5G Programmable Infrastructure Converging disaggregated network and compUte REsources

D7.3 Initial dissemination and communication activities document

This project has received funding from the European Union's Framework Programme Horizon 2020 for research, technological development and demonstration

5G PPP Research and Validation of critical technologies and systems

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1.0	Final Revision and submission to the EC	Jesús Gutiérrez (**IHP**)	30.11.2018

Table of Contents

List of Figures

List of Tables

Executive Summary

This document summarises the dissemination, communication and standardisation activities that have occurred in the framework of 5G-PICTURE's Work Package 7 (**WP7**). This document presents the outcomes the project has achieved in this regard from the project starting date.

1 Introduction

The goal of the eighth framework programme funding research, technological development and innovation (H2020 programme), implemented by the European Commission (EC), is to invest in research that will bring Europe at the heart of research and innovation and drive its economic growth. The ongoing research within the H2020 Programme and, more specifically, within the 5G Infrastructure Public Private Partnership (5G-PPP), would be incomplete if the results of the funded projects are not shared with industry and the public in general, and these results are not captured in standardisation bodies. Therefore, a clear dissemination communication and standardisation plan is critical to ensure the required return on this huge investment.

Dissemination is important to guarantee awareness of the 5G-PICTURE project activities and results. In addition, sustainability, communication, as well as data and knowledge management are also essential measures to maximise the impact and ensure the aforementioned expected impact is achieved. In this context, the main pillars of the required measures to maximise the impact for the 5G-PICTURE project results, can be summarised as:

i. publications in top conferences and journals;
ii. standardisation through the communication and lighting standard development organisations (SDOs); and
iii. Industry events and demonstration activities where the applications enabled by the 5G-PICTURE technology will be showcased.

This deliverable presents an overview of 5G-PICTURE dissemination and communication activities carried out in the first reporting period. It is the first of a total of two deliverables, being the second one (D7.4) the one that will capture the activities planned in the second reporting period. Table 1-1 summarises the related documents and their associated due dates.

Table 1-1: Related deliverables on the topics communication and dissemination.

Del. No	Title	Lead Beneficiary	Est. Delivery Date
D7.3	Initial Dissemination and communication activities document	**IHP**	30.11.18
D7.4	Final Dissemination and communication activities document	**IHP**	30.11.19

Organisation of the document

This document is structured in four sections. Following the introduction section, Section 2 describes the communication activities triggered within 5G-PICTURE from the starting date of the project. In Section 3, the updated dissemination plan and the contributions/activities carried out during the first reporting period are outlined. Finally, Section 4 concludes the document and provides pointers to upcoming work in these topics.

2 Communication activities

The communication activities within 5G-PICTURE are targeting the generation of visible impact to stakeholders, public, media, as well as to other communication targets. The communication plan is targeted and adapted to audiences that go beyond the project's own community, including the media and the public.

2.1 Stakeholders

The 5G-PICTURE project stakeholders are outlined below:

- **Network Operators**: it is of the interest of the 5G-PICTURE Consortium to engage the network operators to adopt the 5G-PICTURE transport solution, or at least to incorporate the principles laid out in the 5G-PICTURE architecture.
- **SMEs**, which are a key player in the European economy, must have more visibility in the 5G-PPP. 5G-PICTURE champions the involvement of SMEs and directly or indirectly benefit the engagement of these companies in the development of 5G.
- **Open Source communities**: in 5G-PICTURE some of the developments are based on open source components.
- **SDOs**: 5G-PICTURE will contribute to standardisation and regulatory-related activities at a European and an international level that might influence the work in the project.
- **5G-PPP**: 5G-PICTURE will actively seek to contribute within 5G-PPP by collaborating in the framework with partner projects and to promote jointly the development and trialling of 5G in Europe.
- **Scientific and Academic**. Even though the development of 5G has already moved from the research field to the development field, still the work carried out in 5G-PICTURE opens up research possibilities and to motivate the involvement of scientific and academic organisations.

2.2 Communication plan update

The communication activities are targeted at all the above stakeholders, as well as at the general public, and consumers outside of the technical knowledge of the project. All partners are actively involved in carrying out these activities. The 5G-PICTURE Consortium continues using several tools for both internal and external communications. These are:

- An interactive **Website** for external communications, see section 2.3.1 for more details. Most of the public Website is publicly available, except an area for internal exchange of information within the Consortium and with the EC Project Officer and Experts.
- An internal document exchange is enabled by a project repository (**Sciebo**). In Sciebo takes place the internal communication: generation of highlights, presentation of management data (manpower, finances, deliverables, partner contacts, Gantt charts, etc.), organisation of meetings, a document library, discussion forum, etc.
- Regarding Social Media, the 5G-PICTURE **Twitter** account was set-up in June 2017 (https://twitter.com/5G_PICTURE) and we plan to actively promote and disseminate the 5G-PICTURE activities using this communication channel. The 5G-PICTURE **LinkedIn** account was set-up in June 2017. As in Twitter, the Project disseminates news and contributions made

2.3 Internal/External Communication

From the starting date of the Project, 5G-PICTURE has achieved a relevant impact within the 5G-PPP framework and, in general, in the 5G community in Europe. This section provides an insight on the ongoing Social Media activities, which make known to the community the 5G-PICTURE demonstration activities of various use cases for both the ICT, but also vertical industries in support of the long term 5G vision.

2.3.1 5G-PICTURE Website

The 5G-PICTURE project website [1], set up on July 2017, has been one of the key dissemination and communication channels within the project. It is maintained by the Project Coordinator (PC) and represents an essential tool for 5G-PICTURE's communication. The Website presents the project's objectives and includes a description of the partners. It includes as well links to the different social media channels, which can be utilized by any member of the project.

Figure 2-1: 5G-PICTURE Website "Home" page.

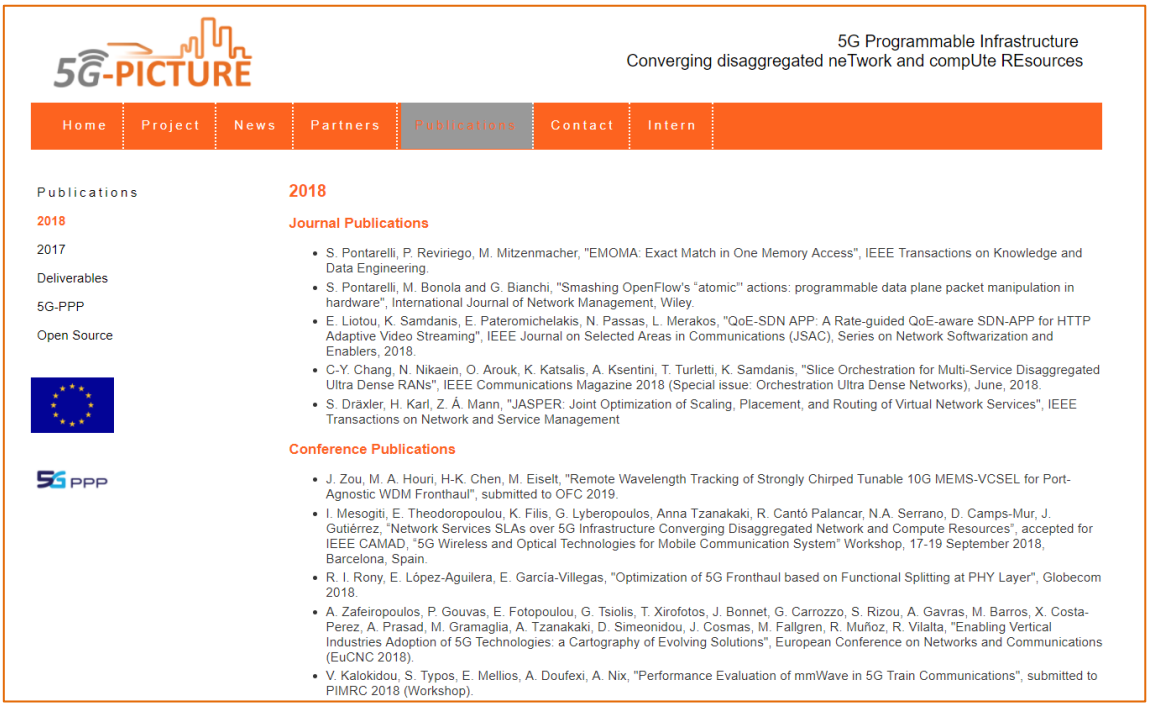

Figure 2-2: Publications part of the Website, where deliverables, 5G-PPP Contributions and Open Source activities can be accessed.

The 5G_PICTURE Website statistics are only available from June 2018 on. In this period, the following performance measures have been obtained:

- 10000 visits.
- 14322 page views (impressions).

2.3.2 Sciebo

5G-PICTURE utilises Sciebo as the internal repository. Sciebo is a Non-commercial cloud storage for research, studying and teaching based on ownCloud. It is operated by 22 universities in NRW, Germany and funded by the state of NRW. Data stored and processed exclusively at three locations in NRW (Münster, Bonn, Duisburg-Essen), protected by Germany's strict data protection law. University of Paderborn (UPB) has gently set up a 5G-PICTURE project box (see Figure 2-3).

2.4 Social Media

2.4.1 Twitter

5G-PICTURE set up a Twitter account on 20th of June 2017. The 5G-PICTURE Twitter has got almost 1,000 profile visits, around 18000 impressions, 55 tweets published, and 377 followers. The integration and initial demonstration activities will be carried out in 2019 and the Consortium expects strengthening the social media activity accordingly. Table 2-1 reflects some of the performance achievements of the account in the first reporting period. Figure 2-4 shows a screenshot of the main 5G-PICTURE Twitter page.

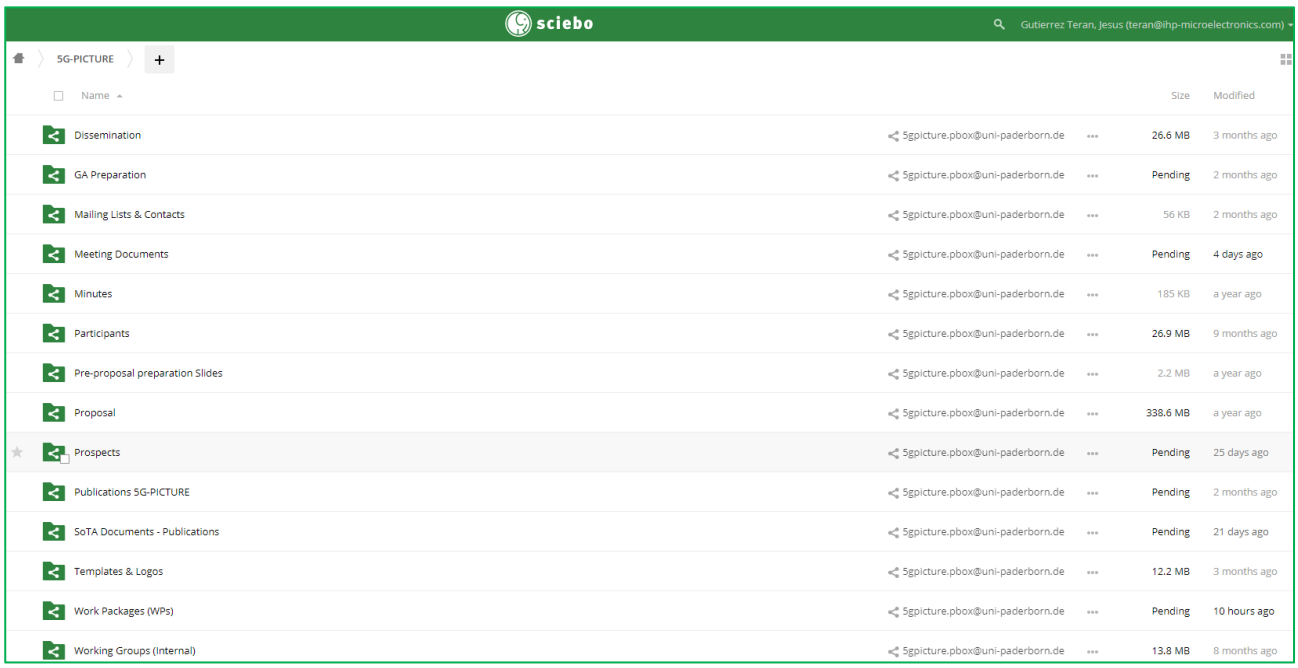

Figure 2-3: 5G-PICTURE's Sciebo Web Interface.

Table 2-1: Twitter performance during the First Reporting Period.

	Results	
Year	**2017**	**2018**
Followers	96	377
Total impressions	7347	10093
Total Profile Visits	322	650

Figure 2-4: 5G-PICTURE Project Twitter account.

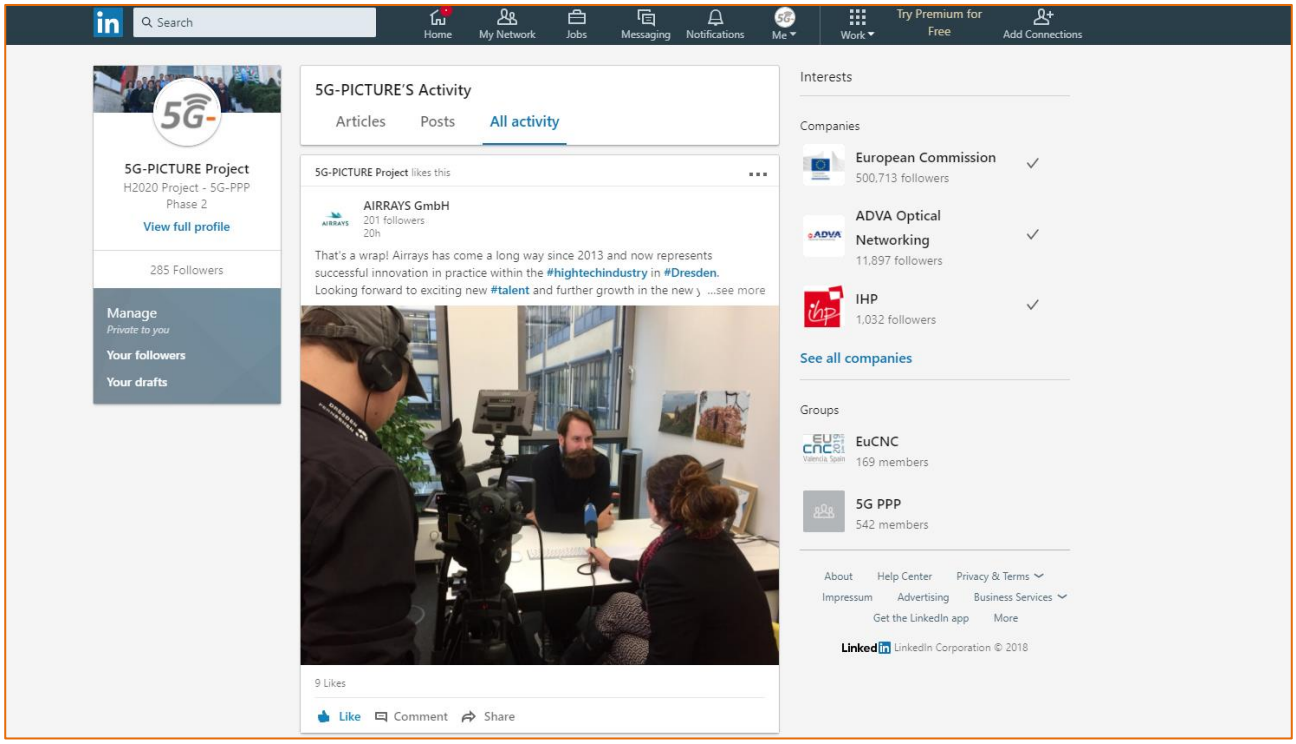

Figure 2-5: 5G-PICTURE LinkedIn account [2].

2.4.2 LinkedIn

5G-PICTURE set up a LinkedIn account on June 2017. The project is part of the 5G-PPP and has made many connections across Europe and abroad. The project has currently 285 followers and, as done in Twitter, is setting up links to other 5G-PPP Projects and making known the project activities and accomplishments. The profile can be accessed via: https://www.linkedin.com/in/5g-picture-project-9a931a152/. Figure 2-5 shows a snapshot of the LinkedIn account.

2.4.3 Others

5G-PICTURE contributes to the 5G-PPP Communications Mailing List (Comms@5g-ppp.eu) with its achievements and new releases. Figure 2-6 shows the 5G-PPP communication of the release of three (3) 5G-PICTURE deliverables this year.

Figure 2-6: Release of 5G-PICTURE deliverables in the 5G-PPP News Page.

3 Dissemination activities

3.1 Dissemination plan

The main objectives of the 5G-PICTURE project regarding dissemination are:

- Active participation in 5G-PPP events as well as in various industrial events such as Mobile World Congress (MWC), IWPC, Small Cell World Summit, Next generation optical networks, and rail events such as Smart City Expo, Innotrans, and SmartRailEurope.
- Interaction with the 5G-PPP Working structure by setting-up a communication link for ensuring co-operation and commitment to joint activities, as well as support on relevant issues: technology, market, etc.
- Organisation of (at least one) 5G-PICTURE Workshop and/or educational exhibitions.
- Internal to the companies' dissemination/communication activities.
- Dissemination through scientific publications in international magazines/conferences/workshops.
- Management of contacts with other companies, institutes and authorities to actively promote the project results.
- Issuing press releases to inform the general public about the objectives and the project results.

The 5G-PICTURE project maintains in Sciebo a dissemination repository, where the PC keeps track of the dissemination activities carried out within the project (https://gast.sciebo.de/remote.php/webdav/5G-PICTURE/Work%20Packages%20(WPs)/WP7/Dissemination%20Activities/5G-PICTURE%20-%20Dissemination%20Repository.xlsx).

3.1.1 Education and training activities

Academic partners in 5G-PICTURE are incorporating the project developments in the curricula of their institution to strengthen the availability of 5G skills. Concrete examples are included in Table 3-1.

Table 3-1: 5G-PICTURE specific training plans.

Specific Training Activity
CNIT organized a PhD school on Network and Computer Sciences in Lipari (Italy) in July 2015. The PhD school introduced the use of Stateful data planes in Software Defined Networks and the programmabiliy models used by those dataplanes (P4 and XFSM). CNIT will also organize the 2019 edition that will be focused on network softwarisation and on the use of Machine learning techniques for networking.
IHP will exploit the 5G-PICTURE results academically through its annual summer school in 2019, and lectures given at Universities in Berlin (Humboldt University) and the graduate school supporting PhD students at IHP. A Graduate Workshop on 5G architectures and technologies is envisioned, encompassing other institutions in Berlin, e.g. FhG FOKUS, Humboldt-University and Technical University of Berlin.
TUD's results in the project will be part of an improved teaching program within the Communications Laboratory of TUD and will thus contribute to maintaining a competitive academic program. TUD will also use its 5G Lab Germany initiative (www.5glab.de) to disseminate 5G-PICTURE results, for example in the annual 5G Lab Summer Schools.
UPB will integrate 5G-PICTURE's results in ongoing teaching activities, e.g., in an MSc-level lecture on future Internet and will use 5G-PICTURE's findings in tutorials, presentations, and hands-on sessions on NFV and SDN high-presence events. Currently, UPB is engaging students in practical implementations in the context of 5G-PICTURE in the form of a 1-year project for a group of 8 students, working on orchestration support for multi-version services.
UNIVBRIS results in the project will be part of an improved teaching program within the Doctoral Training in Communications and will thus contribute to maintaining a competitive academic program.
UTH will provide hands-on experience to graduate students since significant development and experimen-

tation work related to the orchestration and implementation of NFV-based RAN and transport network functions will take place at NITOS testbed. Researchers and students will be educated through research conducted along the lines of 5G-PICTURE in the form of theses, fellowships or research internships in industrial or other academic partners.
EUR will integrate the results developed and achieved in 5G-PICTURE to be part of Graduate student and Doctoral education training, research and development experience, and theses work.

3.1.2 Corporate dissemination

Apart from the overall Project dissemination through the project-related dissemination channels established in June 2017, several partners of the Consortium acknowledge the 5G-PICTURE achievements in their own Websites. Figure 3-1 shows an example of the dissemination of ADVA and TP demonstration award achieved at ECOC 2018 (see section 3.3.9 for more details on this specific accomplishment).

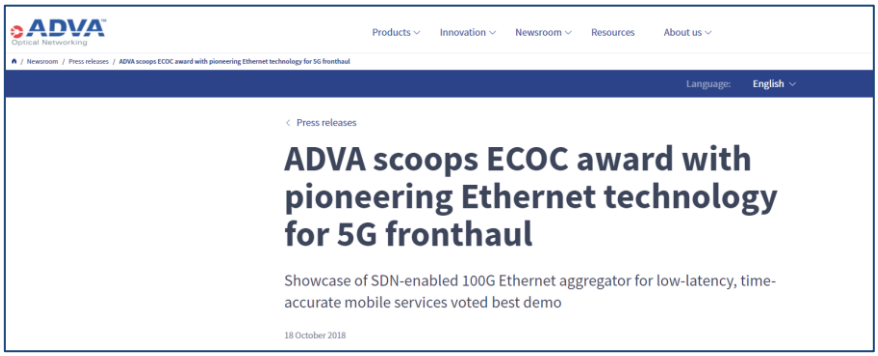

Figure 3-1: ADVA's acknowledgement of the ECOC award.

Another example is the references Airrays makes to 5G-PICTURE in its own Website (see Figure 3-2) https://www.airrays.com/research/, https://www.airrays.com/news/

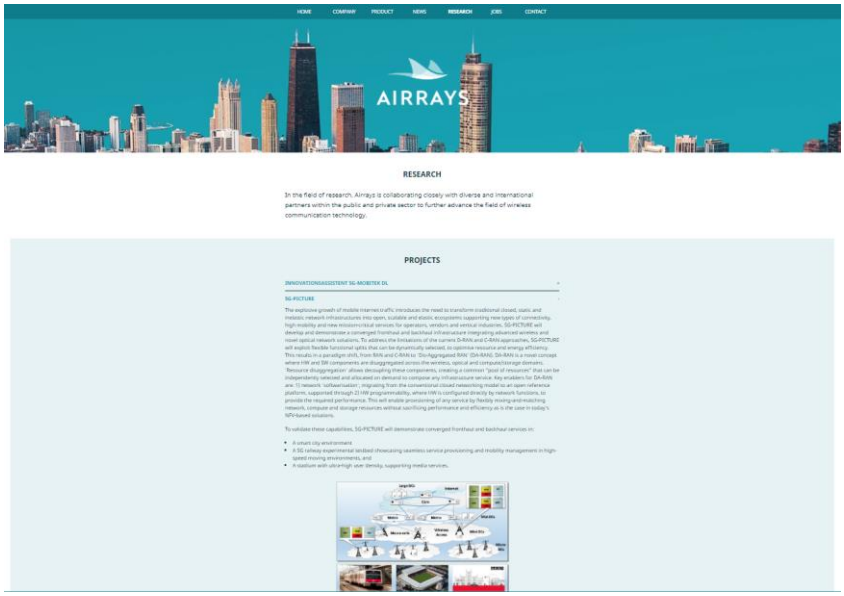

Figure 3-2: 5G-PICTURE included in Airrays Website.

Moreover, 5G-PICTURE has been reported in a press release issued by COSMOTE in Oct 2017, available under the link.

Finally, 5G-PICTURE has been reported in the 2017 Annual Sustainability Reports of COSMOTE (Report 1, pages 55 and 56), and the Deutsche Telecom Group (Report_DT).

3.2 Contributions to 5G-PPP

In this section we describe our collaboration with the 5G-PPP and the various Working Groups (WGs) we are involved in.

3.2.1 Dissemination in Working Groups (WGs)

5G-PICTURE has declared, at the beginning of the Project, its degree of involvement in most of the Working Groups (WGs) related to 5G-PPP, either triggered by the 5G IA or the 5G-PPP itself. We proceed to summarise the contributions per WG. Table 3-2 outlines the main contributors from the 5G-PICTURE project to these WGs.

3.2.1.1 Architecture WG

The Architecture WG is perceived as one of the major targets of 5G-PICTURE. Our Technical Manager (TM), Dr. Anna Tzanakaki (**UNIVBRIS**), presented the 5G-PICTURE architectural concept at a Teleconference held on June 5th 2018. Moreover, initial results on the optimisation of disaggregated compute resources were discussed. The slide set can be accessed via:

https://bscw.5g-ppp.eu/sec/bscw.cgi/256508

The associated work can be accessed via the 5G-PICTURE Website:

- A. Tzanakaki et al., "Converged Access/Metro Infrastructures for 5G services", invited to OFC 2018, San Diego, CA. https://www.5g-picture-project.eu/download/cam_ofc_hpn_2018.pdf

5G-PICTURE will provide an additional presentation on March 1st 2019 including the up-to-date results extracted from the 5G-PICTURE architecture evaluations, which will be completed and captured in deliverable D2.3 in May 2019.

3.2.1.2 Spectrum WG

IHP is taking part in the telephone conferences organized by WG Spectrum on a regular basis. In the Spectrum WG, IHP has actively contributed to the “WG Spectrum Response to 5G-IA on RSPG 2nd Opinion”. In particular the position of 5G-PICTURE on the role of millimetre wave (mmWave) technologies for access and transport network applications were outlined and are reflected in the letter of WG Spectrum to the 5G-IA.

Furthermore IHP has actively contributed and influenced the discussion on spectrum defragmentation which is outlined in the “5G IA Response to the Public consultation on the Draft RSPG Opinion on 5G implementation challenges (RSPG 3rd opinion on 5G)”.

Moreover, 5G-PICTURE via IHP has also actively contributed and generated input to the "EC Request to consider Spectrum Issues in FP9 timeframe".

3.2.1.3 TB KPIs WG

Our colleagues Kostas Katsalis (**HWDU**) and Chia-Yu Chang (**EUR**) represent 5G-PICTURE in the 5G Infrastructure TB discussions on KPIs. 5G-PICTURE is contributing to the TB Performance KPIs ad-hoc Team Status document.

Kostas took part in the PPP Technical Workshop held in Kista on November 20-22. Currently 5G-PICTURE is preparing a more descriptive text on KPIs.

Figure 3-3: 5G-PPP Workshop on performance KPIs.

3.2.1.4 5G IA Pre-Standardization WG

The 5G IA Pre-Standardization WG monitors continuously the 5G functionalities proposed and their mapping target SDOs indicated. The goal of this WG is to obtain information about current standardisation work or planned work in each of the 5G-PPP Projects.

5G-PICTURE provides to this WG with the mapping of the contributions of the Project to Standards. This information is updated regularly to monitor and/or contribute to SDOs, where we indicate Partners' involvement, as well as contributions of companies from the vertical industries.

3.2.1.5 5G Software Networks

Since the 5G-PICTURE project started in June 2017, the 5G Software Networks WG has been steered to tackle the Cloud Native initiative. The topics 5G-PICTURE wanted to promote, open source standards (e.g. OpenAirInterface) and orchestration software implementations, which are related to the developments carried out in the project, have not been much of interest for the WG towards the preparation of the White Paper released in July 2018 (https://5g-ppp.eu/wp-content/uploads/2018/07/5GPPP-Software-Network-WG-White-Paper-July-2018.pdf).

Lately, 5G-PICTURE has been asked to provide its vertical use-cases and their usage of the cloud native principles identified in the abovementioned White Paper. A description of the contribution from 5G-PICTURE to the discussion is included below:

"Running network aware apps over sliced heterogeneous, programmable networks. Target application: Crowdsource video. The application will have components deployed locally on the Stadium infrastructure as well as on a cloud platform. Application will be network aware at the Edge (Stadium) and will use APIs to partially control the traffic in its slice. This use-case attempts to validate standard means of interaction between Orchestrators, Controllers, MANO and the physical network. The view taken is end-to-end and not restricted to cloud or connectivity."

3.2.1.6 Trials WG

5G-PICTURE is monitoring the Trials WG and providing the required information about those happening in 5G-PICTURE. It is expected that in 2019 we will strengthen our involvement in the WG thanks to the definition of the trials in deliverable D6.1, which we will be able to present and detail to the Trials WG community.

Table 3-2: 5G-PICTURE Contributors to the different WGs established by the 5G-IA and the 5G-PPP.

WG	Involvement	1st	2nd	3rd	4th
Architecture WG 5G-PPP	**High**	Anna Tzanakaki UNIVBRIS	Daniel Camps I2CAT	Giuseppe Bianchi CNIT	Jesús Gutiérrez IHP
WG 5G Pre-standardization WG 5G IA	**High**	Salvatore Pontarelli CNIT	Mickaël Fontaine TP	Achim Autenrieth ADVA	
WG 5G Spectrum 5G IA	Medium	Eckhard Grass IHP			
WG SME Networld2020	Low	Peter Legg BWT	Vassilis Seferidis ZEETTA	Peter Meyer AIR	Mickaël Fontaine TP
WG Vision and Societal Challenges WG 5G IA	Medium	Andrea di Giglio TIM	Anna Tzanakaki UNIVBRIS		
WG Software Networks (SDN,NFV) 5G-PPP	**High**	Paris Flegkas UTH	Azahar Machwe ZEETTA		
WG Trials 5G IA	**High**	Dimitra Simeonidou UNIVBRIS	Crispin Dent-Young ZEETTA	Manuel Alfageme COMSA	
Cross projects/METIS-II Use Cases, Requirements, KPIs 5G-PPP	**High**	Kostas Katsalis HWDU	Chia-Yu Chang EUR		

3.3 Participation of 5G-PICTURE in Events

5G-PICTURE has participated in several Events since its starting date (July 1st 2017). We make below a brief overview of those Events.

3.3.1 5G Summit Greece

5G-PICTURE TM, Dr. Anna Tzanakaki (**UNIVBRIS**), chaired one of the sessions of the 5G Summit taking place in Thessaloniki (Greece) in July 11th 2017. She presented as well the architectural concept of 5G-PICTURE using the following slides.

3.3.2 INFOCOM World

Ioanna Mesogiti (**COS**) presented the 5G-PICTURE concept at the INFOCOM World Conference (https://www.infocomworld.gr/19o-infocom-world-2017-2/erevnitika-programmata-o-t-e/programma-erevnitikon-programmaton-o-t-e/). More information can be accessed here.

3.3.3 Mobile World Congress 2018

The 5G-PICTURE project disseminated its ongoing developments and future demonstration activities related to the Railway at Mobile World Congress 2018. The PC, Dr. Jesús Gutiérrez Terán (**IHP**), provided a presentation on the expected work on 5G for Railways at the stand of the Metropolitan Transport Authority (*Autoritat del Transporte Metropolitá*) in Barcelona, where some of the Railway-related colleagues took part in the talk.

5G-PICTURE generated a Flyer for the event, which was available at the 5G-IA Stand as well as at the "*Autoritat del Transporte Metropolitá*" Stand.

3.3.4 EuCNC 2018

EuCNC is one of the key venues for dissemination of 5G-PICTURE activities. 5G-PICTURE was present at EuCNC 2018 with the organisation of two Workshops:

- **Workshop 3** entitled "Multi-provider, multi-vendor, multi-player orchestration: from distributed cloud to edge and fog environments in 5G" (https://www.eucnc.eu/workshops/workshop-3/), and
- **Workshop 5** entitled "Optical and Wireless Network Convergence: An Enabler for 5G" (https://www.eucnc.eu/workshops/workshop-5/).

Figure 3-4: Dr. Jesús Gutiérrez (IHP) presenting 5G-PICTURE concept at the Stand.

Figure 3-5: Workshop 5 about to start in EuCNC 2018.

Figure 3-6: Dr. Anna Tzanakaki (UNIVBRIS) presenting in Workshop 5.

5G-PICTURE contributed as well to Workshop 2, entitled "From cloud ready to cloud native transformation: What it means and Why it matters" (https://www.eucnc.eu/workshops/workshop-2/).

5G-PICTURE contributed as well to EuCNC with five (5) publications, being the Phase-2 project with more published papers at the Conference:

- N. Gkatzios, M. Anastasopoulos, A. Tzanakaki, D. Simeonidou, “Compute Resource Disaggregation: An Enabler for Efficient 5G RAN Softwarisation”.
- S. Dräxler, H. Karl, H. Razzaghi Kouchaksaraei, A. Machwe, C. Dent-Young, K. Katsalis and K. Samdanis, “5G OS: Control and Orchestration of Services on Multi-Domain Heterogeneous 5G Infrastructures”.

- H. Razzaghi Kouchaksaraei, S. Dräxler, M. Peuster and H. Karl, “Programmable and Flexible Management and Orchestration of Virtualized Network Functions”.
- N. Ul Hassan, W. Xu and A. Kakkavas, “A Comparison of Shaping Techniques for Wireless Backhaul.
- Marco Spaziani Brunella, Salvatore Pontarelli, Marco Bonola, Giuseppe Bianchi, “V-PMP: a VLIW Packet Manipulator Processor”.
- S. Bjørnstad, D. Chen, R. Veisllari, “Handling Delay in 5G Ethernet Mobile Fronthaul Networks”.

In 2019 5G-PICTURE plans to bring several demos to an own Exhibitor prior to the final demonstrations happening at the end of 2018 and at the beginning of 2019.

3.3.5 ONDM 2018

5G-PICTURE contributed to the Workshop "Optical technologies in the 5G era" at ONDM 2018 with a presentation entitled "5G Networking: an enabler for vertical industries". Find more details via (https://ondm2018.scss.tcd.ie/optical-technologies-in-the-5g-era/).

Our 5G-PICTURE colleague, Dr. Markos Anastasopoulos (**UNIVBRIS**), gave a presentation on "5G Networking: an enabler for vertical industries", providing an an specific example on Railway Systems, which will be showcased by our Project.

Figure 3-7: Dr. Markos Anastasopoulos (UNIVBRIS) presenting at ONDM 2018.

3.3.6 5G-XHaul Project Conclusion and Dissemination Workshop

5G-PICTURE held its third Technical Meeting in the city of Bristol, UK; hosted by the University of Bristol. The 5G-PICTURE Consortium took part in the 5G-XHaul Final Demonstration Event, where our colleagues successfully demonstrated its wireless and optical technologies in a real city wide infrastructure. Many lessons learned were shared with the 5G-PICTURE Consortium, given that in the next 1’5 years demonstrations will take also place in the city of Bristol demonstrating both operational and end-user use cases. Figure 3-8 shows the finalisation of the Demonstration day.

Figure 3-8: The 5G-PICTURE Consortium celebrating the success of the 5G-XHaul Final Demonstration event.

3.3.7 IEEE CAMAD 2018

5G-PICTURE partnered with its partner Projects 5G-PHOS, 5GESSENCE and BlueSpace for the organization of a Workshop at the IEEE CAMAD 2018 conference (http://camad2018.ieee-camad.org/program/), which took place in Barcelona in September 2018.

Figure 3-9: 5G-PICTURE Joint Workshop at IEEE CAMAD 2018.

3.3.8 PSC 2018

The International Conference on “Photonics in Switching and Computing – PSC 2018 took place in Limassol, Cyprus on September 19-21 2018. A Cross-Pollination of EU project meetings took place in this Conference, where Metro-Haul, BlueSpace, 5G PHOS and 5G-PICTURE jointly organised a Workshop on “Optical Fronthaul and Backhaul Technologies for 5G Networks”. This workshop aimed at highlighting the advances in optical and networking technologies for 5G front and backhaul in the second phase of 5G-PPP, to set them into a global context, and to foster collaboration between the involved projects and identify common goals and approaches.

Our 5G-PICTURE TM, Dr. Anna Tzanakaki (**UNIVBRIS**), gave a presentation at the Workshop, entitled “Converging Optical wireless and DC networks:The 5G-PICTURE approach” (Figure 3-10).

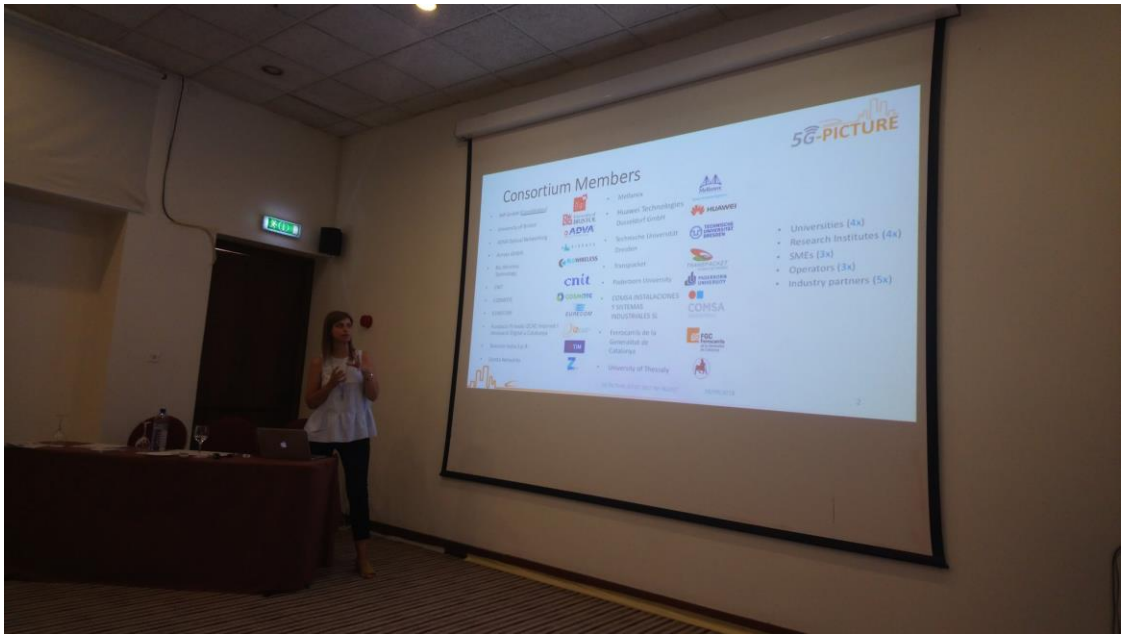

Figure 3-10: 5G-PICTURE Presentation at PSC 2018.

3.3.9 ECOC 2018

At the 44th European Conference on Optical Communication (ECOC 2018), the 5G-PICTURE partners **ADVA** and TransPacket (**TP**) jointly showcased SDN-enabled 100G Ethernet aggregator for low-latency, time-accurate mobile x-haul in a live demo. Three aggregator nodes enable ultra-low bounded-delay aggregation and fixed-delay transmission for fronthaul converged with less delay-sensitive backhaul traffic. PTP synchronization is guaranteed through a fixed-latency service channel. This showcase was finally awarded as the Best Demo among total 16 candidates at the closing ceremony (see Figure 3-11)!

Figure 3-11: ADVA and TransPacket winners of the ECOC Demo.

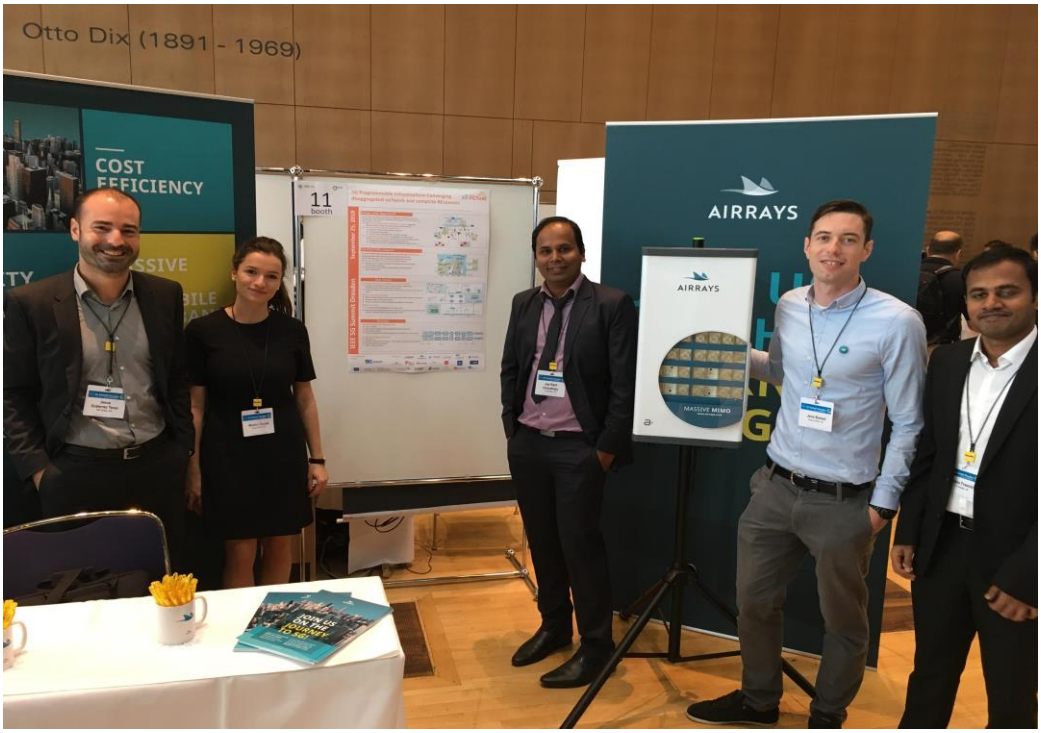

Figure 3-12: 5G-PICTURE Colleagues at Airrays booth showcasing the massive MIMO technology to be used in the project.

3.3.10 IEEE 5G Summit

5G-PICTURE was present at the IEEE 5G Summit Dresden (http://www.5gsummit.org/dresden/), organized by 5G Lab Germany and IEEE, where some Project colleagues (in Figure 3-12) were showing the Massive MIMO antenna from AIRRAYS GmbH (https://www.airrays.com/).

3.3.11 Mobile World Congress 2019

5G-PICTURE submitted a proposal for demonstrations to be showcased at the Mobile World Congress 2019 (MWC 2019). The proposals from different 5G-PPP Projects were evaluated already and, unfortunately, the 5G-PICTURE demo proposal was not accepted for showcasing on site. The University of Thessaly (**UTH**), along with other 5G-PICTURE partners, have drafted the concept and required demonstration equipment, etc. in Figure 3-13, which will be shown a video footage at MWC 2019.

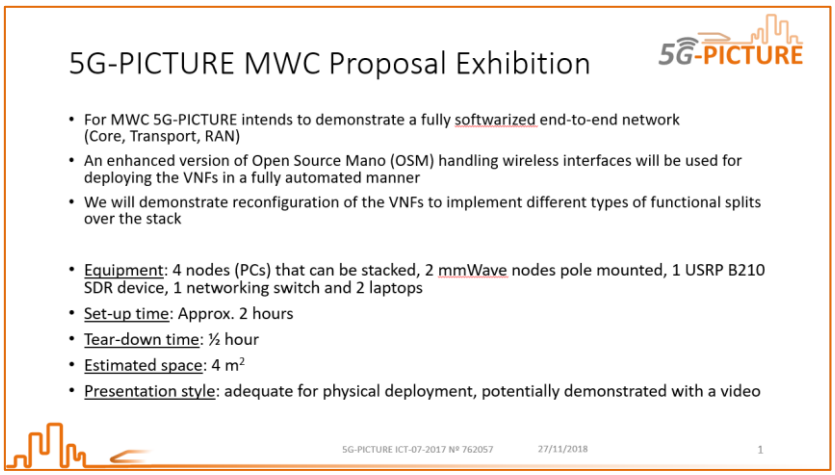

Figure 3-13: 5G-PICTURE MWC 2019 Demo proposal.

ADVA and **TP** plan a joint experiment/demonstration. The results could be showcased by video or slide set at ADVA's booth at MWC 2019. The proposal, illustrated in Figure 3-13, will demonstrate an integrated 5G-XHaul solution transporting synchronisation and fronthaul traffic (possibly backhaul as well) through TP's Time Sensitive Ethernet aggregator nodes and distributed through ADVA's G.metro passive WDM system.

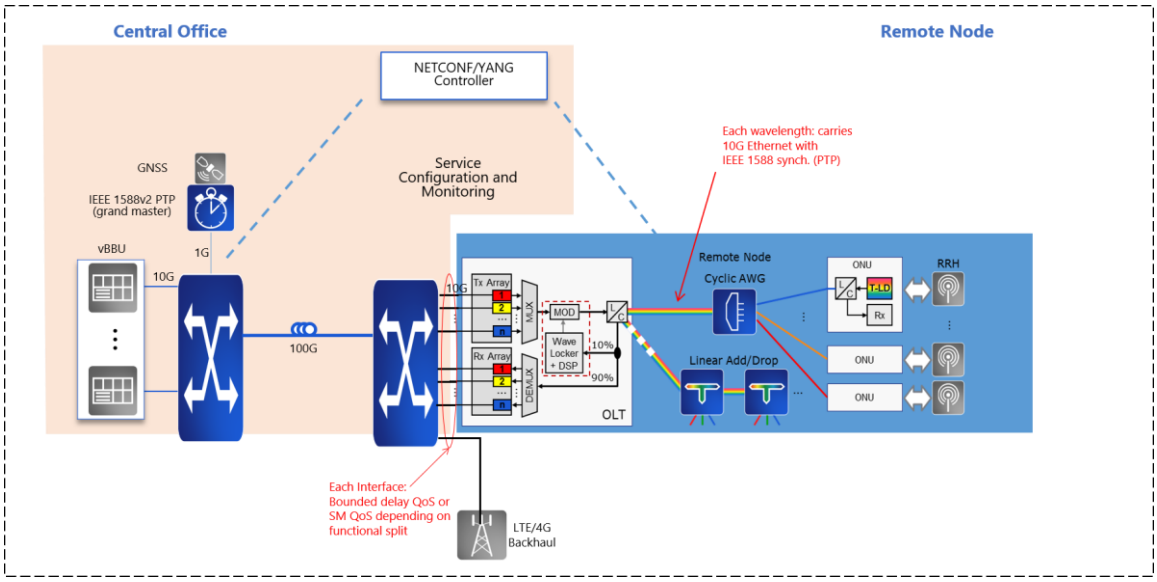

Figure 3-13: ADVA/TP MWC 2019 Demo proposal.

3.4 5G-PICTURE Publications within 5G-PPP

3.4.1 5G Annual Journal

5G-PICTURE contributed to the 5G Annual Journal 2018, a report which mainly targets to an external audience, and has to reflect the activities of the 5G-PPP Projects and 5G-IA in the past year (mid-2017 to mid-2018) with a summary of the concept, the main technical and research challenges, some of the results presented in deliverable D2.1 and a description of the planned demonstrations. The journal can be accessed via this link.

3.4.2 Eurescom Message Magazine

5G-PICTURE has contributed to the last release of the Eurescom Message Magazine (Summer 2018) with an article on "5G for Railway Innovation", which presents the 5G-PICTURE approach for future railway systems (link to the publication).

3.5 5G-PICTURE Publications

5G-PICTURE has disseminated the work carried out in the project in different forms and in different venues. In this first reporting period the project has contributed to many presentations and publications, complying with that what was targeted in the DoW.

The project has contributed so far with a total of:

- 28 publications in Conferences (see Table 3-3 for more details).
- 5 demonstrations at Conferences and/or 5G-related events (see Table 3-4 for more details).
- 7 publications in high-ranked Journals (see Table 3-5 for more details).
- 10 presentations in 5G-related Workshops (see Table 3-6 for more details).

Table 3-3: Conference papers belonging to the first reporting period.

	Venue	Date	Location	Type of contribution	Title	Author(s) / Presenter	Partner	Status	Related WP(s)
1	IEEE ICC 2018	May 20-24, 2018	Kansas City, USA	Paper	Software-based Implementation of LTE/Wi-Fi Aggregation and Its Impact on Higher Layer Protocols	D. Ibarra, N. Desai, I. Demirkol	I2CAT/UPC	Accepted	WP4
2	IEEE ICC 2018	May 20-24, 2018	Kansas City, USA	Paper	A Graph Coloring based Inter-Slice Resource Management for 5G Dynamic TDD RANs	E. Pateromichelakis, K. Samdanis	HWDU	Accepted	WP4
3	IEEE WCNC 2018	May 20-24, 2018	Barcelona, Spain	Paper	Softwarized LTE Self-Backhauling Solution and Its Evaluation	J.Gamboa, I. Demirkol	I2CAT/UPC	Accepted	WP4
4	Cloud Computing 2018	February 22, 2018	Barcelona, Spain	Paper	Joint Orchestration of Cloud-Based Microservices and Virtual Network Functions	H. R. Kouchaksaraei, H. Karl	UPB	Accepted	WP5
5	TRA 2018	April, 16-19, 2018	Vienna, Austria	Paper	ICT platforms in support of future railway systems	M. Anastasopoulos, A. Tzanakaki, D. Simeonidou	UNIVBRIS	Accepted	WP2
6	OFC 2018	March 2018	San Diego, USA	Paper	Scenarios and Economic Analysis of Fronthaul	A. di Giglio, A. Tzanakaki and D. Simeonidou	TIM	Invited	WP2
7	OFC 2018	March 2018	San Diego, USA	Paper	Converged Access/Metro Infastructures for 5G services	A. Tzanakaki et al.	UNIVBRIS	Invited	WP2
8	OFC 2018	March 2018	San Diego, USA	Paper	Experimental Demonstration of 100 Gb/s Optical Network Transport and Aggregation for Ethernet Fronthaul with Low and Bounded Delay	R. Veisllari et al.	TP	Accepted	WP3
9	NOMS 2018	April 23-27, 2018	Taipei, Taiwan	Paper	JOX: An event-driven orchestrator for 5G network slicing	K. Katsalis, N. Nikaein and A. Huang	HWDU	Accepted	WP5
10	IEEE IWQoS 2018	June 4-6 2018	Banff, Alberta, Canada	Paper	SWAM: SDN-based Wi-Fi Small Cells with Joint Access-Backhaul and Multi-Tenant Capabilities	M. Grandi, et al.	I2CAT	Accepted	WP3/ WP4
11	EuCNC 2018	June 18-21	Ljubljana, Slovenia	Paper	5G OS: Control and Orchestration of Services on Multi-Domain Heterogeneous 5G Infrastructures	S. Dräxler et al.	UPB	Accepted	WP5
12	EuCNC 2018	June 18-21	Ljubljana, Slovenia	Paper	Programmable and Flexible Management and Orchestration of Virtualized Network Functions	H. Razzaghi Kouchaksaraei et al.	UPB	Accepted	WP5
13	EuCNC 2018	June 18-21	Ljubljana, Slovenia	Paper	V-PMP: a VLIW Packet Manipulator Processor	M. Spaziani Brunella et al.	CNIT	Accepted	WP3
14	EuCNC 2018	June 18-21	Ljubljana, Slovenia	Paper	Compute Resource Disaggregation: An Enabler for Efficient 5G RAN Softwarisation	N. Gkatzios	UNIVBRIS	Accepted	WP3
15	EuCNC 2018	June 18-21	Ljubljana, Slovenia	Paper	Handling Delay in 5G Ethernet Mobile Fronthaul Networks	S. Bjørnstad et al.	TP	Accepted	WP3
16	EuCNC 2018	June 18-21	Ljubljana, Slovenia	Joint Paper	Enabling Vertical Industries Adoption of 5G Technologies: a Cartography of Evolving Solutions	A. Zafeiropoulos et al.	UNIVBRIS contrib.	Accepted	-
17	ONDM 2018		Dublin, Ireland	Paper	Provisioning of 5G Services Employing Machine Learning Techniques	A. Pelekanou et al.	UNIVBRIS	Accepted	
18	PIMRC 2018	Sept 9-12 2018	Bologna, Italy	Paper	Performance Evaluation of mmWave in 5G Train Communications	V. Kalokidou	UNIVBRIS	Accepted	WP3
19	MobiWac 2018	Nov 2 2018	Montréal, QC, Canada	Paper	Access-aware Backhaul Optimization in 5G	R. I. Rony	I2CAT/UPC	Accepted	WP3-4
20	Globecom 2018	Dec 9-13 2018	Abu Dhabi, UAE	Paper	Optimization of 5G Fronthaul based on Functional Splitting at PHY Layer	R. I. Rony	I2CAT/UPC	Accepted	WP4

21	IEEE CAMAD	Sept 17-21	Barcelona, Spain	Paper	Network Services SLAs over 5G Infrastructure Converging Disaggregated Network and Compute Resources	I. Mesogiti et al.	COS	Accepted	WP2
22	NetSoft	2018	Montreal, Canada	Paper	Generating Resource and Performance Models for Service Function Chains: The Video Streaming Case	S. Dräxler, M. Peuster, M. Illian, H. Karl	UPB	Accepted	WP5
23	ALENEX	2018	New Orleans, LA, USA	Paper	Adaptive Cuckoo Filters	M. Mitzenmacher, S. Pontarelli, P. Reviriego	CNIT	Accepted	WP3
24	GI/ITG KuVS Fachgespräch Fog Computing	2018	Darmstadt, Germany	Tech. Report	Towards Predicting Resource Demands and Performance of Distributed Cloud Services	S. Dräxler. M. Peuster, M. Illian, H. Karl	UPB	Accepted	WP5
25	ECOC 2018	2018	Rome, Italy	Paper	Field-Trial Evaluation of Low-Latency and Timing-Accurate 100G Ethernet Aggregator for Converged Mobile X-haul	J. Zou et al.	ADVA/TP	Accepted	WP3
26	ACP 2018	2018	Hangzhou, China	Paper	Converged Fronthaul/Backhaul based on Integrated Hybrid Optical Networks	F. Tonini et al.	TP	Accepted	WP3
27	IEEE 5G World Forum (5GWF)	2018	Santa Clara, CA, USA	Paper	A Reconfigurable Architecture for Packet Based 5G Transport Networks	R. Rao, R. Veisllari, M. Fontaine	TP	Accepted	WP3
28	OFC 2019	2019	San Diego, CA, USA	Paper	High-speed transport and aggregation for ethernet fronthaul with low and bounded delay	R. Veisllari et al.	TP	Invited	WP3

Table 3-4: Demos at Conferences.

	Venue	Date	Location	Title	Author(s) / Presenter	Partner	Related WP(s)
1	Mobile World Congress (MWC 2018)	2018	Barcelona, Spain	P4 Runtime support into the ONOS SDN	M. Kadosh	MLNX	WP3
2	NetSoft	2018	Montreal, Canada	Pishahang: Joint Orchestration of Network Function Chains and Distributed Cloud Applications	H. R. Kouchaksaraei et al.	UPB	WP5
3	P4 Workshop	2018	CA, USA	Switch ASIC programmability in hybrid mode https://p4.org/assets/P4WS_2018/14_Matty_Kadosh_ASIC.pdf	M. Kadosh	MLNX	WP3
4	ECOC 2018	2018	Rome, Italy	LiveDemo of Low-Latency and Timing-Accurate Mobile X-haul based on SDN-Enabled 100G Ethernet Aggregator	J. Zou et al.	ADVA/TP	WP3
5	ECOC 2018	2018	Rome, Italy	Demonstration of a per-flow Token Bucket implemented on Open Packet Processor	G. Bianchi et al.	CNIT	WP3

Table 3-5: Journal Papers belonging to the first reporting period.

	Venue	Title	Author(s)	Partner	Status	Related WP(s)
1	IEEE Transactions on Network and Service Management	JASPER: Joint Optimization of Scaling, Placement, and Routing of Virtual Network Services	S. Dräxler, H. Karl, Z. Á. Mann	UPB	Accepted	WP5
2	IEEE Communications Magazine, Special issue: Orchestration Ultra Dense Networks	Slice Orchestration for Multi-Service Disaggregated Ultra Dense RANs	C-Y. Chang, N. Nikaein, O. Arouk, K. Katsalis, A. Ksentini, T. Turletti, K. Samdanis	EUR	Accepted	WP5
3	IEEE Journal on Selected Areas in Communications (JSAC)	QoE-SDN APP: A Rate-guided QoE-aware SDN-APP for HTTP Adaptive Video Streaming	E. Liotou, K. Samdanis, E. Pateromichelakis, N. Passas, L. Merakos	HWDU	Accepted	WP4 / WP5
4	International Journal of Network Management, Wiley	Smashing OpenFlow's "atomic"' actions: programmable data plane packet manipulation in hardware	S. Pontarelli, M. Bonola and G. Bianchi	CNIT	Accepted	WP3
5	IEEE Transactions on Knowledge and Data Engineering	EMOMA: Exact Match in One Memory Access	S. Pontarelli, P. Reviriego, M. Mitzenmacher	CNIT	Accepted	WP3
6	Appl. Sci. 2018 Special Issue: Optical Communications and Networking Solutions for the Support of C-RAN in 5G Environments	C-RAN Traffic Aggregation on Latency-Controlled Ethernet Links (Open Access "Gold")	F. Tonini, B. M. Khorsandi, S. Bjornstad, R. Veisllari, C. Raffaelli	TP	Accepted	WP3
7	IEEE/OSA Journal of Optical Communications and Networking, Special Issue on Latency in Edge Optical Networks	Minimizing Delay and Packet Delay Variation in Switched 5G Transport Networks	S. Bjornstad, R. Veisllari, D. Chen, F. Tonini, C. Raffaelli	TP	Submitted	WP3

Table 3-6: 5G-PICTURE Presentations at Workshops.

	Venue	Date	Location	Type of contribution	Title	Presenter	Partner	Related WP(s)
1	IEEE 5G Greece Summit	July 11 2017	Thessaloniki, Greece	Presentation	5G Programmable Infrastructure Converging disaggregated neTwork and compUte REsources	A. Tzanakaki	UNIVBRIS	WP1
2	Infocom World	Oct 25 2017	Athens, Greece	Presentation	5G Programmable Infrastructure Converging disaggregated neTwork and compUte REsources	I. Mesogiti	COS	WP1
3	Mobile World Congress	Feb 28 2018	Barcelona, Spain	Presentation	5G Programmable Infrastructure Converging disaggregated neTwork and compUte REsources	J. Gutiérrez	IHP	WP1, WP6
4	ONDM 2018	May 15 2018	Dublin, Ireland	Presentation	5G Networking: an enabler for vertical industries	M. Anastasopoulos	UNIVBRIS	WP2
5	EuCNC	June 18 2018	Ljubljana, Slovenia	Presentation	Optical X-Haul Technologies for 5G over SDN-Enabled Network	J. Zou	ADVA	WP3
6	EuCNC	June 18 2018	Ljubljana, Slovenia	Presentation	Advanced Optical Networking: An Enabler for 5G	A. Tzanakaki	UNIVBRIS	WP2
7	EuCNC	June 18 2018	Ljubljana, Slovenia	Panel	Optical and Wireless Network Convergence: An Enabler for 5G	J. Zou	ADVA	-
8	EuCNC	June 18 2018	Ljubljana, Slovenia	Presentation	HW based Offloading of Transport layer functions on SmartNICs	A. Tulumello	CNIT	WP3

9	PSC 2018	Sept 18 2018	Limassol, Cyprus	Presentation	Converging Optical wireless and DC networks: The 5G-PICTURE approach	A. Tzanakaki	UNIVBRIS	WP2
10	PSC 2018	Sept 18 2018	Limassol, Cyprus	Presentation	Advanced Optical X-haul Technologies for 5G Networks	J. Zou	ADVA	WP3

4 Summary and Conclusions

This deliverable presents the dissemination and communication achievements of the 5G-PICTURE project during its first reporting period. In a future deliverable, D7.4, due in November 2019, the Consortium will provide an overview of the activities to be carried out in the second reporting period.

5 References

[1] 5G-PICTURE Web Page, http://www.5g-picture-project.eu

[2] 5G-PICTURE LinkedIn page, https://www.linkedin.com/in/5g-picture-project-9a931a152/

6 Acronyms

Acronym	Description
EC	European Commission
MWC	Mobile World Congress