HORIZON 2020

ICT - Information and Communication Technologies

Deliverable D1.4
EMPOWER Strategy Document and Collaboration Roadmap v3

Project Acronym:	**EMPOWER**
Project Full Title:	**EMpowering transatlantic PlatfOrms for advanced WirEless Research**
Grant Agreement:	**824994**
Project Duration:	**42 months (Nov. 2018 - Apr. 2022)**
Due Date:	**30 April 2022 (M42)**
Submission Date:	**11 May 2022**
Dissemination Level:	**Public**

Executive summary

This document presents the final EMPOWER Strategy Document and Collaboration Roadmap developed within the last year of the project. This document looks at the past activities, building over previous reports[1] [2] [3] to update the list of activities performed. It also looks at the future, providing a list of recommendations for trans-Atlantic collaboration activities.

D1.3 presented a list of different collaboration areas which EMPOWER has identified as key in Advance Wireless Platforms. During the last year, EMPOWER has focused mainly on two of them, AI, and the Common Software Toolboxes, been these two areas the ones most relevant now, triggering most of the collaborations. AI collaboration area has been explored in deep details in the related EMPOWER WHITE PAPER ON AI/ML IN TESTING OF MOBILE WIRELESS NETWORKS[4], providing in this document a very summary of its contents. The Common Software Toolboxes collaboration area has been also explored in detail on the EMPOWER WHITE PAPER ON SUSTAINABILITY ON EU/US COLLABORATION[5], providing in this document also a summary.

Considering the unexpected situation due to the outbreak of the COVID-19, early 2020, the consortium had to reshape a significant part of the strategy and activities initially planned in the previous versions of the EMPOWER Strategy Document and Collaboration Roadmap. COVID-19 restrictions, and the global pandemic uncertainties obliged EMPOWER partners to re-organize their activities to ensure the impact of the project. The way the project has faced these issues is by initiating a very successful activity, TheNetworkingChannel, where experts on different networking areas (with a priority on USA/EU collaboration) present key topics on networking. This document presents a summary of statistics and associated activities from TheNetworkingChannel, which will be extended in WP4 deliverables.

Finally, and most important, this deliverable presents a set of recommendations for Policy-Makers and regulators, on the areas of Standards and Radio-spectrum. We conclude this deliverable with specific recommendations to the EU on how to tackle EU/USA collaboration on the next phase of the SNS.

[1] D1.1, EMPOWER Strategy Document and Collaboration Roadmap v0, May 2019, https://www.advancedwireless.eu/deliverables/deliverable1-1 [Online, last access 10 May 2022]

[2] D1.2, EMPOWER Strategy Document and Collaboration Roadmap v1, Nov 2020, https://www.advancedwireless.eu/deliverables/deliverable1-2/ [Online, last access 10 May 2022]

[3] D1.3, EMPOWER Strategy Document and Collaboration Roadmap v2, May 2021, https://www.advancedwireless.eu/deliverables/deliverable1-3/ [Online, last access 10 May 2022]

[4] EMPOWER White Paper, "AI/ML in testing in mobile wireless networks", March 2022, https://www.advancedwireless.eu/deliverables/deliverable-white-paper-4/ [Online, last access 10 May 2022]

[5] EMPOWER White Paper, "Sustainability of EU/US collaboration", March 2022, https://www.advancedwireless.eu/deliverables/deliverable-white-paper-3/ [Online, last access 10 May 2022]

Table of Contents

1. Introduction

Throughout the lifespan of the EMPOWER project, partners from the US and Europe have identified potential areas of collaboration and synergy towards a transatlantic cooperation of future wireless research. EMPOWER has identified that US and Europe research community should lean towards the testing an integration of Artificial Intelligence and open-source solutions in the wireless ecosystem.

This document details how EMPOWER has boosted the collaboration between US and Europe partners. Namely, the consortium has triggered joint efforts to develop transatlantic cooperation in research testbeds and has started the integration of existing open-source software for beyond 5G research. The technical activities among the partners have helped to identify in white papers which are the technological gaps to achieve a realistic cooperation between the US and European wireless community. In this deliverable, the EMPOWER consortium points out that matching national-funds of the different countries is quite impossible, as it is the case of the COLOSSEUM and OAI platforms, which complement each other thanks to the mutualization of software and hardware equipment carried out throughout the EMPOWER project.

EMPOWER envisions those advanced wireless platforms should aim to have interchangeable end-to-end entities with the help of softwarization. Moreover, despite the spectrum regulation of each country, this deliverable identifies that SDR hardware and open-source are key enablers to enhance the transatlantic cooperation of the research community. Indeed, EMPOWER partners have contributed in a joint effort to standardization bodies to merge the vision of the EMPOWER consortium on future wireless platforms.

This deliverable sets out the how EMPOWER has disseminated its ongoing activities during the last reporting period. Although COVID-19 pandemic situation, EMPOWER has been actively involved in conference and workshop panels, so as in theNetworkingChannel, to incentivize the transatlantic cooperation of the wireless networking community. The document also details how the PAWR office and European entities have promoted the collaboration in between the countries, so as a recommendation to foster the future collaboration in between the EU 6G-IA and US NGA.

2. Summary of the work done regarding the areas of collaboration

This section specifies how the EMPOWER consortium has contributed towards designing an advanced wireless platform. In particular, the section enumerates the standardization and white papers' contribution to fields such as bringing AI to the network, and how the partners have built a common software toolbox. Additionally, this section points out the missing gaps and the road map to achieve a modular advanced wireless platform for stake-holders and researchers in the US and EU.

2.1 Updated areas of collaboration

2.1.1 Reference architecture

Despite the difficulties in matching funding and the burden created by the Covid situation, EMPOWER developed a strategy for the partners in the US and Europe, to agree and start designing a reference architecture for a common platform for the future. This strategy has been highlighted in deliverables and most of the events organized by EMPOWER. It is based on the transition to network disaggregation as well as the numerous efforts carried out by diverse consortia (O-RAN, ONAP, ONF, …). The principle is for future wireless platforms to benefit from the huge effort of open-source initiatives to use some of their components. Still, a lot of effort is necessary to fit this in a consistent solution as every initiative has its own goal.

2.1.2 Reproducibility

Experimentally-driven research should be grounded on a solid methodology that is understood and implemented by other disciplines. Consequently, we should not only target the deployment of the instrument/facility but as importantly, address the full research life-cycle, including open data, data management and reproducibility. The issue related to reproducibility is clearly identified in the US and in Europe (see EOSC for instance) but very little progress has been made due to the complexity and the effort needed.

However, the trend is clear. Researchers and research stakeholders nowadays require that research data is made available for other researchers to examine, experiment, and develop further. Additionally, preserving the data in conjunction with how conclusions from the data were drawn, accelerates the discovery process, enable easier reproducibility of the results, and thus supports evidence. It is then necessary to develop policies and procedures for regulating the management and publication of research data to make them interoperable and widely available. New efforts are ongoing as for instance the articulation of the newly established ESFRI SLICES project with EOSC.

2.1.3 AI

Artificial Intelligence and Machine Learning (AI/ML) are gaining momentum, also for inclusion in core and access networks, as well as in various vertical applications such as health, transportation, energy, finance, etc. EMPOWER has identified that AI/ML also must be used in testing methodology for mobile networks and has released a White Paper that discusses the need for including AI/ML in testing of mobile networks.

This stems from a number of significant changes in software testing as well as the trends for emerging mobile network technologies, i.e., mainly towards 6G. We have identified some key research topics in this context. The introduction of autonomic functions in mobile networks has resulted in many initiatives towards a new architectural framework from 3GPP, NGNM, ITU, ETSI, TM Forum and GSMA. In the White Paper, EMPOWER is providing a comprehensive analysis of the different initiatives.

Of specific interest are ETSI Work Items on AI in test systems and testing of AI models. The NGMN has also proposed a generic framework for testing and certifying autonomic functions. EMPOWER concluded that some specific areas deserve needs further research: 1) Pending issues in Data Collection, like how data are monitored and captured, what kind of data needs to be captured, how much and for how long, and how the data

aggregation is done, 2) Guideline for AI/ML testing and validation, 3) Transfer of knowledge and AI/ML models, and 4) Network simulators, which are capable of simulating both normal operations as well as diverse anomalies.

2.1.4 Building common Software Toolboxes

2.1.4.1 Mutualization of Software, Equipment and Human Resources

One of EMPOWER's main objectives is to stimulate mutualization of platform components and software and to demonstrate the joint developments and proof-of-concept activities at high-profile venues such as the Mobile World Congress and Linux Foundation events. Specifically, EMPOWER members now have ongoing engagements with several entities in the USA, the PAWR facilities and associated testbeds as well as Linux foundation MAGMA and OPNFV-VCO3/5G Cloud-Native[6] projects as well as joint activities with the Open Networking Foundation (ONF). These collaborations aim firstly to reduce fragmentation by producing common software toolsets and secondly coordinating joint development efforts.

A key endeavor is now underway with teams from OAI in Europe and US colleagues from PAWR through the OpenAirX-Labs[7] initiative, which targets accelerated development of 5G RAN and Core Network open-source software components through community-based development. The software tools are primarily of EU origin. The latter primarily targets knowledge exchange and establishing a strong academic development community in the USA to assist EU developers. In the same vein, steps were taken to harmonize software deployment methodologies to join forces on testbed computing resource management. This objective aims at providing common blueprints that can be used to deploy containerized versions of radio-access, core network software, mobile-edge computing functions and mobile service frameworks.

EMPOWER contributes to aggregating testing procedures across multiple platforms. Because of differences in infrastructure at different sites (different computing platforms and radio equipment) testing of common software packages should firstly be automated by a continuous-integration (CI) and continuous-delivery (CD) system and secondly adapted to the specific needs of the experimental sites. These needs are expressed in terms of features, deployment environments (static, highly-mobile, over-the-air or with test and measurement equipment) and require a high-level of coordination between the various parties.

EU-labs such as EURECOM, INRIA-R2Lab are working closely with the OpenAirX Labs in the USA on defining and implementing a multi-site testing architecture for open-source telco software packages using the various academic sites at its disposal. This will reduce the amount of time for testing community development and encourage more developers from the USA to contribute to the codebases that are largely led by EU developers. In a similar vein, through national initiatives such as the France Relance Engage5G[8] project in France, efforts are being made to extend this open tooling approach for testing open-source radio and core network software components on these experimental networks derived from 5G-EVE which now comprise elements from industry-led communities such as O-RAN and ONAP. A similar effort is being implemented with the Magma Foundation and the Open Core Network (OCN) project.

[6] VCO Demo 3.0 Home - OPNFV Summit Demo Discussion - OPNFV Wiki, https://wiki.opnfv.org/display/OSDD/VCO+Demo+3.0+Home [Online, last access 10 May 2022]

[7] OpenAirX-Labs (OAX) - Platforms for Advanced Wireless Research – PAWR, https://advancedwireless.org/oax/ [Online, last access 10 May 2022]

[8] France Relaunch: developing 5G applications in the field of health, https://www.entreprises.gouv.fr/fr/presse/crise-sanitaire/france-relance/france-relance-developper-des-applications-5g-dans-domaine-de [Online, last access 10 May 2022]

2.2 Proposed vision and roadmap to policy-makers

2.2.1 Building Advanced Wireless Platforms

Advanced wireless platforms development is essential for reaching a predominant position in the next generation of wireless technologies. As defined previously, there are still some challenges to tackle to foster research in the future advanced wireless networks.

Discussions with researchers in the area evidence that the community misses an end-to-end platform to test beyond 5G networks. It is no longer valid to resort to expensive hardware solutions to test the performance of the technology in a closed testbed. The future networks aim for modularity; hence, advanced wireless platforms should offer a modular end to end platform that allows the exchange of some of its components with research purposes.

Still there are no full end to end solutions offering the modularity, and such gap is an inconvenience in the research community that has traditionally focused in the PHY layer, for now they are expanding their interest also in the controller components. Namely, there is an ongoing trend in resorting to SDR hardware components to enhance the research of O-RAN, and the software components become as important as the radio equipment hardware to bring intelligence to the network.

On top of the need of having a modular end to end solution, there is also still a gap in the transatlantic cooperation. Existing connections across the ocean suffer from high jitter and delays that restrict the use cases to test, and limit researchers to only use roaming-alike solutions that are not suitable for future advanced wireless platforms. Moreover, using of scientific networks as GEANT brings in complexity and time investment that make it intractable for fast testing and prototyping. Hence, the US-Europe connectivity lacks from a proper connectivity for research purposes. It is possible that projects such as NSF Bridges will provide solutions as a 100gps optical link has been deployed between Boston and Paris and a second one will be available between Chicago and Amsterdam. A MoU has been signed between the ESFRI SLICES project and Bridges.

Regarding the usage of future advanced wireless platforms, EMPOWER identifies software defined solutions as key-enablers for SMEs and verticals that want to test their products. Even if pre-commercial vendors hardware provides connectivity solutions for testing, they lack from programmability to accommodate to the SMEs and vendors need, given the closed solutions offered by vendors. Thus, SDR hardware and modular end to end solutions will benefit not only the research community, but the stake holders of beyond 5G networks; and we believe an advanced wireless platform should encompass a modular end to end network, composed of interchangeable blocks implementing each basic functionality.

2.2.2 Impacting Standard

The final technology roadmap released by EMPOWER in November 2021[9] accounted for the latest development in key standardization development organizations namely 3GPP, IEEE and ETSI. The EMPOWER project through partner InterDigital has seeded the very first ETSI 6G pre-standards working group on reconfigurable intelligent surfaces[10], one of the key technologies identified in the EMPOWER roadmap. This group launched at ETSI back in September 2021 for a first period of 2 years and is chaired by InterDigital. Its current accounts for over 32 ETSI members including key stakeholders such as InterDigital (Chair), BT, Orange, Telecom Italia, Telefonica, Qualcomm, Apple, Samsung, Huawei, ZTE, NEC, Sony, etc. (ETSI, 2022).The EMPOWER project also provided contributions to the ITU-R IMT-2030 vision and technology trends report through WWRF on various technologies featuring in the EMPOWER Roadmap. Furthermore, EMPOWER disseminated its roadmap including target capabilities for 6G at the NGMN forum in February 2022. EMPOWER also hosted a webinar in March 2022 on the

[9] D2.5, Final technology roadmap for advanced wireless, Nov 2021, https://www.advancedwireless.eu/deliverables/deliverable2-5/ [Online, last access 10 May 2022]

[10] Industry Specification Group (ISG) on Reconfigurable Intelligent Surfaces (RIS), https://www.etsi.org/committee/ris [Online, last access 10 May 2022]

transatlantic 6G vision and roadmaps featuring ETSI, ATIS and H2020 HEXA-X project[11], and is invited by ETSI Board to present on the 13th of April the technology roadmap developed to help identify further pre-standards activities on 6G within ETSI.

2.2.3 Impacting Radio Spectrum and Regulators

Recognizing the high importance of spectrum issues for the EMPOWER strategy discussion, we identified several challenges and potential questions to be developed further and they have been updated based on the work carried out in EMPOWER:

1. *Which new spectrum bands are being considered for the 5G evolution?*

The general trend is a push towards higher frequencies, into sub-THz bands. ITU WRC-19 identified quite a few bands between 24 and 71 GHz for IMT-2020. It also includes bands specially identified for the use of HAPS (High Altitude Platforms), as we describe in D2.3.

2. *What are the spectrum regulation trends pointing forward?*

Regarding the general regulatory trends, traditional exclusive licensing is still being used for 5G, as we know from before. Another trend is that more and more bands are re-allocated from e.g., fixed, satellite and broadcast services to IMT.

3. *Will EU and US work towards a harmonization, both on specific frequency bands and conditions for usage?*

No specific harmonization work is ongoing but EMPOWER has put mmWave spectrum research on the agenda in the Networking Channel in April 2021.

4. *Will new and relevant spectrum bands be available for research and experimentation in Europe and US before licensed to operational use, and will there be reserved bands for e.g., propagation studies?*

There is no evidence of spectrum reservations for propagation studies, however, FCC has introduced 'Spectrum Horizon Licenses' between 95 GHz and 3 THz.

5. *What will come out from WRC-19 related to spectrum beyond 5G and what will be the agenda for WRC-23?*

The agenda for WRC-23 was a bit disappointing with regards to spectrum for B5G. Some new bands for IMT below 10 GHz are to be discussed, which are the only agenda items pointing towards IMT.

6. *How can we influence spectrum regulations for the purpose of good conditions for research and experimentations?*

Direct influence was early understood to be out of reach of the project. Spectrum policies are set on the national level normally complying with regional and global agreements. Taking new bands into use, is usually preceded by hearings where different stakeholders can give input to policies, license conditions and price levels. Research communities fall short in 'competing' on this ground, because licenses are awarded to commercial bidders for providing services. This leaves mostly unlicensed spectrum available for research purposes. Some exceptions are that e.g., 5G spectrum has been available for test licenses a limited period before commercial licensing has begun. Further, when it comes to spectrum bands which are not commercially exploitable yet, for example because technology is immature, these might be easy to get access to for research. The drawback is that these bands normally have e.g., propagation properties far from what is relevant for research on today's technologies.

[11] TheNetworkingChannel: "Transatlantic perspectives on 6G Vision, Roadmap and Development Model", 2 March 2022, https://networkingchannel.eu/transatlantic-perspectives-on-6g-vision-roadmap-and-development-model-downloads/ [Online, last access 10 May 2022]

3. Review and evolution of Strategy Document and Collaboration Roadmap

Since the launch of EMPOWER and based on the inputs gathered from the different project activities (workshops, site visits, survey, etc.), a set of community building tools was defined and the first activities were carried out during the first two years. Those tools are essential for the proper and efficient implementation of the Collaboration Roadmap. However, due to the current situation caused by the COVID-19 pandemic, and its related uncertainty, the partners had to set up corrective actions and define a new plan of action. Unfortunately, some of the activities involving physical mobility, could not take place before the end of the project.

To cope with this situation and in order to guarantee that this will not affect the final outputs and impact of EMPOWER on the community, it has been decided to reshape the Collaboration Roadmap defined previously. The objective is to propose as much as possible virtual events instead of physical events and propose new activities if it is not possible to turn physical activities in online activities.

3.1 Evaluation of the Strategy Document and Collaboration Roadmap

Until now, the Strategy Document and the Collaboration Roadmap followed the plan defined on the project description. However, in 2020, it became much more difficult to follow it and it forced the consortium to reconsider its plan on a short and medium term, especially regarding physical events.

Since the last version of the Strategy Document and the Collaboration Roadmap, the partners attended several events and had the opportunity to present the project in international conferences. Concerning the organization of the community building activities, the pace of implementing the activities was slower because of the pandemic outbreak but after a period of adoption and discussion, the partners decided to prepare an alternative, as described in the next sections.

Regarding the publications, until now, the partners have published 4 White Papers, all available on the project website:

- EMPOWER White Paper on Empowering Transatlantic Platforms for Advance Wireless Research;
- EMPOWER White Paper on Future trends analysis for Advance Wireless Platforms;
- EMPOWER White Paper on Sustainability of EU/US collaboration;
- EMPOWER White Paper on AI/ML in testing of mobile wireless networks.

Figure 1 shows all the activities, conferences, site visits, mobilities and meeting EMPOWER will organize and participate in the upcoming months with the aim to foster a networking collaboration related to 5G, beyond 5G and 6G, including the most important actors working in this field. In most of the cases, the meetings and events will be organized remotely.

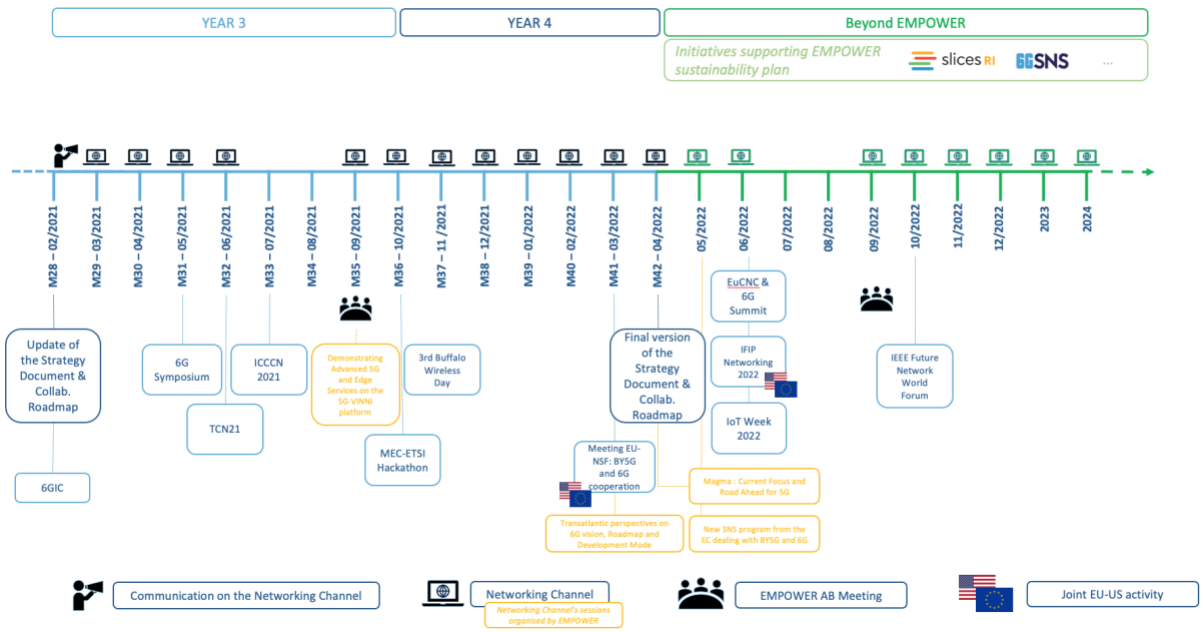

Figure 1: Collaboration Roadmap

Table 1 presents the events, most of them virtual, attended by the partners since D1.3. Those events were an opportunity to disseminate on EMPOWER project but also to gather information and outputs useful for the project outputs, such as the technology roadmap.

Table 1: List of events attended by EMPOWER partners

EVENT NAME	REL TO EMPWER	DATES	PLACE	OUTPUTS
6GSymposium https://www.6gworld.com/spring-2021-6g-symposium-agenda/#Anchor-2	Technology Trends towards 6G: a keynote by Dr Alain Mourad	4-6 May 2021	Virtual	EMPOWER participated at the 6GSymposium, Spring 2021 A variety of process, technology and political challenges pose problems for traditional approaches to standardization. At the same time, approaches based on an open-source methodology would struggle to replicate the strengths of standardization. https://www.6gworld.com/spring-2021-6g-symposium-agenda/#Anchor-2 By 2030 and the dawn of commercial 6G the world's climate aspirations, population, economy and work will have changed. If we are to deliver a smart, connected world that can meet the many demands on it, we need to start with all the stakeholders in the room and grow a complete set of viable solutions and business cases, not just a technology. The Spring edition of 6G Symposium, when leaders from across different industries, public and private sector and academia will meet to explore the key questions around what 6G offers industry and society and how to get there.

				Two panels are scheduled, directly related to EMPOWER: 1. The Standardization Roadmap: moderated by Alain Mourad (IDCC) and participation of Raydmon Knopp (EURECOM). 2. The Spectrum Roadmap: participation of Prakash Moorut (NBLF).
INFOCOM 2021	Key ICT conferenc e	10-13 May 2021	Virtual	IEEE INFOCOM is a top-ranked conference on networking in the research community. It is a major conference venue for researchers to present and exchange significant and innovative contributions and ideas in the field of networking and closely related areas. In particular, the CNERT workshop (Workshop on computer and networking experimental research using testbeds) is developing topics fully aligned with Empower concern. Several partners did follow and contributed to the program in 2021.
TCN21 https://tnc21.geant.org/	Serge Fdida, EMPOWER coordinat or, presented EMPOWER activities	21-25 Jun. 2021	Virtual	Serge Fdida, EMPOWER coordinator, presented EMPOWER activities
Mobile World Congress		28 Jun.-01 Jul. 2021	Barcelo na	MWC Barcelona is the world's most influential exhibition for the connectivity industry. In 2019, up to 2,400 exhibitors, 8,000 CEOs and 59% of the industries' most important decision makers gathered here.
The 30th International Conference on Computer Communications and Networks	Serge Fdida, EMPOWER coordinat or, presented EMPOWER activities	19-22 Jul. 2021	Athens, Greece	EMPOWER presented at the panel of ICCCN 2021 conference Cities of the future: what possible evolution towards the creation of smart communities. http://www.icccn.org/icccn21/wp-content/uploads/2021/ICCCN21-Tech-Program-Combined-5-14-2021.pdf
3rd Buffalo Wireless Day	Serge Fdida, EMPOWER coordinat or, presented EMPOWER activities	19 Nov. 2021	Virtual	http://www.acsu.buffalo.edu/~guan/wirelessday/2021.html
University of South Carolina Technology Seminar	Alain Mourad	03 Decemb er 2021	Virtual	Presented on "Technology Trends towards 6G with a Deeper Dive on RIS"
GLOBECOM 2021	Pannel presentati on organized by Antonio de la Oliva with key	07-11 Dec. 2021	Madrid	The 2021 IEEE Global Communications Conference (GLOBECOM) will be held in Madrid, Spain, from 7 - 11 December 2021. Themed "Connecting Cultures around the Globe," this flagship conference of the IEEE Communications Society will feature a comprehensive high-quality technical program including 12 symposia, selected areas in

	EMPOWER players.			communications track and a variety of tutorials and workshops. IEEE GLOBECOM 2021 will also include an attractive Industry program aimed at practitioners, with keynotes and panels from prominent research, industry and government leaders, business and industry panels, and vendor exhibits.
WWRF Steering Board 6G Workshop	Alain Mourad	17 December 2021	Virtual	Presented on "EMPOWER B5G Technology Roadmap"
NGMN 6G Forum	Alain Mourad	17 February 2022	Virtual	Presented on "The Path to 6G: Target Capabilities and Technology Trends"
ETSI Board	Alain Mourad	13 April 2022	Virtual	Presenting on "EMPOWER Technology Roadmap"
EU-US (NSF-DG Connect) meeting – BY5G and 6G cooperation	Organisation by Serge Fdida, EMPOWER coordinator	15 Mar. 2022	Virtual	Meeting between the EU and the NSF to discuss the EU-US BY5G and 6G cooperation

It is important to highlight that the partners planned a series of events which were finally cancelled due to the COVID-19, such as:

- **Mobile World Congress 2020** (February 24-26, 2020 – Barcelona, Spain): InterDigital was organizing two panels related with EMPOWER (1. What Do We Need to Do to Get 5G to Really Support AI and Machine Learning? / 2. Collaboration in the Open-Source Ecosystem). The EMPOWER technology roadmap and its consultation was planned to be presented.
- **EUCNC 2020** (June 16-17, 2020 - Dubrovnik, Croatia): EMPOWER was part of the workshop titled: Workshop on B5G key technology planning for EC collaboration with other geographical regions (B5G-COLAB). It was planned to present the technology roadmap but only the main conference was organized virtual and not the workshops.

3.2 TheNetworkingChannel

As a consequence of the Covid Pandemic and its effects on the physical barriers and difficulties to cooperate, EMPOWER took the initiative to launch together with the NSF PAWR Office, and in cooperation with ACM Sigcomm, the Networking Channel (https://networkingchannel.eu), acting as a catalyst between the global communities involved in future advanced networking activities. It aims at continuing the dialogue and build community in this unprecedented time and beyond, organizing a series of events as an online "channel" where the global networking research and education community will be able to meet and share.
The networking community channel is organized as a regular event, taking place ***every other Wednesday, at 8am PST (11am EST, 5pm CET, 1am JST)***, where a diversity of events is organized for the community, live and pre-recorded. Topics are broad and open ranging from research to experimentation and education. The channel consists of webinars, panels, tutorials, virtual site visits, keynotes, and any other innovative forms of community interaction. A YouTube Channel (https://www.youtube.com/channel/UCAtFAG5JdQrHac6ArIWJ-hw, see Figure 2) is available where previous streams can be downloaded and viewed asynchronously.

The Programme Committee co-chairs are:

- Matthew Caesar, University of Illinois, USA;
- Serge Fdida, Sorbonne Université, France;

- Abhimanyu Gosain, Northeastern University, USA;
- Jim Kurose, University of Massachusetts, USA;
- Stavroula Maglavera (communication/administration).

The Networking Channel started its operation on 24/3/2021 and organized the following events:

- 24/3/2021: The Network will be programmed by many, operated by a few - Nick McKeown – Professor of Computer Science and Electrical Engineering, Stanford University. With a panel of graduate student discussants from around the world (https://networkingchannel.eu/the-network-will-be-programmed-by-many/); Registrations: 480; Attendees: 268
- 7/4/2021: A Journey with mmWave research - Joerg Widmer – Research Professor and Research Director of IMDEA Networks; Sundeep Rangan – Associate Director, NYU WIRELESS; Michele Zorzi – University of Padova, Italy; Xinyu Zhang – Associate Professor, Department of Electrical and Computer Engineering, University of California San Diego (https://networkingchannel.eu/a-journey-with-mmwave-research/); Registrations: 256; Attendees: 147
- 21/4/2021: 5G and Next G Innovation Opportunities and Challenges: Enabled by Disaggregation, SDN and Open Source - Guru Parulkar – Executive Director of Open Networking Foundation (ONF) and Executive Director of Stanford Platform Lab; Sachin Katti – Assistant Professor of Electrical Engineering and Computer Science at Stanford University, Co-Chair of O-RAN Alliance; Christian Maciocco – Principal Engineer and Director Telecom Systems Research, Intel Labs; Florian Kaltenberger – EURECOM (https://networkingchannel.eu/5g-and-next-g-innovation-opportunities-and-challenges/); Registrations: 342; Attendees: 174
- 5/5/2021: Advice on how to succeed in grad school - Jennifer Rexford – Professor of the Computer Science Department at Princeton University; Edmundo de Souza e Silva – Federal University of Rio De Janeiro, Brazil; David Patterson – Berkeley, USA; Anja Feldmann – Max Planck Institute for Informatics. With a panel of graduate student discussants from around the world (https://networkingchannel.eu/advice-on-how-to-succeed-in-grad-school/); Registrations: 939; Attendees: 575
- 19/5/2021: Emerging Trends in AI/ML and Implications for Networking Research- Dr Sujata Banerjee – Sr. Director of Research, VMware, USA; Dr. Somdeb Majumdar – Intel's AI Lab, USA; Dr Dario Rossi – Huawei, France; Dr Dan Pei – Tsinghua University, China (https://networkingchannel.eu/emerging-trends-in-ai-ml-and-implications-for-networking-research/): Registrations: 386; Attendees: 182
- 2/6/2021: Challenges at Layer 8: Network neutrality, the digital divide and spectrum - Scott Marcus – Senior Fellow at Bruegel, Belgium; Eric Burger – Professor of Computer Science, Georgetown University, USA; Chris Marsden – Professor of Internet Law, University of Sussex, UK; Sonia Jorge – Executive Director, A4AI, Head of Digital Inclusion, Web Foundation; Paul Brooks – Consulting CTO and Chair of Internet Australia, Australia(https://networkingchannel.eu/challenges-at-layer-8-network-neutrality-the-digital-divide-and-spectrum/); Registrations: 162; Attendees: 69
- 15/9/2021: Google Networking: Infrastructure and Selected Challenges - Christophe Diot – Principal Engineer at Network Operations team, Google; Paulie Germano – Senior Staff Network Engineer, Google (https://networkingchannel.eu/google-networking-infrastructure-and-selected-challenges/); Registrations: 625; Attendees: 292
- 29/9/2021: Demonstrating Advanced 5G and Edge Services on the 5G-VINNI platform - Andrés Gonzalez – Senior Researcher, Telenor Research, Norway; Johan Morten Tetlie – Solution Architect, Ericsson Norway; Antonios Dimitriadis – Lead Telco Cloud Infrastructure and Automation Solution Architect, Nokia; Tirthankar Ghosh – Solution Architect, Service Orchestration, Nokia; Kennet Nomeland – Radio System Architect, Norwegian Defence Material Agency (https://networkingchannel.eu/demonstrating-advanced-5g-and-edge-services-on-the-5g-vinni-platform/); registrations: 175; Attendees: 96
- 19/10/2021: Networking Education During and After the Pandemic - Bamba Gueye – Université Cheikh Anta Diop, Senegal; Jörg Liebeherr – University of Toronto, Canada; Koojana Kuladinithi – Hamburg University of Technology, Germany; Luciano Paschoal Gaspary – Federal University of Rio Grande do Sul; Prométhée Spathis – Sorbonne Université, France. With a panel of student discussants from around

the world (https://networkingchannel.eu/networking-education-during-and-after-the-pandemic/); Registrations: 90; Attendees: 76

- 27/10/2021: Experiments in the Edge to Cloud Continuum - Kate Keahey – University of Chicago; Jason Anderson – University of Chicago (https://networkingchannel.eu/experiments-in-the-edge-to-cloud-continuum/); Registrations: 172; Attendees: 83
- 10/11/2021: A day in the life of Netflix Streaming: A conversation about Netflix Adaptive Streaming and more - Te-Yuan Huang– Streaming Algorithm team, Netflix; Renata Teixeira – Streaming Algorithms team, Netflix (https://networkingchannel.eu/a-day-in-the-life-of-netflix-streaming-a-conversation-about-netflix-adaptive-streaming-and-more/); Registrations: 299; Attendees: 175
- 24/11/2021: Quantum Networks - Frédéric Grosshans – Sorbonne Université; Rodney Van Meter – Keio University; Donald F. Towsley – University of Massachusetts Amherst (https://networkingchannel.eu/quantum-networks/); Registrations: 239; Attendees: 134
- 8/12/2021: Human-centered Networking - Ellen Zegura – Georgia Tech (https://networkingchannel.eu/human-centered-networking/); Registrations: 136; Attendees: 80
- 19/1/2022: QUIC and its impact on secured transport layer management in SATCOM systems - Nicolas Kuhn – Project Manager Technical Lead at Centre National d'Études Spatiales; Christian Huitema – Private Octopus Inc; Emile Stephan – Orange Labs; Alexandre Ferrieux – Orange Labs; Isabelle Hamchaoui – Orange Labs; John Border – Hughes Network Systems; Chi-Jiun Su – Hughes Network Systems; Marie-José Montpetit – Telecom Paris Sud (https://networkingchannel.eu/quic-and-its-impact-on-secured-transport-layer-management-in-satcom-systems/)
- 2/2/2022: How can we improve diversity and inclusion in the systems and networking community? Margaret Martonosi – NSF; Tracy Camp – Colorado School of Mines; Mythili Vutukuru – IIT Bombay; Ahmed Elmokashfi – Simula Research; Craig Partridge – Colorado State University; Manuel Perez Quinones – University of North Carolina at Charlotte (https://networkingchannel.eu/how-can-we-improve-diversity-and-inclusion-in-the-systems-and-networking-community/)
- 16/2/2022: Kanchana Kanchanasut – Asian Institute of Technology, Randy Bush – Arrcus (https://networkingchannel.eu/deploying-networking-in-developing-regions/)
- 2/3/2022: David Boswarthick, ETSI; Mikko Uusitalo, Nokia Bell Labs, Douglas Castor, InterDigital Research and Innovation for 6G (https://networkingchannel.eu/transatlantic-perspectives-on-6g-vision-roadmap-and-development-model/
- 16/3/2022: Open Educational resources for teaching and learning networking : Larry Peterson-Princeton University, Systems Approach LLC, Open Networking Foundation; Fraida Fund –NYU Tandon School of Engineering; Laurent Vanbever –ETH Zürich; Damu Ding - University of Oxford; Olivier Bonaventure –Université catholique de Louvain; Christian Esteve Rothenberg –University of Campinas; Kameswari Chebrolu –Indian Institute of Technology, Bombay; Nate Foster - Cornell University; Ryan Doenges –Cornell University; Pieter-Tjerk de Boer – University of Twente (https://networkingchannel.eu/open-educational-resources-for-teaching-and-learning-networking/) Registrations: 167; Attendees: 137
- 30/3/2022: Network Datasets: what exists, and what are the problems? Timur Friedman –Sorbonne Université – LIP6; Phillipa Gill – Google; Sue B. Moon – KAIST; Dave Clark – MIT; Italo Cunha – UFMG (https://networkingchannel.eu/network-datasets-what-exists-and-what-are-the-problems/) Registrations: 209; Attendees: 121
- 13/4/2022: End-to-End Network Programmability with P4 Nate Foster –, Cornell University; Nick McKeown – SVP/GM and Senior Fellow, Intel, Stanford University; Jennifer Rexford – Princeton University; Costin Raicu –University Politehnica of Bucharest; Georgios Nikolaidis –Intel; Minlan Yu – Harvard (https://networkingchannel.eu/end-to-end-network-programmability-with-p4/) Registrations: 344; Attendees: 192
- 27/4/2022: Magma: Current Focus and Road Ahead for 5G with Amar Padmanabhan – Freedomfi, Tien-Thinh Nguyen – EURECOM / OAI, moderated by Raymond Knopp – EURECOM (https://networkingchannel.eu/magma-current-focus-and-road-ahead-for-5g/) Registrations: 109; Attendees: 60
- 11/5/2022: 6G EU and US Programmes with Dr. Colin Willcock – Nokia, Head of Research Alliances – 6G-IA Governing Board Chairman – Smart Networks and Services (SNS) Joint Undertaking (JU) Governing

Board Chairman; Dr. Mike Nawrocki – ATIS, Vice President Technology and Solutions ; Dr. Alexandros Kaloxylos – 6G-IA Executive Director ; Dr. Alex Sprintson – NSF Program Director Resilient & Intelligent NextG Systems (RINGS). Moderated by: Dr. Didier Bourse – Nokia, Senior Director, European R&I Programs – 6G-IA Vision Working Group – Portfolio Structuring and Analysis (PS&A) Sub-Group Leader (https://networkingchannel.eu/6g-eu-and-us-programmes/)

Figure 2 presents the YouTube channel where the different talks are being stored for future audience. There are currently (May'22) more than 383 subscribers in the YouTube Channel and the recordings of the events have been viewed hundred times.

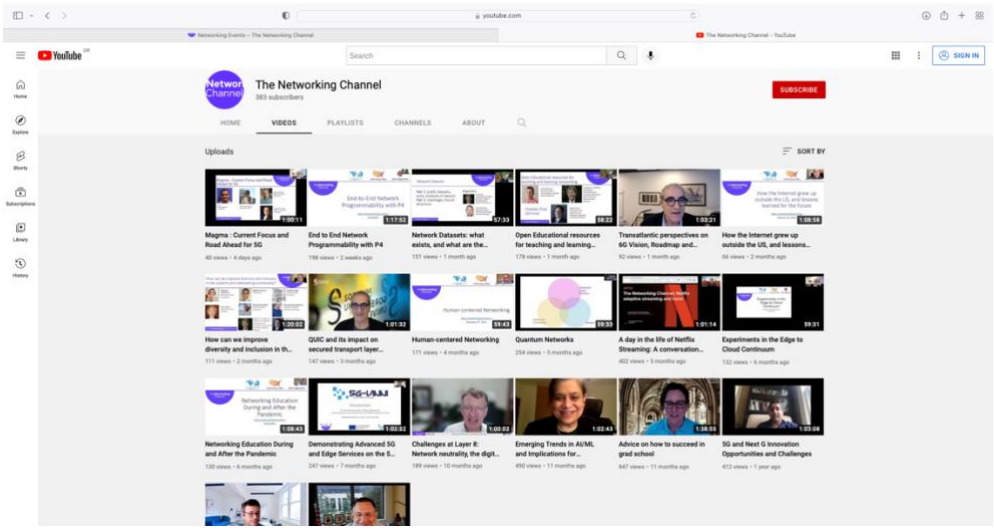

Figure 2: YouTube Channel

Some statistics regarding the attendance of theNetworkingChannel events depicted in Figure 3, Figure 4, and Figure 5.

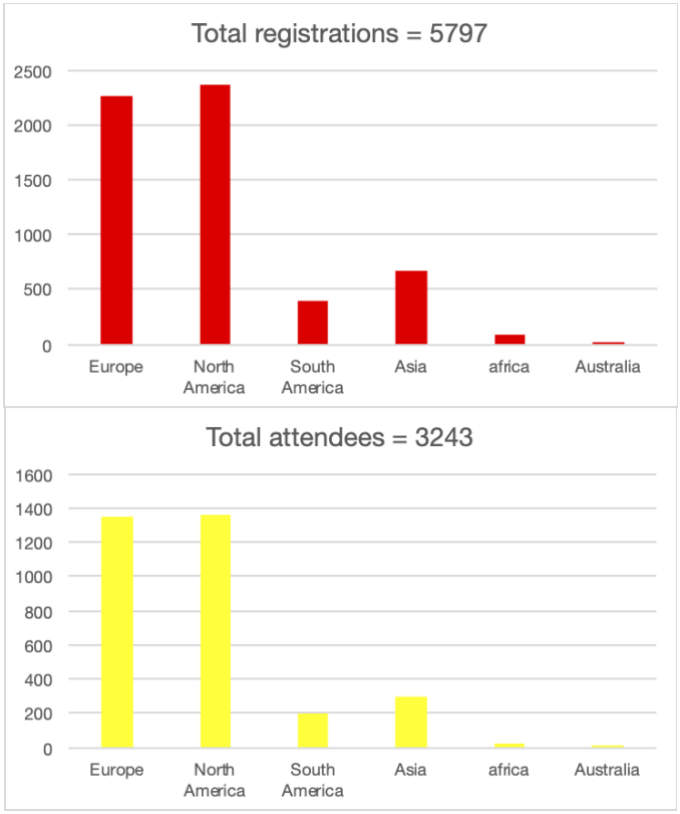

Figure 3: Statistics of the total registrations and attendees for the events organized till April 2022.

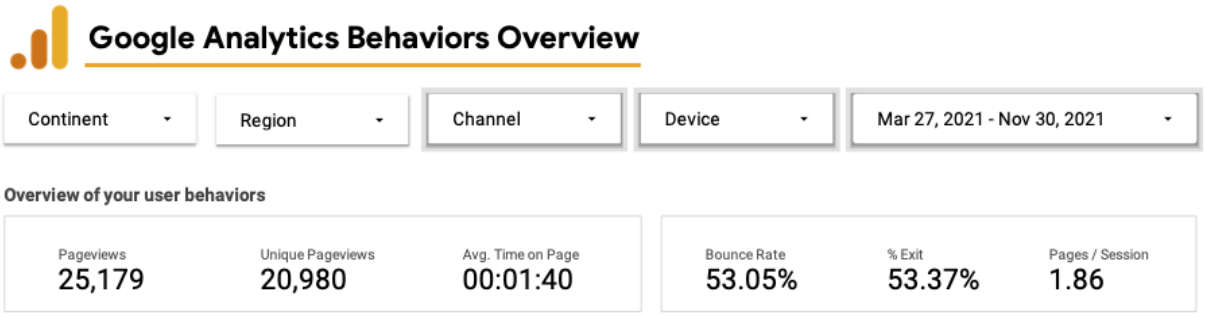

Figure 4: Total visitors of the website

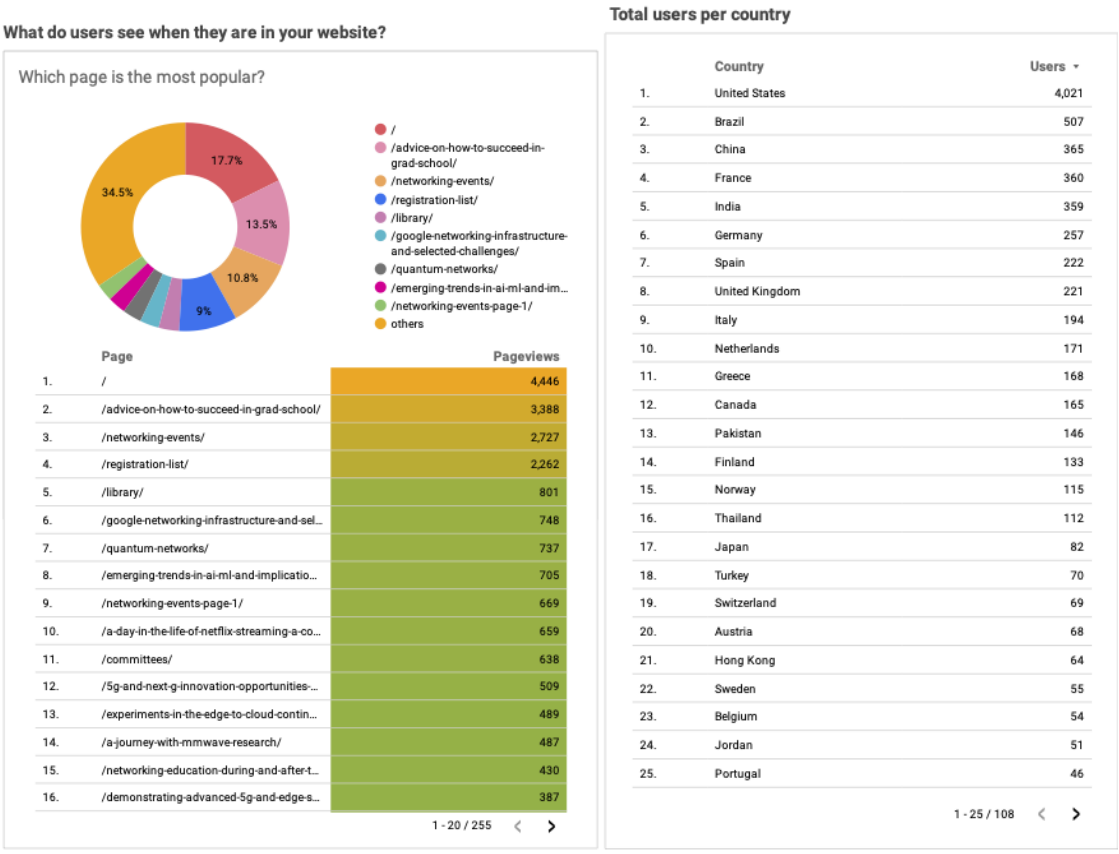

Figure 5aTop pages visited, 5b: Top countries

As can be extracted from above figures, TheNetworkingChannel is working as a fantastic venue for the collaboration between EU and USA. In the last years, characterized by the explosion of virtual events, TheNetworkingChannel has succeed on attracting the networking community thanks to its top-quality talks and speakers. Surprisingly, one of the first talks (as shown in Figure 5), more related to the academic world and the PhD process, is the one with higher number of visits. This indicates that the channel is widely disseminated not only among networking experts but also between young researchers in the area.

3.3 List of future related events

In addition to the events organized by EMPOWER, in the framework of the Networking Channel, the project will participate in the next events, out of its implementation period.

EVENT NAME	DATES	PLACE	OUTPUTS
IFIP Networking 2022	13 Jun. 2022	Catania, Italy	EMPOWER together with PAWR and SLICES organises a workshop titled: Scientific Instruments to support digital infrastructure science
EuCNC 2022	6 Jun 2022	Grenoble, France	EMPOWER organizes a Workshop on EU USA collaboration

4. Sustainability

The value of EMPOWER deserves that it will be sustained. This has been discussed both by the stakeholders and the community during various venues and workshops. In particular, this was a topic of mutual interest in the agenda of the EU-US (NSF - DG Connect) meeting dealing with BY5G and 6G cooperation, held on March 15, 2022 and organized by EMPOWER.

Participants US:
Zachary Blackburn: International Telecommunications Policy Specialist International Telecommunications Policy Specialist; US Department of Commerce, NTIA
Gurdip Singh: NSF CNS Division Director
Alexander Sprintson: NSF-CNS program director
Murat Torlak: NSF-CNRS program director

Participants EU :
Bernard Barani: Deputy Head of Unit at European Commisson- DG CONNECT - Future Connectivity Systems
Remy Bayou: Policy Officer, DG CONNECT - Future Connectivity Systems
Peter Stuckman: Interim Executive Director of the Smart Networks and Services Joint Undertaking and Head of Unit, Future Connectivity Systems at European Commission

The meeting started with welcome and presentations from both side on their future roadmap. The first objective is a mutual understanding of the respective workplans and the domain of mutual interest regarding potential cooperation with impact. It deals with academic research but also how to engage with industry (as SNS is public-private partnership, and ATIS is mostly industry driven).

Different topics have been identified and discussed:

- Open software components (alike Open RAN);
- AI/ML in networking and especially data sharing (open data approach);
- Specific components to be discussed further (RIS for instance);
- SDG driven-goals alike Carbon footprint and inclusiveness.

Presentation from Bernard Barani
Slides here: https://dropsu.sorbonne-universite.fr/s/MfkTsYLG7g3zW44

Presentation by Alex Sprintson
Slides here: https://dropsu.sorbonne-universite.fr/s/m4RC86qdmnFBXGp

The tool for enabling the cooperation is always an issue. Bernard mentioned the possibility for defining an international cooperation agenda and tools for the next SNS call (early 2023). Peter stressed the importance to provide a lightweight coordination effort that should not be discontinued.

As the EMPOWER CSA is ending in April, ESFRI SLICES is volunteering to serve as a surrogate for the EU side, and NSF PAWR Office is going to continue to serve on the US side. This principle was agreed by the participants as a lean and simple way to sustain the important activities developed by EMPOWER. On the EU side, SLICES (slices.eu) already got the funding and sustainability to engage into an international cooperation precisely on the core topics identified by EMPOWER. Likewise, on the US side, this mission is devoted to the PAWR office. Running the main tools should not mobilize too much resources as co-funding will be used by the actions developed jointly.

Other opportunities for discussing this further are:

- the workshops organized at the EUCNC & 6G event, June 7-10, 2022;
- the workshop organized at the IFIP Networking 2022 conference, June 13-15, 2022;

- the full day event organized during the IoT week, Dublin, June 23 2022;
- The MERIF workshop, Madison Wisconsin, June 1-3, 2022;
- The IEEE Network world Forum, Montreal, October 12-14, 2022.

This shows that EMPOWER will be sustained. Actions will be continuously monitored. A continuous dialogue with the stakeholders will be maintained, and the discussion will continue to adjust the strategy in the medium to long.

5. Advisory Board up-dates

5.1 Report on meetings with the Advisory Board during the last year of the project

EMPOWER – Advisory Board Workshop (13 September 2021)

List of participants:

Name	Organisation
Advisory Board members	
Serge FDIDA	Sorbonne Université, EMPOWER Coordinator and Chair of the AB
Antonio DE LA OLIVA	University Carlos III of Madrid, EMPOWER WP1 Leader
Alain MOURAD	InterDigital, EMPOWER Industry Representative and WP2 Leader
Colin WILLCOCK	5G-Infrastructure Association representative
Rui AGUIAR	Networld2020
Tommaso MELODIA	PAWR Research Director
Abhimanyu GOSAIN	PAWR Technical Program Director
Edward KNIGHTLY	High-level representative from US wireless research community
Ivan SESKAR	High-level representative from US platform community
EMPOWER partners	
Émilie MESPOULHES	Sorbonne Université
Stavroula MAGLAVERA	University of Thessaly
Thanasis KORAKIS	University of Thessaly
Raymond KNOPP	EURECOM
Per LEHNE	TELENOR
Ole GRØDALEN	TELENOR
Didier BOURSE	Nokia Bell Labs France (NLBF)

Since this is a public document, we have decided to anonymise the opinions in the AB, therefore we use ABm for members of the Advisory Board and EP for the EMPOWER members.

Introduction and short presentation of SLICES

SLICES has been recently selected in the framework of the ESFRI program. ESFRI is a huge recipient of funding with the aim to support the creation of large-sale infrastructures/scientific instruments in Europe, in different domains. The funding comes from both the EU and the member states. SLICES becomes the first large-scale scientific instrument in the field of digital science.
ESFRI gives SLICES a strong label that will allow this research infrastructure (RI) to apply to more funding and open doors for discussions with different organizations, at European and national level.

First of all, on behalf of the consortium, Advisory Board member (ABm) thanks the members of the Advisory Board for their participation and support to the EMPOWER project. Despite the fact this workshop is remote, it is a very good opportunity to meet again and exchange on EMPOWER project progress.

This workshop focussed on 4 main topics:

- **SLICES**: a new successful initiative in Europe that provides a framework for collaboration for the future;

- **TheNetworkingChannel**: due to the COVID, we have been paused, without the opportunity to organize the events planned (mobilities, workshops, hackathons, etc.), and we had to switch everything to virtual. The Networking Channel has been created on that purpose, supported by ACM Sigcomm. It is a very successful initiative; Also, a place where we can promote activities on both sides of the Atlantic as well communicate broadly;
- **Open Standards / Source projects:** because the infrastructure is becoming softwarized, we think that one of the key ways of collaboration would be to develop a global architecture of the platforms. Many functionalities can be leveraged at open-source components;
- **Future opportunities for EU-US collaboration**: it will be the opportunity to discuss on how to implement these future opportunities of collaboration.

Presentation of SLICES – Questions/Discussions

1. Question from ABm: What about the funding structure? Is it only focused on the infrastructure side or also science/research side?
   - ABm congratulated the consortium for the work done and the overall progress;
   - EMPOWER Participant (EP): the funding mostly covers the infrastructure side but not only the equipment itself, also the human resources. What is interesting is that we will build up our own governance, with its own legal entity to manage the infrastructure. In parallel, each country represented in SLICES will have its local office;
   - EP: The ESFRI program will not provide funding for the research per se. We will have other funding opportunities for research. We can get funding also for all the part dealing with the open data.

2. Question from ABm: Will the users (e.g., professors, students) pay to use the infrastructure? Or is it available for free and they will only have to pay for their time/travel?
   - EP: One of the reasons why we applied to ESFRI is that over the last 20 years, we received funding, mainly from the DG connect, but it has always been complex because you need to answer the need for research but also the one of the industry, SMEs, etc. However, when you look at the example of the telescope, you see that the model is sustainable because it is a public-good one. We decided to go for this model;
   - EP: Example of the telescope: the access is based on excellence. You have to wait to be accepted and approved, by a scientific committee, before doing your experiment. In the case, the access is free. In parallel, you have the market access for industrials or for projects with an exploitation plan;
   - EP: There are also some calls in Horizon 2020 where one of the conditions is to use this kind of infrastructures.

3. Question from EP: in the case of the telescope, the community (leader researchers, users, etc.) comes together to define some audacious goals to go for. This part is missing/not clear for SLICES. Do you have this kind of partnership with the community?
   - EP: this is a large initiative; it was sized based on projects such as the telescope ones. You have 2 panels for the evaluation: one based on excellence (you have to address some specific scientific questions, with a strong community behind) and another one based on implementation (to prove that you know how to build your RI);
     - In the case of SLICES, we have the support from most of the key researchers in our field in Europe;
     - SLICES succeeded in both panels.
   - EP: now, we have 2 projects funded by the EC. One is related to the community building (SLICES-SC), to organize the dialogue with the community to define the next steps in the development of the RI. We cannot disconnect the RI from the community and we have to prove that the RI is serving the demand from our scientific community. We have to permanently involve the researchers.

4. Question from ABm: you are going to set up an entity which will build you RI and operate it. Will this entity be in charge of interacting with the research community to get inputs? Or will it be separate?

- EP: besides the community, we will have a scientific committee (+ inputs from the member states), which will be responsible for interacting with the scientific community. It is responsible for building and operating the RI but it has also to demonstrate that it is well aligned with the demand.

5. Question from ABm: the policy is going to be based on who is using the RI, internal determination or outside influence? Can somebody priorities some projects? Is there going to be a committee to choose?
   - EP: it will be mixt. On the top of the governance, you will have the stakeholders (the ones who are funding). We don't think it will have a strong impact on the architecture itself. Regarding the usage, it will follow the principles of ESFRI: excellence-based and eventually market-based.
   - EP: there will be a board with the stakeholders and a scientific committee. SLICES will be driven by science (this is an advantage of ESFRI), compared to Horizon Europe which is more driven by industry (TRLs / Impact).

6. Question from EP: ESFRI is less driven by the industrial influence, it democratizes and is more focused on the scientific committee needs?
   - EP: Yes, and it is a plus because it means that we have the control of the scientific development and the value for the research in a sustainable way. However, even ESFRI is considering industrial participation. It is important for us and this is the reason we started to discuss with some units of the EC about potential cooperation and they are very interested about SLICES. For the future calls, we expect to be on the radars and they could use us in the public-private partnership.

7. Question from EP: if it is managed separately in Europe (ESFRI vs. DG CONNECT), do you see a separate entity as the same level as ESFRI in the US? Where should we be focused on educating our stakeholders? Is that the Science Foundation? At state level?
   - EP: it is a difficult question. At the time of GENI, Guru (Parulkar) thought about Senate funding but he never succeeded. The long-term level is to compete with the telescope; but to be practical, on the short term, NSF should be the right target.
   - EP: With SLICES, we position ourselves as a telescope (e.g., we compete with the scientific instruments of all other domains) and not an instrument funded by computer scientists alone. If you need help form SLICES to support some claims, please do not hesitate to ask.
   - EP: The ESFRI framework is different but very interesting because you understand how other scientific domains look at experimental driven research. It was a good exercise to convince ESFRI that we were mature enough as computer scientists. There are plenty of issues where we can evolve as a community.

8. Question from EP: Should we still consider SLICES as part of the EMPOWER forum or something outside EMPOWER? How to deal with it?
   - EP: EMPOWER will end in 6 months and the funding will end at that time. ESFRI as such does not publish solicitation to support international collaboration although this is part of the objectives of the instrument. However, we can use SLICES funding to foster international cooperation. At the policy level there are different stakeholders that can support the partnership.
   - EP: We can use EMPOWER for the next 6 months and SLICES beyond to substitute our EMPOWER joint activities. Therefore, I consider that we have a sustainable framework to discuss and even support our current EMPOWER cooperation.

9. Question from ABm: As members of the Advisory Board, how can we best help you for the next 6 months? and longer term? what do you need from us?
   - ABm: we need a recurrent dialogue on a few topics we can leverage as well as escalade the discussion on international cooperation (NSF/EC). We need to define a few topics to work together.

TheNetworkingChannel

Due to the COVID-19, we had to move all the events, initially planned in EMPOWER, to virtual, in order to maintain and build the global community among networking researchers, teachers and students. Virtual events are nice but you missed the physical interactions.

The idea of the Networking Channel is to be inclusive and to be useful for the community even after the pandemic. This initiative has been possible thanks to the support of the PAWR Office; we also have been approached by ACM Sigcomm.

ABm reminded the fantastic forum, the very good attendance numbers as well as the topics.

ABm: the idea of the Channel is that it is not webinar. You know that every second Wednesday, at your local time, there is an event and you can book it. We propose a large range of topics and we solicit the community to define them. If you want to organize something, you can propose a topic and we are here to help but you will be responsible for handling it. It is a tool for the community. The events are recorded (potential exceptions on case-by-case basis).

Unfortunately, due to the lack of resources and time for the organizers of the different sessions, we were so far not very successful with the activity on the slack channel (provided by ACM Sigcomm) to continue the discussions between each session of the Networking Channel.

What we need from the AB members is to disseminate and suggest programs inputs and related speakers.

1. Question from EP: Are we all set up with the fall? Do we have already all the programs set up? The core wireless is not reflected yet in the fall session.
    - EP: we try to alternate and have a diversity of topics (education, training, long-term research, industry, etc.). We always try to have 3-4 programs in the pipeline. We still have one slot available until December. ABP is working on quantum which is becoming more practical in terms communication. He is touch with several colleagues here and there. It is a way to raise awareness of our community in quantum because we do not see our community much involved in that field;
    - EP: we do not want this to be a dialogue only between Europe and the US. Colleagues from South-East Asia and Africa are invited as well;
    - EP: we will start planning next year by November;
    - EP: it is not only research, there are also industrial topic. The next program is related to Google. After this one, it will be something new: a site visit of the TELENOR's facility (5G-VINNI);
    - EP proposed to organize one Webinar focused on the new EC Horizon Europe program dealing with 6G.

Open Standards/Source projects

EP presents of some activities carried out on both sides of the Atlantic in the framework of Open-X project. The aim is to develop mutualised tools. Moreover, before the end of EMPOWER, the partners plan to organise a second joint workshop with ETSI on open-source methodologies.

EP: we try to see how the new situation both in the US and Europe can bring new opportunities. We try to see how we can support those joint activities in EMPOWER, on the EU side.

EP: This is an active ongoing activity on how to share roadmap, develop joint activities and mutualized tools. There is no specific feedback and recommendations. The EMPOWER angle is good but the idea to work on the medium/long term.

1. Question from ABm: do you see opportunities on the EU climate to speed this up and accelerate this development?
    - EP: No inputs from the EU industry. We do not know how to increase that. If you ask the EU governments are still not convinced that the way to go is to open things up. On the other side, they are happy we are doing that in the academic level: on the one hand they want the academic to push but on the other hand, they do not put the funds for that. In the context of SLICES-RI, we can maybe find other ways to fund this kind of things. You are very fortunate in the US;
    - EP: it is a very sensitive topic in the EU. All sensitive sovereignty issues are now being discussed in Europe. We started to discuss with some stakeholders in the EC, to see how SLICES could be used as a framework for that purpose. We will see how far we can go but it is an opportunity for the EC as well;
    - ABm: at this moment, everything in the field of international cooperation is tricky. Everybody wants to cooperate but they are not addressing properly the amount of money to invest in it. It is a challenge. The relationship is in pause and it is the moment to think what to do during this pause in order to have a stronger cooperation when it will fully restart again;
    - ABm: there are 2 aspects that influence this situation: the change of government in the US, the previous administration was less willing to collaborate; at the EU level, we are between two major funding programs. It takes long to enter into the new funding program, to see where to invest money (e.g., 5G, 6G). We are at the beginning of a new period. We need to settle down during a period of time (9-12 months) before major new bilateral initiatives;
    - ABm: there are things we can do in the meantime. In Europe, the process is usually slow but it is engaging for people. We will start to discuss what will be the important research topics in our area. The discussions will start by the end of this year (Nov. 2021: RA plans to discuss with CW);
    - EP: there is a lot of debate on this but with the COVID, we realize that international cooperation is more important than ever. The problem is when you move from cooperation to competition. What we could do is to move our own way. In SLICES, we will have to move to the implementation in 2-3 years and we will have to deploy nodes in 12-15 member states. If those nodes can be organized with software components, part of them being shared and interoperable across the Atlantic, then, we can have a way to drive innovation. There will be space for other kind of projects (PPP). There is an opportunity for us.
    - ABm: my impression is that the US side will be more open to cooperate with European entities, in the next few years. The political climate is evolving in this sense.

2. Question from EP: do you foresee twin calls/funds in the US? In Europe, we will not have any joint calls in the next 1,5 years.
    - ABm: in theory, some fractional funding is available;
    - ABm: the problem is that often the amount available is very low (200k) to set an intercontinental program;
    - ABm: some of the existing programs are even lower than that. It is very difficult to act as a bridge;
    - EP: matching funding (EC/NSF) will always be a nightmare (little amount of money vs lot of time dedicated). If we can secure a good amount of money on both sides, we can see how to leverage the cooperation. We can send some research/students to work on some topics. It will be a problem on the short/medium term to match funding;

- EP: it is an issue: matching funding is a nightmare but not doing it (no funding) is a problem;
- EP: the proposed topics are very good. If we manage to find a program to do this kind of collaboration, it can be very interesting.

6. EMPOWER EU/USA recommendations for next phase of SNS JU

EMPOWER has been working on fostering the relationship and collaboration between USA and EU in Advanced Wireless Infrastructure for the last 3 years. During this time, a deep understanding on the best way of promoting joint activities has been developed together with a strong trust relationship among the partners. In this document, the EMPOWER project presents the devised recommendations for the EU to develop join programs and activities with the USA.

The main USA forum promoting USA Leadership on 6G is the ATIS Next Generation Alliance[12] launched in 2020. This alliance mirrors the European 6G-IA industry association and includes key USA industry stakeholders on 6G including members of EMPOWER such as Nokia and InterDigital. The NGA work structured includes 6 working groups so far including National 6G Roadmap, Green Generation, Spectrum, Technology, Applications and Societal and Economic Needs. EMPOWER is already engaged with ATIS NGA noticeably on the technology roadmap.
The recommendations from EMPOWER to build future collaboration activities with USA are the following:

- It is recommended that the EU 6G-IA establishes a MoU with ATIS NGA, like the MoU established with ETSI, for both peer bodies EU 6G-IA and USA NGA to collaborate on the 6G roadmap priorities and areas of synergies bi-laterally and globally in international forums such as the ITU, NGMN and GSMA;
- It is recommended that the coordination of USA collaboration activities, jointly with the collaboration with other geographical areas, is handled in a separated CSA within the phase-2 of the SNS JU;
- EMPOWER recommends two kinds of R&I activities to be considered for further collaboration on the area of Advanced Wireless Platforms research. On the one hand, a R&I EU/USA collaboration project with twinned funding to liaise and further develop open advanced wireless platforms is recommended. This project's aim is to interlock the SNS Stream C platforms and their equivalent in the USA, including capacity budling and training. On the second hand, we recommend the development of a R&I project that will fund (cascade funding) experimental activities (using the Advance Wireless Platforms considered in the R&I project described above), research focused projects and mobility of European partners towards interworking with USA research ecosystem.

[12] The Next G Alliance's website, https://nextgalliance.org/ [Online, last access 10 May 2022]

7. Conclusion

This document presents the final EMPOWER Strategy Document and Collaboration Roadmap. During the last years, EMPOWER has placed itself as the main research liaison between the EU and US aiming at sharing information and roadmap as well as aligning the visions and components of the future platforms. Joint activities and events provide evidence about the strong dialogue and trust that has been developed between the two communities. As shown in this document, EMPOWER partners, jointly with USA PAWR colleagues, have worked together in a set of activities to foster the collaboration between the two geographical areas, establishing a continuous relationship between the key players at both sides of the Atlantic.

As main point of this deliverable, we have presented a list of recommendations to Policy-makers and the EU, to provide guidelines for the next phase of EU/USA collaboration. The main conclusion and key recommendation to the EC and 6G-IA is to work closely with recently created bodies such as the ATIS NGI on roadmap and research priorities for 6G development, which will for sure require of Advanced Wireless Platforms for testing. In addition, after working with USA partners and analyzing the USA research ecosystem, we propose USA/EC collaboration to be structured in two different projects, one twining SNS Stream C platforms with USA PAWR infrastructures and a different one, with twin funding, on research and use of the new platforms.

Finally, we advocate to pursue and strengthen the trust relationship developed by the partners and stakeholders during the Empower journey, at a time where the BY5G and 6G topic will become even more strategic. It is therefore worth to sustain, continue to structure and support the cooperation activities among EU and US partners. A practical solution has been proposed in this document, at least in the short/medium term.

Annex I: Updated list of related European and USA Activities

EMPOWER keeps track of all activities involving Advanced Wireless Platforms in EU and USA regions. For completeness and to shorten this deliverable, the current list is available at:
https://www.advancedwireless.eu/deliverables/deliverable1-4/