER's one. Last but not least, Alain Mourad has also engaged in the work 6Genesis is planning on the 6G research agenda (due in 2019). This will provide EMPOWER with nice alignment opportunity and feed inputs into the WP2 activities.
IEEE INFOCOM 2019	Joint meeting with PAWR and panel chair	1 May 2019	Paris, France	In addition to the above-mentioned joint meeting, EMPOWER and PAWR chaired a panel during the INFOCOM conference. Title: "*Panel B: Experimentation Meets Platforms: A Survey of Macro Trends in Mobile Communication Research and Its Impact on Future Testbed Development*". "Softwarization" is often referred to as a general paradigm shift in telecom architecture from "boxes" to "functions", and from "protocols" to "APIs". This has profound impact on research testbed platform architecture and its components. The panel begun with exploration of such fundamental advances at all layers and by delving into investigations of the research infrastructures suitable for hosting at-scale experimentation in future mobile architectures, services, and applications, and use of such infrastructures for experimental research using practical examples. The distillation of the lessons learned above are laid out as requirements for future at-scale platforms[4]. Moderated by Sorbonne University (EMPOWER coordinator) and Abhimanyu Gosain (PAWR office), the panelists were representatives of EMPOWER (Raymond Knopp from EURECOM and Alain Mourad (Interdigital, UK) and PAWR funded projects: Edward Knightly from Rice University ; Ivan Seskar from Rutgers University and Kobus Van der Merwe from University of Utah, who represented RENEW, COSMOS and POWDER. They gave a global view of efforts underway to implement platforms for experimenting on 5G and Beyond Technologies across radio, network and compute to be built on top of convergent RF/network/IT infrastructure to provide well defined abstractions and modularity to end users (e.g. researchers, developers and testers).
Wireless World Research	EMPOWER presentation by	15-16 May 2019	Tokyo, Japan	Wireless World Research Forum plan to foster an international discussion through 5G. Different countries from Europe, America, Africa and Asia participate in the effort to roll out 5G

[4] https://infocom2019.ieee-infocom.org/panels, visited on 7th October 2019.

Forum Meeting 42	Alain Mourad, InterDigital.			technologies, and an ongoing debate as to how to meet the requirements of the various vertical industries that will make use of 5G. During his presentation, Alain Mourad gave an overview of EMPOWER objectives, stressing the work currently implemented to define the B5G Technology Roadmap. The main objective of this presentation was not only to present EMPOWER but also to invite WWRF attendees to collaborate with our EU-US initiative.
3rd Future Network Development Conference	EMPOWER presentation by Serge Fdida, Sorbonne Université	22-23 May 2019	Jiangning Nanjing (China)	Prof. Serge Fdida was one the speakers of the 3rd Future Network Development Conference, organized on 22-23 May 2019 in China (number of attendees > 3,000). His presentation (title: The Disappearing Internet) was the opportunity to present to the community the current situation in Europe and EMPOWER, as one of the European initiatives taking part in the international dialogue for the future network, was included in his presentation. The main input for EMPOWER is the visibility provided by the attendance to this conference at international level.
IEEE International Symposium on Local and Metropolitan Area Networks	EMPOWER has been invited to give a talk.	1-3 Jul. 2019	Paris, France	The IEEE International Symposium on Local and Metropolitan Area Networks aims to present and discuss the latest technical advances in local and metropolitan area networking, bringing together researchers and practitioners in the field. Organised in 2019 in Paris, Prof. Serge Fdida, coordinator of the project, chaired the Keynote #1 related to "*The need for a research infrastructure in digital sciences*". The presentation highlighted the main approaches and solutions currently being deployed and discussed the various challenges and concerns regarding the design and usage of research platforms. The talk will be illustrated with examples taken from various projects (EMPOWER was cited). This presentation gave visibility to EMPOWER initiative towards the community.
IEEE World Forum	EMPOWER presentation by Alain Mourad, InterDigital.	1 Oct. 2019	Dresden, Germany	Alain Mourad represented EMPOWER taking part to the panel titled "*Industry Panel: Industry Perspectives for AI Applications in Future Wireless Communication Systems*". Organised in the framework of the IEEE 2nd 5G World Forum, the aim of this panel was to bring out the view from industry on AI/Machine Learning applications as a means to derive desired 'intelligent' outcomes based on the insights developed and address issues with the expected complexities in future wireless systems[5].

[5] https://ieee-wf-5g.org/industry-panels-industry-perspectives-for-ai-applications-in-future-wireless-communication-systems/, visited on 7th October 2019.

43rd Meeting of WWRF	Attendance of EMPOWER's partners.	October 9-10, 2019	London, UK	Charles Turyagyenda, from Interdigital, attended this event and represented EMPOWER project. The 43rd meeting of Wireless World Research Forum (WWRF) was dedicated to "Intelligent Applications for a 5G Connected World". The main topics of the discussions were related to Smart Cities, Smart Connected Farming, Smart Mobile Health, Connected Vehicles, Smart Logistics.
EU-Taiwan Workshop	Presentation of EMPOWER from Alain Mourad	October 31, 2019	Taipei	Alain Mourad presented: B5G Technology Roadmap. The presentation focused on the introduction to EMPOWER, the baseline of the EMPOWER Technology Roadmap and followed by the Next Steps.
6G Summit	Presentation of EMPOWER from Alain Mourad	16-17/3/2020	Virtual event	Alain Mourad presented: The Path to 6G – Performance Targets and Technology Enablers. The EMPOWER Technology roadmap presented as well the first results and insights of the EMPOWER consultation.

At this point, it should be mentioned that several events were planned and organised, however they have been cancelled due to the COVID-19 outbreak last February. A list of events are depicted below:

Table 2 - List of cancelled events due to the outbreak of COVID-19

EVENT NAME	RELATION TO EMPOWER	DATES	PLACE	OUTPUTS
CANCELLED EVENTS due to the outbreak of COVID-19				
Mobile World Congress 2020	EMPOWER planned to be presented in 2 panels.	February 24-26, 2020	Barcelona, Spain	InterDigital was organising the following two panels that were related with EMPOWER. The EMPOWER technology roadmap and its consultation was planned to be presented. However, due to the COVID-19 outbreak the MWC was cancelled. • Monday, February 24th, 2020: What Do We Need to Do to Get 5G to Really Support AI and Machine Learning? • Tuesday, February 25th, 2020: Collaboration in the Open Source Ecosystem
EUCNC 2020	EMPOWER planned to be presented at a workshop.	June 16-17, 2020	Dubronvic, Croatia	EMPOWER was part of the workshop titled: Workshop on B5G key technology planning for EC collaboration with other geographical regions (B5G-COLAB). Alain Mourad planned to present the technology roadmap. However, due to the COVID-19 outbreak, EUCNC2020 will be organised virtual only the main conference and not the workshops.
INFOCOM2020	EMPOWER planned to organise a panel	Initially April 2020, now virtual June 2020	Initially in China, then moved to Toronto	EMPOWER planned to organise a panel on reproducibility.

2. EMPOWER site visits

During the workshops' discussions, it came out that it would be interesting for the community to organise site visits in both Europe and the USA. The aim of these visits is to give a first-hand view of the different approaches considered on both sides of the Atlantic, understanding the strong and weak points of the different strategies followed by the different sites. The visits will consider all the experimental facilities discussed in the 5G-PPP Trials WG, with a starting point on the 5G-PPP Experimental Facilities Cartography.

EMPOWER organises together with PAWR, site visits in both Europe and the USA. The aim of these visits is to give a first-hand view of the different approaches considered on both sides of the Atlantic, understanding the strong and weak points of the different strategies followed by the different sites. The visits will consider all the experimental facilities discussed in the 5G-PPP Trials WG, with a starting point on the 5G-PPP Experimental Facilities Cartography. The main objective is to strengthen cooperation between the European Union and the US, setting a collaborative transatlantic community on the new connectivity frontiers beyond 5G, with the ambition to accelerate the joint development of the associated advanced wireless platforms.

The planned visits are bi-lateral, a delegation from PAWR and NSF is coming to Europe to meet the selected facilities (Madrid, Sophia Antipolis and Oslo) and discuss experimentation with some of the scientists running them. In the same way, European scientists will travel to the USA to meet the PAWR facilities.

2.1 US-EU visit, Aveiro, November 2020

A first visit took place on 6th November, in Aveiro (Portugal) for the US delegation, which included:

- Abhimanyu Gosain, Technical Program Director, PAWR Project Office
- Rudra Dutta, North Carolina State University. AEPRAW
- Deep Medhi, Program Director, National Science Foundation
- Ivan Seskar, Rutgers University, COSMOS

The idea was to take advantage of the GEFI workshop and the fact that many PAWR facilities' representatives were in Europe to arrange a tour at one of the 5G-VINNI experimentation facilities. This facility is hosted by Altice Labs (ALB) and Instituto de Telecomunicações (IT)[6]. The agenda of the meeting included the following items of discussion:

- NSF introduction
- PAWR presentations
    - Project overview
    - COSMOS, NYC
    - AERPAW, North Carolina
- 5GinFire and EU ICT project overview
- Site and Lab visit

2.2 US-EU visit, March 2020

A delegation from PAWR and NSF planned to come to Europe to meet the selected facilities (Madrid, Sophia Antipolis and Oslo) and discuss about experimentations with some of the scientists running them. The visit was planned the week of 9-13 March 2020. Unfortunately, due to the COVID-19 outreach,some of the US participants cancelled their physical presence at the last moment anda, the visit to Oslo has been cancelled, since it was the last day for US researchers to travel back to the US. Nevertheless, it is important to highlight that the US

[6] https://www.5g-vinni.eu/portugal-experimentation-facility-site/, visited on 7th October 2019.

delegates who couldn't attend physically the visits followed remotely the discussions. The delegation from US included the following experts (participated physically or virtually):

- **Tommaso Melodia** is the William Lincoln Smith Professor with the Department of Electrical and Computer Engineering at Northeastern University in Boston. He is the Director of the Institute for the Wireless Internet of Things and the Director of Research for the PAWR Project Office.
- **Abhimanyu (Manu) Gosain** is a Senior Technical Program Director for PAWR and Director of Industry Engagement for Institute of Wireless Internet of Things at Northeastern University.
- **Ivan Seskar** is the Chief Technologist at WINLAB, Rutgers University responsible for experimental systems and prototyping projects. He is currently the program director for the COSMOS project responsible for the New York City NSF PAWR deployment.
- **Dustin Maas** is a research associate and wireless software engineer in the Flux Research Group at the University of Utah, where he is working to integrate LTE stacks like OpenAirInterface into the POWDER platform.
- **Yufeng Xin** is a senior researcher and assistant director of network research and infrastructure at RENCI, University of North Carolina at Chapel Hill, involved in AEPRAW platform.

The first stop was Madrid and **5TONIC**, the open research and innovation laboratory on 5G technologies, founded by Telefónica and IMDEA Networks, received a US researchers' delegation this morning. The agenda of the meeting is attached in Annex I.

Second stop was Sophia Antipolis and EURECOM, where **5G-EVE** facility is available. The agenda of the meeting is attached in Annex II.

Third stop was planned to be Oslo and **5G-VINNI** Norwegian Facility which is managed and hosted by Telenor Research, where different demos on how use cases are implemented and tested on the platform were shown to the US delegation.

2.2.1 Madrid visit

Figure 6 - US delegation in 5TONIC, Madrid

A summary of the activities during the visit in Madrid follows below:

The event started with a presentation of IMDEA and 5TONIC from Prof. Arturo Azcorra. Issues such as mmwave for access and if 5TONIC plans to add it are discussed. Interesting work in the real time control of robots presented and followed by discussion on the notion of real time for the TCP/IP, there is no notion of time on the protocols and this may be an issue. Discussion on the ASCI robots and tolerance to delay, what is the impact in the loop. In addition, trends towards the deployment of 5G SA were discussed, as well as its future deployment that researchers believe that there will be no two networks in parallel (NSA/SA). It was agreed that 4G is not directly upgradable to 5G and that with NSA, it needed 2 base bands that cannot be aggregated. Questions followed the FTEs dedicated to 5TONIC and how is the work organised and how 5TONIC handles conflicts.

The meeting was followed by demonstrations from IMDEA on Millimeter-Wave Experimentation Platforms: From Narrowband to Ultra Wideband MIMO Systems – Joerg Widmer Group (Presentation + demo 30 min), which seems that COSMOS already includes some mmWave thing coming from Joerg group. It was agreed that this

Figure 8 - Millimeter-Wave Experimentation Platforms

Figure 7 - IMDEA demo on Millimeter-Wave Experimentation Platforms

can be accounted as a join promoted activity by EMPOWER. A presentation from Domenico Giustiniano of the research in Visible Light Communication Systems and demonstration of OpenVLC (openvlc.org) followed with a demo about video streaming using embedded Linux boards and low cost Visible light communication hardware for IoT applications.

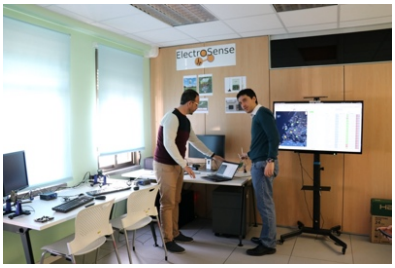

Figure 9 - Electrosense presentation

A presentation and demonstration of Electrosense (electrosense.org) from Domenico Giustiniano followed. The presentation focused on crowdsourced spectrum data analytics with low-cost spectrum sensors and big data architecture. The demonstration showed the new capabilities of the system, with real-time decoding of spectrum data to provide incentives to users.

The discussion was based on how to use the data received and problems with personal information, the way that datasets that can be generated and on the google balloons and how we can connect to that. Interaction between electrosense and Coliseum was discussed and how to feed the data to channel emulator and to provide a channel with real data for emulation, that can be a joint activity from promoted by EMPOWER. Finally, Cosmos can use electrosense by providing a huge based of sensors.

The meeting continued with the presentations on European Research projects and initiatives.

- Didier Bourse from Nokia presented the EC H2020 5G Infrastructure PPP Programme and Projects and the key question on how ICT17 and ICT19 projects can inter-operate. It was pointed out that in USA the main problema is how industry can provide end to end connectivity that is not base not only on hardware.
- Alain Mourad from InterDigital presented the Experimental Platform for 5G Industry Verticals. The presentation followed by questions on connectivity of sites
- Perdo Merino from Univ of Malaga presented the ICT-17 Platform 5GENESIS. The discussion continued with issues of repeatability on the scenarios, their deployment and the relevant KPIs. In addition, issues of architecture discussed. It is important to mention the business use case of infrastructure/software renting in order to perform specific experiments that explain how to build an infrastructure out of distributed resources. Experimentation framework of 5GENESIS could be exploited for other projects, while currently an attempt to expose this to COSMOS is on-going.
- Carmen Guerrero presented the ICT-17 Platform 5G-VINNI, the plans for its sustainability and the role of testing equipment company in the open source of the projects. The 5G-VINNI Demo on Model-based Telemetry for KPI measurement presented by Sonia Fernández (Telefonica R+D) and Adrian Gallego (UC3M). A comparison of metrics between ICT17 and PAWR projects discussed. 5G-VINNI Demo on First steps on Testing as a Service: OpenStack OpenTAP plug-in in 5TONIC Spain Facility organised by Adrian Gallego in collaboration with Keysight, UC3M. Discussion followed on OpenTAP and how do implement that in the hardware, how much nodes with this implementation needed.
- 5G-EVE presented by Pablo Serrano (UC3M). The issue on the interconnectivity of the platforms was raised, since there are a lot of hidden problems while interconnecting this kind of platforms, ARP storms, etc. The 5G EVE Portal and Validation Framework demonstrated by Ginés García (UC3M). Issues such as the format of the blueprint, the matching between the vertical needs and the blueprints, the effort on deploying experiments were discussed. In addition, discussion follow on integration of OpenTAP everywhere, on adding a new interface per platform that talks a northbound interface common to all, on the comparison of the three ICT-17 infrastructures. Finally, the issue of access to the portals from USA researchers was pointed out. Ignacio Berberana (5TONIC) demonstrated 5G EVE Industry 4.0 and low latency.

Possible collaboration discussed with the specific projects. Some key points follows:

- Combine experiment 5GENESIS framework used to manage some nodes in COSMOS, two ways: VPN and run it as is, or second establish a proper link between GEANT and others to have some resources. Further in the roadmap is to have an experiment installing the framework there. COSMOS working with 5GENESIS to export its experimental framework and maybe control something remotely. Possible EMPOWER activity
- Collaboration with EMPOWER. PAWR projects are already recording webinars on how to use the different platforms. Practically, EMPOWER can serve as a neutral playground to have webinars of all platforms

- Collaboration with 5G-VINNI. Status of the intercontinental slice with ARENA (USA). The idea is to setup an NSA network with the core in 5tonic and the gNB in ARENA. Current tests show 280ms as the maximum delay for MME connectivity.
- Collaboration with 5G-EVE is possible on the deployment of North Carolina. 5G EVE has developed some scripts to record measurements and export KPIs, which is something that might be replicated in other testsites. 5G EVE currently has not implemented anything specific for low latency, since they have increased the carrier separation up to 30K. PAWR partners are interested in radio slicing and may be in portal and the monitoring framework. FABRIC, which an NSF project aiming to interconnect dedicated big datacenters for data analysis and PAWR infrastructures are going to become edge nodes, so full connectivity via ultra fast connectivity. Collaboration is open specifically for the interconnection of sites.

A demonstration on vrAIn Proof-of-Concept that is a Deep Learning Approach for Virtualized RAN Resource Control organised by Marco Gramaglia (UC3M), while a video demo of Robot deployment at shopping mall in Taiwan and a video demo about next generation eHealth services organised by Antonio de la Oliva (UC3M).

2.2.2 Sophia Antipolis visit at 5G EVE FACILITY

On 11th and 12th March, a delegation of researchers representing the NSF, the National Science Foundation of the United States, visited the French 5G EVE site facility, EURECOM's open5GLab in Sophia Antipolis. The visit of the US researchers was the second in a series of planned visits to several European research facilities involved in the 5G PPP infrastructure projects. The NSF delegation consisted of Abhimanyu (Manu) Gosain, Technical Program Director of the PAWR Project Office (https://advancedwireless.org) who also acts as the liaison with other large-scale NSF projects, and Ivan Seskar, Program Director of the COSMOS Project (https://www.cosmos-lab.org). A remote-session with representatives of the POWDER and AERPAW Projects was organised on the 12th of March.

Figure 10 - Two views of the 5G-EVE French Facility in Sophia Antipolis (EURECOM)

The two-day visit started with presentations by the managers of the French 5G-EVE facility and Sophia Antipolis site, Rodolphe Legouable (Orange) and Raymond Knopp (EURECOM), on the project status and French facility capabilities. This was complemented by Adlen Ksentini (EURECOM), the manager at EURECOM for the 5G!DRONES ICT-19 project, who presented a use case of the 5G-EVE Sophia Antipolis site, namely 5G-Slicing for UAV communications. Francesco Mani (EURECOM) followed with a presentation of the current status of the OpenAirInterface (OAI) open-source 5G implementation followed by live demonstrations of outdoor 5G links using the OAI RAN and Core on the 5G-EVE facility. Navid Nikaein (EURECOM) presented an additional demonstration of Kubernetes Operator-based deployment of OAI.

The participants from the US and Europe discussed several collaboration opportunities at the meeting aiming at mutualisation of USA PAWR resources. These included for testing OAI-based solutions for 5G deployments at POWDER and COSMOS, integration of OAI RAN and Core software with ONAP infrastructure at COSMOS, and

replication of 5G NR FR2 (mmWave) configurations currently used at the French 5G-EVE facility at all the PAWR sites in the USA.

2.2.3 Oslo visit

The final stop was planned to be Oslo and **5G-VINNI** Norwegian Facility which is managed and hosted by Telenor Research, where different demos on how use cases are implemented and tested on the platform were shown to the US delegation. Unfortunately, this part of the visit had to be cancelled, due to COVID-19 outbreak. The agenda of the meeting is attached in Annex III. It should be noted that on 12th of March a rehearsal of the meeting was organised as depicted from the following photos.

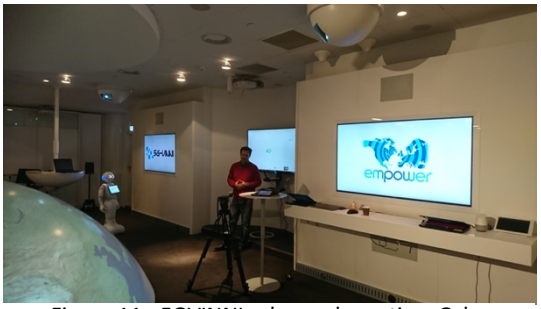

Figure 11 - 5GVINNI rehearsal meeting, Oslo

Figure 12 - 5GVINNI rehearsal meeting, Oslo

In addition, 5G-VINNI still ran the planned demos on the 13th March via webex. Recordings were made, and after some editing, they are available on Youtube. There are three demos available:

- 5G VINNI demo day for US visitors Topology and Network Slices: https://youtu.be/7doqYa3DAC4
- 5G VINNI demo day for US visitors Service Orchestration: https://youtu.be/Koe7GA4bbcc
- 5G VINNI demo day for US visitors Defence use case: https://youtu.be/XQajYCAtQIM

2.3 EU-US visit

The EU-US visit was initially planned to the PAWR sites during the 18/05 week. Due to the COVID-19 outbreak, EMPOWER and PAWR had to postpone the visit to a later stage that the pandemic situation will be solved and travel from Europe to US will be safe and allowed.

The main focus of the EU delegation visit to US is described as follows:

- The EU / EC / PPP Visit to US / NSF (PAWR) Platforms was planned to be organized during the week of 18.05.20. The potential Platforms to be visited are related to COSMOS, POWDER and AERPAW Projects (https://advancedwireless.org/).
- Discussions and interactions were initiated with US / NSF / PAWR colleagues. A final proposal for EU Visit based on EMPOWER and PPP Members interests related to Projects / Platforms / Nodes was planned to be prepared. The Visit was planned to be organized over 2 or 3 sites potentially sequentially or in parallel, depending on overall expressed interests and logistic possibilities/constraints.

The draft list of the delegation's participants was the following:

- Serge Fdida, University Sorbonne, Paris (France) - EMPOWER project

- Arturo Azcorra, U. Carlos III and IMDEA Networks, Madrid (Spain) - 5TONIC Laboratory, 5G-EVE and 5G-VINNI testbed projects
- Raymond Knopp, EURECOM, Nice (France) - Open Air Interface Laboratory, 5G-EVE and 5GENESIS testbed Projects
- Didier Bourse, Nokia, Paris (France) - 5G-EVE testbed project
- Pedro Merino, U. Málaga, Malaga (Spain) - Malaga testbed, 5GENESIS project
- Dimitris Tsolkas, U of Athens, Athens, (Greece) - Athens testbed, 5GENESIS testbed project
- Haesik Kim, VTT, Oulu (Finland) - Oulu testbed, 5G-HEART Vertical project

The visit will be rescheduled when the global situation will allow and guarantee safe travel.

3. EMPOWER strategy for future events

EMPOWER is planning organisation of different events for the community. At the moment the events are planned to be organised virtually and if COVID-19 situation allows, a combined participation will be foreseen.

The following three themes/challenges for joint future activities are under discussion and preparation:

- Defining a common reference architecture
- Reproducibility
- Including AI in test facilities

It should be noted the above events have been chosen as the hackathon themes. Demos will included in the implementation of the challenges.

The discussions are finalised for the Reproducibility Challenge. EMPOWER will set up a series of workshop, with regular presentation, demos, panels and discussion. These will be organized virtually but additionally collocated with conference and workshops when possible. Each event will be prepared by a small group of colleagues who will set up the agenda, organize the debate and synthesize recommendations. A continuous "challenge" will be organized with an award to recognize important "hands-on" contributions in the field with a strong emphasis on student involvement.

Topics will cover but are not limited to:

- Reproducible network and system research
- Computation and data reproducibility
- Educating the future researchers
- Open Data
- How other sciences address reproducible research
- etc.

Two virtual workshops are foreseen for September and December and hopefully a physical meeting in Europe next spring time. More details can be found at EMPOWER web-site and specifically at: https://www.advancedwireless.eu/index.php/reproducibility/

4. EMPOWER researcher mobility

The aim of the EMPOWER research mobility scheme is to enhance the community building in both sides of the Atlantic and to enhance networking and coordination of the efforts of the European and American academic and industrial research and innovation communities from advanced Wireless Platforms towards developing a roadmap for long term research and collaboration.

Research mobility is particularly important in promoting knowledge flows and ensuring a diverse and highly skilled workforce that has the capacity to respond to opportunities and challenges in EU-USA in wireless research. The goal of this integration activity is to increase ties to transnational research in advanced wireless platforms and to promote the knowledge flows and collaboration between institutions promoting new interdisciplinary academic – industrial networks.

EMPOWER planned to implement the following type of mobilities:

- 19 short research mobility
- 5 long research mobility

The following mobilities are already planned:

- Two short mobilities. One is related for a researcher from Europe (Greece) to US and one from US to Europe (Spain).
- One long term mobility and is related to a researcher from Europe (Greece) to US.

All the above mobilities will be implemented when the situation related to COVID-19 will allow travelling from EU to US and vice versa.

EMPOWER consortium agreed to support mobilities from Europe to US and some selective from US to European institutes. The application for a research mobility should include the following

- Goal of the researcher mobility
- Domain covered by the cooperation
- Relation to EMPOWER activities
- Expected impacts
- Contribution to the collaboration between EU-US

After the end of the mobility a short report should be provided.

The application for researcher mobility is included in Annex II. It is important that the researchers' mobility will support the activities of the specific WPs and will be followed by a report at the end of the mobility.

Due to COVID-19, the researchers mobility activities have been postponed to the near future and when the situation will allow travelling between Europe and US and vice versa.

5. Conclusions and next steps

This document describes the organisation of EMPOWER events and workshops from M1 to M18, as well as the events where EMPOWER presented through the participation of its members. Finally, it presents the US-EU visits that took place during the reporting period. The future activities planned to be organised by EMPOWER, will be presented in D4.2. EMPOWER will align its activities with the current situation after the outbreak of COVID-19 and will organise virtual events and workshops in order to engage the community.

ANNEX I

USA to EU scientific missions

Agenda for the visit to 5G-VINNI and 5G-EVE 5TONIC platforms

Day 1: March 9: 5TONIC, Madrid

10:00 arrival to 5TONIC

10:15 -11:00 Presentation of IMDEA and 5TONIC by Arturo Azcorra (UC3M, IMDEA, 5TONIC)

11:00 - 11:30 Coffee

11:30 - 13:00 Demonstrations

- Millimeter-Wave Experimentation Platforms: From Narrowband to Ultra Wideband MIMO Systems – Joerg Widmer Group (Presentation + demo 30 min), IMDEA
- Presentation of research in Visible Light Communication Systems and demonstration of OpenVLC (openvlc.org). Demo about video streaming using embedded Linux boards and low cost Visible light communication hardware for IoT applications – Domenico Giustiniano (20 min), IMDEA
- Presentation and Demonstration of Electrosense (electrosense.org): crowdsourced spectrum data analytics with low-cost spectrum sensors and big data architecture. The demonstration will show the new capabilities of the system, with real-time decoding of spectrum data to provide incentives to users – Domenico Giustiniano (20 min), IMDEA

13:00 - 14:00 Lunch

14:00 - 16:00 Presentations on European Research projects

- EC H2020 5G Infrastructure PPP Programme and Projects – Didier Bourse (15 min), Nokia
- InterDigital's Experimental Platform for 5G Industry Verticals – Alain Mourad (15 min, Webex), IDCC
- ICT-17 Platform 5GENESIS – Pedro Merino (20 min), UMA
- ICT-17 Platform 5G-VINNI
    - 5G-VINNI 5G Vertical Innovation Infrastructure project presentation – Carmen Guerrero (20 min), UC3M
    - 5G-VINNI Demo on Model-based Telemetry for KPI measurement – Sonia Fernández (Telefonica R+D) and Adrian Gallego (UC3M) (20 min)
    - 5G-VINNI Demo on First steps on Testing as a Service: OpenStack OpenTAP plug-in in 5TONIC Spain Facility – Adrian Gallego (20 min) in collaboration with Keysight, UC3M

16:00 - 16:30 Coffee

16:30 - 18:00 Collaboration Meetings

- Collaboration discussion with 5GENESIS – 30 min (Pedro Merino)
- Collaboration discussion with EMPOWER – 30 min (Didier Bourse, Antonio de la Oliva, Arturo Azcorra)
- Collaboration discussion with 5G-VINNI – 30 min (Carmen Guerrero, Sonia Fernández, Adrian Gallego)

20:00 Dinner

Day 2: March 10: 5TONIC, Madrid + Travel Home PM

9:00 Arrival to 5TONIC

9:15 - 10:15 Presentations on European Research projects

- 5G-EVE
    - 5G EVE project presentation – Pablo Serrano (10 min), UC3M
    - 5G EVE Portal and Validation Framework presentation + demo – Ginés García (20 min), UC3M
    - 5G EVE Industry 4.0 demonstration – Ignacio Berberana (10 min), 5TONIC

10:15 - 11:00 Collaboration Meetings

- Collaboration discussion with 5G-EVE – Pablo Serrano, Ignacio Berberana, Ginés García (45 min)

11:00 - 11:30 Coffee

11:30 - 12:30 Demonstrations

- Demo: vrAIn Proof-of-Concept — A Deep Learning Approach for Virtualized RAN Resource Control – Marco Gramaglia (30 min), UC3M
- Video demo of Robot deployment at shopping mall in Taiwan – Antonio de la Oliva (10 min), UC3M
- Video demo about next generation eHealth services – Antonio de la Oliva (15 min), UC3M

12:30 – 13:00 Ad-hoc meetings with researchers

13:00 – Adjourn

ANNEX II

EMPOWER Mobility Application

Name of Applicant: _____

Affiliation of applicant: _____

Sending organization: _____

Hosting organization: _____

Duration of mobility: _____

Description of the mobility: _____

The description of the mobility should include the following (not more than one page):

- Goal of the researcher mobility
- Domain covered by the cooperation
- Relation to EMPOWER activities
- Expected impacts
- Contribution to the collaboration between EU-US

After the end of the mobility a short report should be provided.

ANNEX III

USA delegation visit to 5G-VINNI

13 March 2020, Oslo

Agenda

09:00 arrival at Telenor Expo

09:00 – 09:20 Welcome and round-table

09:20 – 10:20 Introduction to 5G-VINNI Norwegian Facility and use cases – Pål Grønsund, Kashif Mahmood, Per Hj Lehne, Håkon Lønsethagen; Telenor Research

10:20 – 10:40 Coffee Break

10:40 – 12:00 Demonstrations:

- *Demo #1: Millimeterwave capabilities*. 5G 26 GHz speed demonstration. 5G VINNI is implementing both 3.6 GHz and 26 GHz bands on the RAN setup. At Telenor Headquarters, a 26 GHz gNB has been deployed by 5G-VINNI partner Huawei. Achievable downlink/uplink speeds will be demonstrated. Huawei (Presentation and demo)
- *Demo #2: End-to-End Service Orchestration and Network Slicing Automation*. The ultimate goal in 5G is fully automated network slicing, starting from Service Orchestrator, down to ETSI NFV MANO, Transport, Security and VIM layers. 'One-click' slice deployment is achievable, but a lot of preparation is needed. In this session we are going to show the challenges that 5G VINNI and Nokia face in a multi-vendor ecosystem, the different steps and phases that are needed for an operator to deploy and terminate network slices dynamically. Also a mixture of open source and custom APIs plugins are necessary to orchestrate the services deployment and provisioning. Finally we will demonstrate a slice deployment with multiple network services and automated network configuration (Nuage, Openstack) – Antonios Dimitriades and Tirtha Ghosh; Nokia (Presentation and demo).

12:00 – 13:00 Lunch

13:00 – 14:30 Demonstrations (continued):

- *Demo #3: Norway Defense Slice*. Network Slicing is one of the most revolutionary concepts in 5G, defining a generation shift by enabling different vertical industries to share the same 5G infrastructure while maintaining full isolation. Norway Facility is implementing 5G Non-StandAlone (NSA) and 5G StandAlone (SA) slices including one 5G NSA slice to support different Military Uses Cases. This slice for Military called Defense Slice is distributed in multiple sites by orchestrating all the different components in the ecosystem, using automation, Autonomous Edge principles to fulfill performance, isolation and security requirements. Defense slice is multivendor deployment where Ericsson, Nokia and Metaswitch are providing different 5G

Network and Cloud components – Jan Pitter; Ericsson and Antonios Dimitriades; Nokia (Presentation and demo)

- *Demo #4: Test as a Service: Cloud-native test automation solution for 5G networks*. 5G is a complex network, where multiple components and actors need to interplay to ensure SLA to the customer. The only way to achieve such reliability and robustness, is to perform test cycles across all the life cycles of the network development, and of all the network components, from onboarding to slice deployment. Test as a Service (TaaS) will help the Mobile Network Providers to achieve the goal while keeping at bay the associated complexity and costs. By enabling cloud-native automation solutions, TaaS will help gluing all the needed testing instruments, scripts, and interfaces needed in every stage, making operations easy. In the demo it will possible to see what Keysight Laboratories is developing within the frame of 5G-VINNI, leveraging on the open source community of OpenTAP, and bringing it to the cloud. From Test Case (scripts) composition, to Test Campaigns (experiments) composition and execution, the 5G-VINNI TaaS platform is getting ready to facilitate network operation but also vertical experimentation – Andrea Cattoni; Keysight (Presentation and demo)

14:30 – 15:30 Collaboration discussions. Wrap-up and close.