H2020 5G-TRANSFORMER Project
Grant No. 761536

Report on WP6 progress and update of CoDEP

Abstract

This document presents the progress and activities of the 5G-TRANSFORMER project during Y1 and Y2. All the results are classified according to the Communication, Dissemination, and Exploitation Plan (CoDEP), and taking as reference the plan updated in D6.2. To recall, communication includes all the activities related with the promotion of the project, the interaction with other research projects (including coordination with other 5GPPP projects), as well as with non-specialists, i.e., the society at large. Dissemination includes activities on peer-reviewed publications in academic conferences and journals, and it also includes participation and organization of technical events. Exploitation includes the activities aiming at using the results from the 5G-TRANSFORMER project in various ways, including developing, creating and marketing products or processes, or provisioning a service. Project results will also be exploited through the standardization activities. In addition, the document introduces an update/plan for the CoDEP, as the project is transiting from the *presentation of results* phase (Y2) to *integrated experimental demonstrations* phase.

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List of Acronyms

Acronym	Description
3GPP	Third Generation Partnership Project
5G PPP	5G Public Private Partnership
API	Application Programming Interface
BTS	Base Transceiver Station
CDB	Common Dissemination Booster
CDN	Content Delivery Network
CPRI	Common Public Radio Interface
CSA	Coordination and Support Action
DoA	Description of the Action
DWDM	Dense Wavelength Division Multiplexing
E2E	End-to-end
EPC	Evolved Packet Core
ETSI	European Telecommunications Standards Institute
ICT	Information and Communication Technology
IEEE	Institute of Electronics and Electrical Engineering
IETF	Internet Engineering Task Force
IMT	International Mobile Telecommunications
IoT	Internet of Things
IP	Internet Protocol
IPR	Intellectual Property Rights
IRTF	Internet Research Task Force
ITS	Intelligent Transport Systems
ITU-T	International Telecommunications Union – Telecommunications standardization sector
E2E	End to End
LTE / -A	Long Term Evolution / -Advanced (3GPP)
MEC	Multi-Access Edge Computing
MPTCP	Multi-Path Transmission Control Protocol
MME	Mobility Management Entity
MTP	Mobile Transport and Computing Platform
MVNO	Mobile Virtual Network Operator
NFV	Network Functions Virtualization
NFVRG	NFV Research Group (IRTF)
NGMN	Next Generation Mobile Networks
OBSAI	Open Base Station Architecture Initiative
ONF	Open Networking Foundation
OPNFV	Open Platform for NFV
QoS	Quality of Service
RTT	Round Trip Time
SAC	Standards Advisory Committee
SDN	Software Defined Networks
SDO	Standard Development Organization
SLA	Service Level Agreement
SO	Service Orchestrator
S-/P-GW	Serving / Packet Data Network Gateway
VNF	Virtual Network Function
VNFM	Virtual Network Function Manager
VS	Vertical Slicer
5GC	Fifth Generation Core Network

Executive Summary and Key Contributions

This document presents the progress (achievements and activities) of the 5G-TRANSFORMER project, covering Y1 and Y2, on WP6 activities according to the Communication, Dissemination, and Exploitation Plan (CoDEP). Furthermore, the document presents a plan and an update of the CoDEP for the remaining six months of the project duration.

To recall, and according to common practice [1],[2], *Communication* includes all the activities related with the actions targeting a wide audience, including the interaction with other EU and international projects and the society at large. *Dissemination* focuses on the actions with a research audience working in the same technical field. *Exploitation* deals with the actions that extend the results of the project beyond the project duration aiming at having a long-lasting impact in the form of new products and services, standardization efforts, and their integration in future projects.

First, the document reports all activities and events undertaken during Y1 and Y2 of the project. Similarly to D6.2 [3], these achievements are presented following the same order of classification of the CoDEP, which offers a systematic way of checking the results of its execution. A major difference with D6.2 is the introduction of a specific section on standardization aiming at better presenting the results of standardization by clarifying the link with the project activities.

The key achievements of the project are:

- A noticeable presence at Mobile World Congress 2019 and EuCNC 2018, including demonstrations, leaflets and press releases.
- An active communication through 13 videos, more than 35 press releases and more than 15 collaborations with other projects.
- A high number of scientific peer-reviewed publications with 82 published or accepted for publication in reputed scientific journals/magazines and conference/workshop proceedings.
- Technology demonstration of the project concepts in 13 conferences.
- A significant number of contributions submitted to standardization groups, with 23 contributions approved, agreed or adopted.
- A clear path for exploiting project outcomes in specific commercial products and services, listed in a specific table, coherent with the Description of the Action (DoA), with all the involved products and services, partner by partner.
- Software developments in the project prototypes emerge as important assets for all the partners and, in particular, for the SMEs in the consortium.

Finally, the document presents an update of CoDEP, which is basically following what was introduced in D6.2, with a few updates on the exploitation activities. Indeed, the exploitation plan as far as products and services are concerned, is updated.

The communication plan will continuously be monitoring whether any adaptation is needed, with more focus being put on press release activities.

The dissemination plan for the remaining six months will follow the same plan as defined in D6.2, including the added activities: participation to events and Common Dissemination Booster (CDB), which was not included in the original plan (D6.1 [4]). To recall, the Common Dissemination Booster (CDB) services, which the project uses jointly with 5G-Crosshaul and 5G-Coral as part of the CDB04/05-5G-TRANSFORMER group [3] is a service from the European Commission which encourages projects to come

together to identify a common portfolio of results and shows them how to best disseminate to end-users, with an eye on exploitation opportunities. It consists of 5 services ranging from portfolio identification to dissemination campaign management.

As indicated earlier, we separated the exploitation plan and the standardization plan, to better show the standardization activities, and clearly highlight the relation between the standard contributions and the corresponding activities in 5G-TRANSFORMER. The Exploitation plan for the remaining six months extends the plan in D6.2 and refines the potential impact on the products and services of partners. For the last six months of the project, the focus and effort will be dedicated to completing and consolidating all key innovations developed in the first two years of activities and to outline the relevant potential for exploitation in the last period and beyond the project lifetime. Most of the activities in the next months will be dedicated to test beds and trials, which will drive setting out the exploitation directions for the future.

Regarding the standardization plan, it is elaborated according to the Standard Advisory Committee (SAC), which continues ensuring that 5G-TRANSFORMER Standardization efforts clearly reflect specific outcomes from the various activities during the 6 last months of the project.

1 Introduction

As shown in Figure 1, the 5G-TRANSFORMER project is now transitioning from the *presentation of results* phase to the *integrated experimental demonstrations* phase. As a consequence, dissemination and exploitation, including standardization, will continue having a high relevance.

As initially introduced in D6.1, the CoDEP of 5G-TRANSFORMER includes the following groups of activities:

- **Communication:** It includes all the activities related with the promotion of the project and its results beyond the project's own community. This includes the interaction with other research projects (e.g., H2020 5G PPP) as well as communication of its research in a way that is understood by the non-specialist, e.g., the media and the public.

- **Dissemination:** It includes activities related with presenting its results in a technical community working on the same research field. In general, this will be done through peer-reviewed publications in academic conferences and journals, and participation and organization of technical events.

- **Exploitation:** In accordance with the European IPR Helpdesk [1], it covers activities aiming at using the results in further research activities other than those covered by the project, which mostly imply 1) developing, creating and marketing products or processes, 2) creating and providing a service, or 3) standardization activities.

Basically, the original CoDEP has been updated in D6.2, and is updated/refined in the current document for the remaining 6 months of the project.

Both the communication and dissemination parts plan, for the last six months of the project, is practically the same as that D6.2.

The exploitation plan for the remaining six months extends the plan in D6.2 and refines the potential impact on the products and services from partners. For the last six months of the project, the focus and effort will be dedicated on completing and consolidating all key innovations developed in the first two years of activities. In addition, the exploitation plan as far as products and services is concerned is updated.

The standardization plan for the last six months will follow the Standardization plan defined by the Standardization Advisory Committee (SAC), which spots specific outcomes from the project and targets various standardization groups.

The document is structured into two parts: (1) Work progress of WP6 during Y1 and Y2; (2) Update/refinement of CoDEP.

PROPOSAL STAGE

● NDA signature

Proposal writing:
- Identification of high-impact verticals
- Identification of key challenges. Patent search (state-of-the-art)
- Identification of innovation potential
- Identification of current products and standards impacted
- Impact on market and society
- Measures to maximize impact, including **CoDEP**
- **Actions to implement the CoDEP**
- Innovation management
- Per-partner IPR management description

GRANT PREPARATION STAGE

Consortium agreement (CA) defining:
- Confidentiality rules
- Open access publication rules
- Conditions for involvement of third parties
- Identification of background
- Establishment of access rights
- Governance structure, including innovation management
- Rules for ownership and joint ownership of results
- Rules for transfer of results

Involvement of IPR and legal departments of partners
Selection of CA template

Iterations on the consortium agreement

Grant agreement (GA): Acceptance of obligations on communication, dissemination, and exploitation

PROJECT IMPLEMENTATION STAGE

Project timespan

Year 1

D6.1. Initial Communication, Dissemination, and Exploitation Plan (CoDEP) draft including Standardization roadmap

MS1. CoDEP for first year ready

D6.2. Communication, Dissemination, and Exploitation achievements of Y1 and plan for Y2

MS2. Updated CoDEP plan for Y2

D6.3. Demos at Mobile World Congress'18 and EUCNC'18 or equivalent

MS3. First demonstration done

Year 2

D6.4. Technical Workshops organized during the second year and Exploitation Workshop

D6.5. Report on WP6 progress and update of CoDEP

MS4. Workshop on exploitation done
CoDEP updated for the remaining of the project

D6.6. Demos at Mobile World Congress'19 and EUCNC'19 or equivalent

MS6. Exploitation plan after project end ready
Second demonstration done

Year 3

D6.7. Communication, Dissemination, and Exploitation achievements through project, exploitation plan after the end of the project and assessment of the contribution of the project in support of the 5G standard

After the end of the project

● Major CoDEP milestones

Communication (web and social media, collab. With projects, univ. lectures, project brochures, videos, open science week...)

Dissemination (conferences, journals, workshops, demonstrations ...)

Exploitation through standardization

Exploitation by patenting and potential licensing

Exploitation by contributing to open source projects

Exploitation through products and services

Further internal and collaborative research

Inter-project collaboration (incl. 5G PPP WG and Common Dissemination Booster)

RAISE AWARENESS

PRESENTATION OF RESULTS (VS, SO, MTP)

INTEGR. TECH. DEMO

LONG-LASTING IMPACT

Timespan of communication, dissemination, and exploitation activities

Main CoDEP focus

FIGURE 1: ILLUSTRATION OF THE COMMUNICATION, DISSEMINATION, AND EXPLOITATION (CoDEP) PLAN OF 5G-TRANSFORMER

The first part of the document is structured into four sub-sections:

(1) Communication activities: It reports on the communication and public activities undertaken during Y1 and Y2. These activities target society at large through various channels, including portal, social networks, videos, and press releases. It also reports on related collaboration activities undertaken with other 5G-PPP

projects and working groups. These activities mainly focus on promotion of the 5G-TRANSFORMER project to 5G R&D stakeholders to create collaboration opportunities with other projects.

(2) Dissemination activities: It details the activities carried out during Y1 and Y2, including talks, workshops, and peer-reviewed journals and conference papers. A dedicated section is devoted to CDB.

(3) Exploitation activities: It presents the activities carried out during Y1 and Y2 and in particular i) the identified list of exploitable innovations, ii) the table of impacted products/services in the portfolios of partners on which projects results are being exploited and will be further exploited in the project lifetime and beyond, iii) the filed IPRs.

(4) Standardization activities: It reports all activities and contributions linked to the project activities to relevant standard bodies, such as 3GPP, IETF, or ETSI.

The second part presents an update of the CoDEP for the remaining six months of the project execution. It is organized in subsections following the order of the CoDEP, i.e. Communication, Dissemination, Exploitation and Standardization.

2 Work progress of WP6

The first part of the document reports the WP6 progress during Y1 and Y2 of the project. Section 2.1 reports the communication activities, Section 2.2 describes the dissemination activities, and Section 2.3 reports the exploitation activities, including products and services, patents and licensing. Section 2.4 is dedicated to the standardization activities.

2.1 Communication

The 5G-TRANSFORMER communication plan is devoted to outreach activities to academia, industry, and society at large and to highlight the major achievements of the 5G-TRANSFORMER project, vision, concept, objectives, and results among the various stakeholders. All 5G-TRANSFORMER partners promote the 5G-TRANSFORMER project to the general public, and through different kinds of activities. In the following subsections, we will report all the activities, such as the Web, social media and project communication material, leaflet and poster, video, press releases and news, articles, presentation/lectures and collaboration with other projects for Y1 and Y2.

2.1.1 Web, social media, and project communication material

In order to achieve the objectives of the 5G-TRANSFORMER activities defined in D6.2, partners continue contributing to the press release and to utilize their internal and external communication tools. In Y2, 5G-TRANSFORMER made a big effort on the generation of press release, as shown in Section 2.1.4. More details can also be found on the project website (http://5g-transformer.eu/). Also, the statistics of 5G-TRANSFORMER social media are presented in Annex II. In Y2, from January to March 2019, the number of 5G-TRANSFORMER website visits reached up to 1386. While we have observed around 4000 visits and 1800 visitors in the last quarter of Y1 with the most visited page reaching more than 1000 visits. In total (Y1 and Y2), 5G-TRANSFORMER website received more than 20,000 visits.

The social media accounts of 5G-TRANSFORMER were also set up, and are the following:

- Twitter: https://twitter.com/5g_transformer
- LinkedIn: http://linkedin.com/in/5g-transformer-eu-project-a05311144
- Instagram: https://www.instagram.com/5g_transformer/
- YouTube: https://www.youtube.com/channel/UClQXD0lCxTK9eh_mQzMweww

Again, in Y2, 5G-TRANSFORMER keeps the steady impact increment of the website and of social media according to the CoDEP execution phase of the project.

2.1.2 Communication leaflets and poster

In Y2, 5G-TRANSFORMER generated several communication leaflets, available on the web, for the promotion of the 5G-TRANSFORMER project. For example, the 5G-TRANSFORMER leaflet (Figure 2) was presented in various booths during Mobile World Congress 2019. Besides, Netmgmt-WG Brochures and 5G-TRANSFORMER leaflet for MWC'19 were used to promote the project in Y2. On the other hand, 5G-TRANSFORMER published leaflets in Y1. In particular, a specific version was generated and used in the 5G-Infrastructure Association booth and booths from partners during Mobile World Congress 2018 (Figure 3).

FIGURE 2: MOBILE WORLD CONGRESS 2019 5G-TRANSFORMER
LEAFLET

FIGURE 3: MOBILE WORLD CONGRESS 2018 5G-TRANSFORMER LEAFLET

2.1.3 Communication videos and brochures

Table 1 and Table 2 present the generated videos during Y1 and Y2, respectively. In Y2, 5G-TRANSFORMER generated several videos, which in addition to being uploaded to our youtube channel, were exhibited in various events (Table 2). Other videos of demonstrations are under preparation as of the time of writing. Y1 videos are also reported in Table 1.

TABLE 1: VIDEOS IN Y1

	Title	Link
1	5G-TRANSFORMER general video (presented, e.g., at Mobile World Congress in Barcelona, Spain, 2018, and EU "Showcase your project!" initiative)	https://www.youtube.com/watch?v=lZALdNBLWBQ

TABLE 2: VIDEOS IN Y2

	Title	Link
1	New general video of 5G-TRANSFORMER	https://www.youtube.com/watch?v=DfhWEoMc4bU
2	Interview with 5G TRANSFORMER project coordinator, Arturo Azcorra @ EUCNC'18	https://www.youtube.com/watch?v=Rkrmcn4FgFM
3	5G network slices for mobile communication services, demo @ EUCN'18	https://www.youtube.com/watch?v=0QxeZerDZKQ
4	5G network slices for media vertical services, demo @ EUCNC'18	https://www.youtube.com/watch?v=sRH4m_eQ6NM
5	Using cloudify and public & private clouds to deploy and entertainment, demo @ EUCNC'18	https://www.youtube.com/watch?v=MhxpLNuTOEE
6	Edge Robotics	https://www.youtube.com/watch?v=aNv6BwB-JRE
7	5TONIC Projects (incl. 5G-TRANSFORMER)	https://www.youtube.com/watch?v=QNq1YL_h4v0

Additionally, a number of communication brochures and posters presented at various venues (e.g., EUCNC, Mobile World Congress) were also generated. They are available for download at: http://5g-transformer.eu/index.php/communication/

2.1.4 Communication. Press releases and news

In the 5G-TRANSFORMER website, various press releases were posted as well as distributed through a variety of channels. Table 3 and Table 4 present the summary of press releases and news during Y1 and Y2, respectively. It is important to highlight the presence of 5G-TRANSFORMER at MWC2019 (http://5g-transformer.eu/index.php/2019/02/25/5g-transformer-presence-in-mwc2019/). In Y1, several press releases were also issued by various partners at various stages of the project, which were promoted through their respective communication channels as shown.

TABLE 3: PRESS RELEASES AND NEWS IN Y1

	Activity
1	News about 5G-T @ Mirantis blog https://www.mirantis.com/blog/network-slicing-and-5g-and-wireless-oh-my/
2	News about 5G-T @ CTTC website http://www.cttc.cat/european-industrial-and-academic-partners-join-to-develop-a-5g-mobile-transport-platform-for-verticals/
3	News about 5G-T @ Ericsson blog https://www.ericsson.com/research-blog/5g-transformer-eu-project-underway/
4	News about 5G-T in Mobile World Congress 2018 @ IMDEA Networks https://www.networks.imdea.org/whats-new/news/2018/investigadores-uc3m-presentan-sus-novedades-sobre-5g-mobile-world-congress-2018
5	News about 5G-T in MWC'18 @ CTTC website

	http://www.cttc.cat/cttc-contributes-to-the-future-5g-mobile-transport-platform-for-verticals-at-mwc18/
6	5G Forum in Malaga http://5g-xcast.eu/2018/04/26/prof-narcis-cardona-presentation-at-the-5g-forum-in-malaga/
7	News about 5G-T @ Portal web del Ayuntamiento de Madrid http://www.madrid.es/portales/munimadrid/es/Inicio/Emergencias-y-seguridad/SAMUR-Proteccion-Civil/?vgnextfmt=default&vgnextoid=c88fcdb1bfffa010VgnVCM100000d90ca8c0RCRD&vgnextchannel=f9cd31d3b28fe410VgnVCM1000000b205a0aRCRD&idCapitulo=6149819
8	News about opening 5G Lab 5TONIC http://s3platform.jrc.ec.europa.eu/digital-innovation-hubs-tool?p_p_id=%20digitalinnovationhub_WAR_digitalinnovationhubportlet&p_p_lifecycle=0&p_%20p_state=normal&p_p_mode=view&p_p_col_id=column-%201&p_p_col_count=1&formDate=1524592222123&freeSearch=5tonic&evolStages=3
9	News about 5G-T in collaboration with Samur-Proteccion Civil http://5g-transformer.eu/index.php/2018/04/20/5g-transformer-in-collaboration-with-samur-proteccion-civil/
10	News about 5G-T as 5G Mobile Transport Platform for Verticals @ globenewswire website http://www.globenewswire.com/news-release/2017/06/21/1027019/0/en/European-Industrial-and-Academic-Partners-Join-to-Develop-a-5G-Mobile-Transport-Platform-for-Verticals.html
11	News about 5G-T for Network Slicing and Industry Verticals @ sdxcentral website https://www.sdxcentral.com/articles/news/new-european-5g-group-will-focus-on-network-slicing-industry-verticals/2017/06/
12	News about 5G-T as part of 5G development @ sdxcentral website https://www.sdxcentral-com.cdn.ampproject.org/c/s/www.sdxcentral.com/%20articles/news/trials-use-cases-top-5g-developments-2017/2017/12/amp/%20Network%20Slicing%20Gets%20Traction
13	Press Release: European Industrial and Academic Partners Join to Develop a 5G Mobile Transport Platform for Verticals http://5g-transformer.eu/index.php/2017/06/20/5g-transformer-press-release/
14	Press Release: The 5G-TRANSFORMER project presents the future 5G mobile transport platform for verticals at MWC'18 http://5g-transformer.eu/index.php/2018/02/23/the-5g-transformer-project-presents-the-future-5g-mobile-transport-platform-for-verticals-at-mwc18/

TABLE 4: PRESS RELEASES AND NEWS IN Y2

	Activity
1	News about 5G-T Workshops at EUCNC http://5g-transformer.eu/index.php/2018/05/03/new-co-organized-workshop/
2	MEC Seminar at UC3M http://5g-transformer.eu/index.php/2018/05/09/multi-access-edge-computing-seminar/
3	Imagine Digital & Connect Europe, ICT2018 http://5g-transformer.eu/index.php/2018/05/18/5g-transformer-at-ict2018/
4	5GPPP Activities at EuCNC https://5g-ppp.eu/5g-ppp-at-eucnc-2018/

5	New Submitted Deliverables http://5g-transformer.eu/index.php/2018/06/02/new-submitted-deliverables/	
6	News about CDB service http://5g-transformer.eu/index.php/2018/06/05/5g_in_cbd/	
7	News in Linkedin about the participation of 5G-T in IEEE BMSB'18 conference 5GPPP group of Linkedin reports the participation of 5G-T in IEEE BMSB'18	
8	5G-T activities at IEEE BMSB'18 http://5g-transformer.eu/index.php/2018/06/10/ieee-international-symposium-on-broadband-multimedia-systems-and-broadcasting/	
9	News about 5G-PPP European Journal 2018 @ 5G-TRANSFORMER website http://5g-transformer.eu/index.php/news/	
10	Press release: 5G-TRANSFORMER presence at EUCNC'18 http://5g-transformer.eu/index.php/news/	
11	News about EC visit to 5GT booth @ EUCNC18 http://5g-transformer.eu/index.php/2018/06/22/the-european-commission-representatives-visited-the-5g-coral-5g-transformer-and-5g-ex-joint-booth-at-eucnc-2018/	
12	New Submitted Deliverables http://5g-transformer.eu/index.php/2018/07/02/new-deliverables-available/	
13	5GT in a tutorial at IEEE NetSoft2018 http://5g-transformer.eu/index.php/2018/07/05/5g-transformer-network-slicing-at-the-iee-netsoft-2018-conference/	
14	News about a talk of 5GT at IEEE 5G Summit Tanger given by Xavier Costa (NEC), June 2018 http://5g-transformer.eu/index.php/2018/07/06/579/	
15	News about Edge Robotics http://5g-transformer.eu/index.php/2018/07/13/edge-robotics/	
16	News about 4th plenary meeting http://5g-transformer.eu/index.php/2018/07/23/4th-plenary-meeting/	
17	News about 5GTONIC new projects http://5g-transformer.eu/index.php/2018/07/27/a-e50m-eu-sponsored-5g-programme-gives-5gtonic-a-key-role/	
18	News about episodes of 5GCrosshaul http://5g-transformer.eu/index.php/2018/09/24/new-series-of-episodes-of-5g-crosshaul-integrated-backhaul-and-fronthaul-transport-network/	
19	News about participation of 5G-TRANSFORMER in 2nd International Robotics Festival 2018 http://5g-transformer.eu/index.php/2018/09/28/2o-international-robotics-festival-2018/	
20	News about participation of 5G-TRANSFORMER in the EuMW2018 http://5g-transformer.eu/index.php/2018/09/27/940/	
21	News European Researchers Night 2018 http://5g-transformer.eu/index.php/2018/10/01/5g-transformer-participated-at-european-researchers-night-2018/	
22	News about 5GCrosshaul Success Story http://5g-transformer.eu/index.php/2018/10/04/taming-the-avalanche-of-mobile-data-the-5g-crosshaul-sucess-story/	
23	News about presence of 5GT in Ran World 2018 http://5g-transformer.eu/index.php/2018/10/15/5g-transformer-in-ran-world-2018/	

24	Press Release: "Towards the interactive digital fan experience" https://atos.net/content/mini-sites/look-out-2020/assets/pdf/ATOS_LOOK%20OUT_SPORTS.pdf ; Also available at: https://5g-transformer.eu/svn/5g-transformer/execution/WP6/T6.1-Communication_activities/Press%20Releases/181016_ATOS_LOOK%20OUT_SPORTS.pdf
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32	News about Plenary meeting Paris January 2019 http://5g-transformer.eu/index.php/2019/01/16/5g-transformer-plenary-meeting-in-paris/
33	News about 5G-TRANSFORMER presence at 5th OSM Hackfest http://5g-transformer.eu/index.php/2019/02/07/5g-transformer-in-the-5th-osm-hackfest/
34	Press release: 5G-TRANSFORMER presence in MWC19 http://5g-transformer.eu/index.php/2019/02/25/5g-transformer-presence-in-mwc2019/
35	News about 5G-TRANSFORMER presence in IEEE workshop Future Networks http://5g-transformer.eu/index.php/2019/03/01/5g-technology-workshop-during-mwc19-in-barcelona/
36	News: Arturo Azcorra: "How to deploy and run Connected Industry 4.0" (MWC19) http://5g-transformer.eu/index.php/2019/03/06/arturo-azcorra-how-to-deploy-and-run-connected-industry-4-0-mwc19/

2.1.5 Communication articles

Table 5 and Table 6 show the activities related to communication articles during Y1 and Y2, respectively. The communication articles target a wider audience than that strictly specialized in the topics of the project.

TABLE 5: COMMUNICATION ARTICLES IN Y1

	Title	Publishied in
1	A Network Service Provider Perspective on Network Slicing	IEEE Softwarization, January 2018

TABLE 6: COMMUNICATION ARTICLES IN Y2

	Title	Published in
1	5G-TRANSFORMER. 5G Mobile Transport Platform for Verticals	5G-PPP European 5G Annual Journal 2018 https://bscw.5g-ppp.eu/pub/bscw.cgi/d257916/Euro%205G%20Annual%20Journal%202018-v1.1.pdf
2	5G-TRANSFORMER. 5G Mobile Transport Platform for Verticals	5G-PPP European 5G Annual Journal 2019 https://bscw.5g-ppp.eu/pub/bscw.cgi/d302069/Euro%205G%20PPP%20Annual%20Journal%202019-web.pdf

Table 7 and Table 8 list the presentations and talks targeting a wide general audience during Y1 and Y2, respectively. They all describe the project general ideas and scope without entering too much into technical details.

TABLE 7: COMMUNICATION PRESENTATIONS IN Y1

	Activity
1	Talk entitled "5G Networks to realize Network society" at the "5G technology for automotive domain" workshop, 2017, including the 5G-TRANSFORMER approach.
2	A talk on 5G in general, and more specifically, on 5G-TRANSFORMER was given to high-school students and general public in the context of 22nd Open Science Week (Setmana de le Ciencia) in November 2017. It is organized by the Catalan Research and Innovation Foundation (FCRi). Information available at: http://www.cttc.cat/the-cttc-will-participate-in-the-22nd-edition-of-the-science-week-2017/
3	Organization of the Internet Festival (http://www.internetfestival.it/), the Robotics Festival 2017 (http://www.festivalinternazionaledellarobotica.it/en/)
4	Three-hour course taught at the National Chiao Tung University (NCTU) in Taiwan on topics related with 5G-TRANSFORMER
5	Master courses in UC3M on NFV and SDN for 5G networks
6	SSSA presents 5G-TRANSFORMER in 5G Summit in Trento
7	5G-TRANSFORMER presentation: 5G Mobile Transport Platform for Verticals in EuCNC workshop in 2017
8	POLITO presents 5G-TRANSFORMER in IEEE 5G Summit 2017 talk
9	SAMUR participation and presentation in 5G Forum in Malaga

TABLE 8: COMMUNICATION PRESENTATIONS AND LECTURES IN Y2

	Activity
1	Demo on Cloud Robotics at Festival Internazionale della Robotica (International Festival on Robotics).
2	Internet Festival Pisa 2018 Internet Festival 2018: Workshop "Internet in the Era of 5G, demo on "5G-Enabled Services"
3	Bright Researchers night 2018 Sant'Anna School celebrates the European "Bright" researchers' night 2018 in Pisa, Pontedera and Livorno
4	23rd edition of Science Week 2018 5G-TRANSFORMER project participates in the 23rd edition of the Science Week 2018
5	Nokia Discovery Day co-organized with IHK

	Industry and Commerce Chamber
6	5G-TRANSFORMER at the I Jornadas de investigación EPS

2.1.6 Collaboration with other projects

A series of activities have been carried out together with 5GPPP projects in the framework of the various 5GPPP working groups. Table 9 lists the main activities within the 5G PPP CSA Working Groups (WGs) during Y1. In Y2, Table 10 summarizes the collaboration with other projects in these WGs as well as joint papers or joint organization of events.

TABLE 9: ACTIVITY WITHIN 5G PPP CSA WGS IN Y1

	Activity
1	Presentation to EC H2020 5G Infrastructure PPP Technical board on Performance KPIs and 5G-TRANSFORMER status in this respect. Active participation on this activity (periodic calls).
2	Inputs on 3GPP and 5G-TRANSFORMER to 5GPPP Pre-Standardization Working Group (WG). Various conference calls, including one with the WG Chair on including other non-3GPP activities.
3	Input on 5G-TRANSFORMER for preparation of a brochure for EUCNC. 5G PPP Network Management & QoS WG.
4	Participation to 5G PPP Trials WG and the roadmap (5G Pan-European trials roadmap 3.0.) generated by the group (https://5g-ppp.eu/5g-trials-roadmap/).
5	Participation to 5G PPP Architecture WG. The group organized a session at EuCNC 2018.
6	Active participation to the 5G PPP Software Networks WG. The 5G-TRANSFORMER project was presented in September 2017. 5G-TRANSFORMER contributed actively to the white paper 'From Webscale to Telco, the Cloud Native Journey''. The white paper will be presented at a EUCNC 2018 workshop, to which 5G-TRANSFORMER participates as well.

TABLE 10: ACTIVITY WITHIN 5G PPP WGS IN Y2

	Activity
1	5G-T Architecture Presentation for 5GPPP Arch WG
2	5G-PPP Software Networks WG white paper
3	WS3 Workshop @ EUCNC 18, joint with 5G-Exchange, 5G-CORAL, 5GCirty, 5G-Picture, Matilda, RECAP
4	Joint booth and Demos @ EUCNC18, with 5G-Exchange, 5G-CORAL
5	Netmgmt-WG Brochures
6	Special Session @ EUCNC'18
7	5G PPP PRE-STANDARDISATION WG - Mapping of Contributions to standards May 2018
8	Edge Robotics Demo in collaboration with 5G-Coral and 5G-Ex
9	Conext Workshop, joint with MONROE and 5G-CORAL
10	Joint paper with 5G-Monarch project for Mobicom'18 entitled "How Should I Slice My Network? A Multi-Service Empirical Evaluation of Resource Sharing Efficiency"
11	Joint paper with H2020-MSCA-ITN-20155G-Aura project @ ACM CONEXT'18 entitled "Overbooking Network Slices through Yield-driven End-to-End Orchestration"

12	PIMRC Workshop, joint with ITN H2020 5GAura
13	Joint paper with 5G-EVE project at IEEE Transaction on Big Data entitled: "From Megabits to CPU Ticks: Enriching a Demand Trace in the Age of MEC"
14	7th CLEEN workshop at WCNC19
15	Collaboration with NECOS project in the context of T1.3
16	Joint paper with 5G-EVE project at ACM/IEEE Transactions on Networking entitled: VNF Placement and Resource Allocation for the Support of Vertical Services in 5G Networks
17	Joint paper with 5G-Monarch project for INFOCOM'19 entitled: "A Utility-driven Multi-Queue Admission Control Solution for Network Slicing"
18	Joint paper with 5G-Monarch project for INFOCOM'19 entitled: "DeepCog: Cognitive Network Management in Sliced 5G Networks with Deep Learning"
19	Joint paper with 5G-Monarch project for IEEE Transactions on Mobile Computing entitled: "A Machine Learning approach to 5GInfrastructure Market optimization"
20	Presentation of an update of 5GT system architecture design to the 5G PPP Arch WG
21	Contribution to 5GIA Pre-Standardization WG
22	Contribution to 5GPPP Arch WG White Paper 3.0
23	Joint Demo with blueSPACE and 5G-Media projects for ACM MobiHoc 2019 Conference
24	Joint Demo with H2020-MSCA-ITN-2015 5G-AURA project
25	Joint Paper with 5G-Carmen project @ IEEE Communications Magazine (Telecom Software, Network Virtualization, and Software Defined Networks Series) entitled: "MANOaaS: A Multi-tenant NFV MANO for 5G Network Slices"
26	Joint Paper with 5G-MoNArch @ IEEE Wireless Communications Magazine entitled: "Artificial Intelligence for Elastic Management and Orchestration of 5G Networks"
27	Contribution to 5GPPP Arch WG White Paper 3.0

2.2 Dissemination

This section presents the work progress of the project, during Y1 and Y2, regarding the dissemination activities, which follow the plan described in D6.2. It reports activities for Y1 and Y2 on the publication of research results (Table 12, Table 13), technology demonstration (0, Table 15), academic activities (Table 16, Table 17), organization of events (Table 18, Table 19) and participation to events (Table 20, Table 21). It also includes a sub-section on the Common Dissemination Booster activities, a service offered by the European Commission towards joint dissemination and exploitation with other projects, in this case 5G-Coral and 5G-Crosshaul.

Table 11 presents a comparison between the achieved metrics on the above-mentioned activities and the targeted metrics included in the DoA and updated in D6.2 (Publication and Participation to events). As seen in the tables for Y1 and Y2, the project achieved the objectives, exceeding all the targeted metrics. Regarding publication of research results, the 5G-TRANSFORMER partners have published 82 scientific papers in peer-reviewed journals, conferences and workshops, in very selective venues, such IEEE Transactions, and the IEEE INFOCOM conference. The technology demonstration activity drastically increased during Y2, as many 5G-TRANSFORMER concepts have

gained maturity, and have been demonstrated via PoC at well-known conferences, such as EuCNC, ACM MobiHoc and IEEE INFOCOM. Several students have been enrolled on topics related to the project, at the PhD, master and Bachelor levels. 5G-TRANSFORMER has organized (or been accepted to organize) 11 events (Table 18, Table 19) collocated with international conferences, such as IEEE WCNC, IEEE EuCNC, IEEE PIMRC, and ACM CoNEXT. Among these events, the IEEE Compass workshop 1 and 2, collocated with IEEE WCNC 2018 and IEEE BMSB 2018, respectively, have achieved more than 70% of attendee satisfaction in terms of scientific and technical content (refer to Annex I). Moreover, an exploitation workshop dedicated to SMEs and large companies (Emerging 5G Business Models: Opportunities for SMEs and large companies-lessons from 5G PPP) will be organized (accepted) in conjunction with EuCNC 2019. Finally, 5G-TRANSFORMER partners have given talks (invited) and keynotes, and participated to panels, on concepts related to the 5G-TRANSFORMER architecture and concepts, such as the Vertical Slicer, Network Slicing, Multi-access Edge Computing, etc., in several international events; this is without including the talks given at international conferences and workshops to present scientific papers.

TABLE 11: TARGETED METRICS VERSUS ACHIEVED METRICS

Activity	Targeted metric	Achieved metric
Publication of research results	8 during Y1, and 12 during Y2	30 during Y1 and 52 during Y2
Technology Demonstration	At least 2 per year	2 during Y1 and 11 during Y2
Academic activities	At least 2 master thesis per academic partner over the course of the project	5 PhD, 4 Master and 2 Bachelor
Organization of events	One 50-people workshop co-located with a major conference with 70% satisfaction	IEEE Compass workshop 1 and 2, with more than 70% of satisfaction (refer to Annex I)
	One 30-people workshop with 70% satisfaction	Exploitation workshop (Emerging 5G Business Models: Opportunities for SMEs and large companies -lessons from 5G PPP) collocated with EuCNC 2019
Participation to events	Not defined for Y1, and average 10 talks during Y2	4 Keynotes, 2 Panels, 1 Tutorial, 7 invited talks, and talks in conferences and workshops to present papers

TABLE 12: PUBLICATIONS IN Y1 (J: PEER REVIEW JOURNAL, B: BOOK CHAPTER, C: PEER-REVIEWED CONFERENCE, W: PEER-REVIEWED WORKSHOP)

	Title	Published in
J	WizHaul: On the Centralization Degree of Cloud RAN Next Generation Fronthaul	IEEE Transactions on Mobile Computing (TMC), February 2018
J	Efficient Caching through Stateful SDN in Named Data Networking	Transactions on Emerging Telecommunications Technologies, Jan. 2018

J	Virtualization-based evaluation of backhaul performance in vehicular applications	Computer Networks, April 2018
J	5G-TRANSFORMER: Slicing and Orchestrating Transport Networks for Industry Verticals	IEEE Communications Magazine, accepted in 2018
J	On Enabling 5G Automotive Systems Using Follow Me Edge Cloud Concept	IEEE Transactions on Vehicular Technology (TVT) 2018
J	Scheduling Advertisement Delivery in Vehicular Network	IEEE Transactions on Mobile Computing (TMC) in 2018
C	Sharing of Crosshaul Networks via a Multi-Domain Exchange Environment for 5G Services	IEEE NetSoft 2017
C	A Simulation-based Testbed for Vehicular Collision Detection	IEEE VNC 2017
C	Software Defined 5G Converged Mobile Access Networks: Energy Efficiency Considerations	Asia Communications and Photonics Conference, 10 - 13 November 2017, The Garden Hotel, Guangzhou, Guangdong China
C	SDN-enabled Latency-Guaranteed Dual Connectivity in 5G RAN	Asia Communications and Photonics Conference, 10 - 13 November 2017, The Garden Hotel, Guangzhou, Guangdong China
C	Network Orchestration in Reliable 5G/NFV/SDN infrastructures	19th International Conference on Transparent Optical Networks (ICTON) 2017, Girona, Spain
C	Requirements for 5G fronthaul	19th International Conference on Transparent Optical Networks (ICTON) 2017, Girona, Spain
C	Network Orchestration in Reliable 5G/NFV/SDN infrastructures	19th International Conference on Transparent Optical Networks (ICTON) 2017, Girona, Spain
C	Virtualized eNB latency limits	19th International Conference on Transparent Optical Networks (ICTON) 2017, Girona, Spain
C	Joint VNF Placement and CPU Allocation in 5G	IEEE International Conference on Computer Communications (INFOCOM) 15-19, April 2018, Honolulu, USA
C	FluidRAN: Optimal vRAN/MEC Orchestration	IEEE International Conference on Computer Communications (INFOCOM) 15-19, April 2018, Honolulu, USA
C	Present-day verticals and where to find them: A data-driven study on the transition to 5G	IEEE WONS 2018
C	Service migration versus Service replication in Multi-access Edge Computing (MEC)	IEEE IWCMC 2018, June 24-29, Cyprus
C	Orchestrating Lightpath Adaptation and Flexible Functional Split to Recover Virtualized RAN Connectivity	OFC 2018, March 11-15, 2018, San Diego, CA, USA

C	Software Defined 5G Converged Access as a viable Techno-Economic Solution	OFC 2018, March 11-15, 2018, San Diego, CA, USA
C	Enabling Flexible Functional Split through software 5G converged access	IEEE ICC 2018, Kansas City, MO, USA
C	Performance analysis of C-V2I-based Automotive Collision Avoidance	IEEE WoWMOM 2018, Chania, Greece
C	Optimization-in-the-Loop for Energy-Efficient 5G	IEEE WoWMOM 2018, Chania, Greece
C	Experimental SDN Control Solutions for Automatic Operations and Management of 5G Services in a Fixed Mobile Converged Packet-Optical Network	IEEE ONDM 2018
W	Orchestrating Lightpath Adaptation and Flexible Functional Split to Recover Virtualized RAN Connectivity (poster)	URLLC 2017
W	WizHaul: An Automated Solution for vRAN Deployments Optimization	WSA 2018 - ITG workshop on smart antennas, March 2018
W	Service Orchestration and Federation for Verticals	IEEE WCNC COMPASS workshop, April 2018, Barcelona, Spain
W	5G Mobile Transport and Computing Platform for Verticals	IEEE WCNC COMPASS workshop, April 2018, Barcelona, Spain
W	Network Slices For Vertical Industries	IEEE WCNC COMPASS workshop, April 2018, Barcelona, Spain
W	Impact of RAN Virtualization on Fronthaul Latency Budget: An Experimental Evaluation	International Workshop on 5G Test-Beds and Trials - Learnings from implementing 5G (5G--Testbed 2017) co-located with Globecom 2017, Singapore

TABLE 13: PUBLICATIONS IN Y2

	Title	Published in
J	Characterizing the Power Cost of Virtualization Environments	Transactions on Emerging Telecommunications Technologies, 2018
J	Optimization of an integrated fronthaul/backhaul network under path and delay constraints	Elsevier Adhoc Journal, February 2019
J	Orchestrating lightpath recovery and flexible functional split to preserve virtualized RAN connectivity	IEEE/OSA Journal of Optical Communications and Networking, Nov. 2018
J	z-TORCH: An Automated NFV Orchestration and Monitoring Solution	IEEE Transactions on Network and Service Management (TNSM), 2018.

J	From Megabits to CPU Ticks: Enriching a Demand Trace in the Age of MEC	IEEE Transactions on Big Data, 2018.
J	Joint Optimization of Edge Computing Architectures and Radio Access Networks	IEEE Journal on Selected Area in Communications (JSAC) SI on Emerging Technologies in Tactile Internet and Backhaul/Fronthaul Networks
J	Cost and availability aware resource allocation and virtual function placement for CDNaaS provision	IEEE Transactions on Network and Service Management (TNSM), 2018.
J	ORLA/OLAA: Orthogonal Coexistence of LAA and WiFi in Unlicensed Spectrum	ACM/IEEE Transactions on Networking (TON), 2018.
J	The RICH Prefetching in Edge Caches for In-Order Delivery to Connected Cars	IEEE Transactions on Vehicular Technology (TVT), Jan. 2019
J	Cellular access multi-tenancy through small-cell virtualization and common RF front-end sharing	Elsevier Computer Communications, 2018.
J	VNF Placement and Resource Allocation for the Support of Vertical Services in 5G Networks	ACM/IEEE Transactions on Networking (TON), 2019
J	A Machine Learning approach to 5G Infrastructure Market optimization	IEEE Transactions on Mobile Computing (TMC), 2019
J	Modeling Mobile Edge Computing Deployments for Low Latency Multimedia Services	IEEE Transactions on Broadcasting, accepted 2019
J	Impact of Virtualisation Technologies on Virtualised RAN Midhaul Latency Budget: A Quantitative Experimental Evaluation	IEEE Communications Letters, accepted 2019
J	Latency-aware Resource Orchestration in SDN-based Packet over Optical Flexi-Grid Transport Networks	IEEE/OSA Journal of Optical Communications and Networking, 2019
J	A Blockchain-Based Network Slice Broker for 5G Services	IEEE Networking Letters 2019
J	Artificial Intelligence for Elastic Management and Orchestration of 5G Networks	IEEE Wireless Communications Magazine
J	MANOaaS: A Multi-tenant NFV MANO for 5G	IEEE Communications Magazine
B	Slicing challenges for Operators	Emerging Automation Techniques for the Future Internet, IGI Editor.
C	Enabling Vertical Industries Adoption of 5G Technologies: a Cartography of evolving solutions	European Conference on Networks and Communications (EUCNC 2018), June 2018, Ljubljana, Slovenia.
C	The Vertical Slicer: Verticals' Entry Point to 5G Networks'	European Conference on Networks and Communications (EUCNC 2018), June 2018, Ljubljana, Slovenia.

C	Experimental Evaluation of Orchestrating Inter-DC Quality-enabled VNFFG Services in Packet/Flexi-Grid Optical Networks	44th European Conference on Optical Communication (ECOC), September, Roma, Italy.
C	Experimental SDN Control Solutions for Automatic Operations and Management of 5G Services in a Fixed Mobile Converged Packet-Optical Network	22nd Conference on Optical Network Design and Modelling (ONDM 2018) (Invited paper), May, Dublin, Ireland.
C	Enabling Flexible Functional Split through Software Defined 5G Converged Access	IEEE international Conference on Communications (ICC), May, Kansas City, USA 2018
C	Latency-aware Network Service Orchestration over an SDN-controlled Multi-Layer Transport Infrastructure	20th International Conference on Transparent Optical Networks (ICTON), July 2018, Bucharest, Romania.
C	Encapsulation Techniques and Traffic Characterisation of an Ethernet-based 5G Fronthaul	19th International Conference on Transparent Optical Networks (ICTON) July 2018, Bucharest, Romania.
C	The Vertical Slicer: Verticals' Entry Point to 5G Networks	European Conference on Networks and Communications (EUCNC 2018), June 2018, Ljubljana, Slovenia.
C	How Should I Slice My Network? A Multi-Service Empirical Evaluation of Resource Sharing Efficiency	ACM International Conference on Mobile Computing and Networking (MobiCom), October 2018, New Delhi, India.
C	On the Impact of IoT Traffic on the Cellular EPC	IEEE Global Communications Conference (Globecom) December 2018, Abu Dhabi, UAE
C	Latency and availability driven VNF placement in a MEC-NFV environment	IEEE Global Communications Conference (Globecom), December 2018, Abu Dhabi, UAE
C	Mobile Transport and Computing Platform for 5G Verticals: Resource Abstraction and Implementation	IEEE Conference on Network Function Virtualization and Software Defined Networks (NFV-SDN), November 2018, Verona, Italy
C	Overbooking Network Slices through Yield-driven End-to-End Orchestration	The 14th ACM International Conference on emerging Networking EXperiments and Technologies (Conext), December 2018, Heraklion/Crete, Greece
C	Deploying a containerized ns-3/LENA-based LTE mobile Network Service through the 5G-TRANSFORMER platform	IEEE Conference on Network Function Virtualization and Software Defined Networks (NFV-SDN), November 2018, Verona, Italy
C	5G Traffic Forecasting: If Verticals and Mobile Operators Cooperate	15th IEEE Wireless On-demand Network systems and Services Conference (WONS), January 2019, Wengen, Switzerland
C	Experimental Demonstration of a 5G Network Slice Deployment Exploiting Edge or Cloud Data-Centers	Optical Fiber Communication (OFC) Conference, March 2019, San Diego, USA.

C	A Utility-Driven Multi-Queue Admission Control Solution for Network Slicing	IEEE International Conference on Computer Communications (INFOCOM) April 2019, Paris, France
C	DeepCog: Cognitive Network Management in Sliced 5G Networks with Deep Learning	IEEE International Conference on Computer Communications (INFOCOM) April 2019, Paris, France
C	Exposing radio network information in a MEC-in-NFV environment: the RNISaaS concept	IEEE Conference on Network Softwarization (Netsoft), June 2019, Paris, France
C	Experimental Evaluation of Dynamic Resource Orchestration in Multi-Layer (Packet over Flexi-Grid Optical) Networks	23rd Conference on Optical Network Design and Modelling (ONDM), May 2019, Athens, Greece.
C	On the Deployment of Large Scale NSaaS	European Conference on Networks and Communications (EUCNC 2019), June 2019, Valencia, Spain.
C	5G-TRANSFORMER Service Orchestrator: design, implementation, and evaluation	European Conference on Networks and Communications (EUCNC 2019), June 2019, Valencia, Spain.
C	A MEC-based Extended Virtual Sensing for Automotive Services	2019 AEIT International Conference of Electrical and Electronic Technologies for Automotive (AEIT AUTOMOTIVE), Turin, Italy 2019.
W	Understanding QoS applicability in 5G transport networks	WS3: Second Edition of the Workshop on Control and Management of Vertical Slicing including the Edge and Fog Systems, IEEE International Symposium on Broadband Multimedia Systems and Broadcasting (BMSB), Valencia, June 2018
W	Multi-domain VNF mapping algorithms	WS3: Second Edition of the Workshop on Control and Management of Vertical Slicing including the Edge and Fog Systems, IEEE International Symposium on Broadband Multimedia Systems and Broadcasting (BMSB), Valencia, June 2018
W	Towards a resilient OpenFlow channel through MPTCP	WS3: Second Edition of the Workshop on Control and Management of Vertical Slicing including the Edge and Fog Systems, IEEE International Symposium on Broadband Multimedia Systems and Broadcasting (BMSB), Valencia, June 2018
W	Orchestrating Inter-DC Quality-Enabled VNFFG Services in Packet / Flexi-Grid Optical Networks	5th International Workshop on Elastic Networks Design and Optimisation (ELASTICNETS 2018), 21-22 June 2018, Valencia (Spain).
W	Arbitration Among Vertical Services	IEEE PIMRC 2018 Workshop 5G Cell-Less Nets, September 2018, Bologna, Italy
W	Resource Orchestration of 5G Transport Networks for Vertical Industries	IEEE PIMRC 2018 Workshop 5G Cell-Less Nets, September 2018, Bologna, Italy

W	Wireless Interface Agent for SDN mmwave multi-hop networks: design and experimental evaluation	The 2nd ACM Workshop on Millimeter Wave Networks and Sensing Systems, October 2018, New Delhi, India
W	A Framework for Orchestration and Federation of 5G Services in a Multi-Domain Scenario	ACM CoNEXT workshop, EM-5G 2018, 1st International Workshop on Experimentation and Measurements in 5G, December 2018, Heraklion, Greece
W	Experimental Demonstration of a Packet-based Protection for Seamlessly Recovering from a Multi-layer Metro Network Fronthaul Failure	The 5th IEEE INFOCOM Workshop on Computer and Networking Experimental Research using Testbeds 2019 (IEEE CNERT 2019), April 2019, Paris, France

TABLE 14: TECHNOLOGY DEMONSTRATIONS IN Y1

Title	Event
Demo of the initial heterogeneous network part of the MTP	Mobile World Congress'18
OVNES: Demonstrating 5G Network Slicing Overbooking on Real Deployments	IEEE INFOCOM 2018

TABLE 15: TECHNOLOGY DEMONSTRATIONS IN Y2

Title	Event
Robotic Control Leveraging a Radio Network Information Service (RNIS)	EuCNC 2018
Orchestrating entertainment network service deployment in a hybrid cloud with Cloudify	EuCNC 2018
Creating a media-oriented slice through the 5G-TRANSFORMER vertical slicer	EuCNC 2018
Overbooking Network Slices End-to-End: Implementation and Demonstration	ACM SIGCOMM 2018
Experimental Demonstration of a 5G Network Slice Deployment through the 5G-TRANSFORMER Architecture	ECOC 2018
Deploying a containerized ns-3/LENA-based LTE mobile Network Service through the 5G-TRANSFORMER platform	IEEE SDN-NFV 2018
Experimental Demonstration of a 5G Network Slice Deployment Exploiting Edge or Cloud Data-Centers	IEEE OFC 2019
Virtual CDN service deployment across multiple sites using 5G-TRANSFORMER architecture	ICT 2018
Latency-driven Network Slices Orchestration	IEEE INFOCOM 2019
Provisioning and automated scaling of network slices for virtual Content Delivery Networks in 5G infrastructures (accepted for Y3)	ACM MobiHoc 2019
Composing Services in 5G-TRANSFORMER (accepted for Y3)	ACM MobiHoc 2019

TABLE 16: ACADEMIC ACTIVITIES IN Y1

Title	Level	Status
eNB split functions (Distributed Unit --- DU --- and Central Unit --- CU) virtualization and its impact on fronthaul available latency budget.	PhD	Ongoing
Resource Orchestration in Virtualized Networks through SDN-enabled OpenStack	PhD	Ongoing
Software Defined Networking based mobility management in small cells	PhD	Ongoing
Mechanisms to integrate and enhance NFV and MEC	PhD	Ongoing
Design and optimization of solutions for discovery and federation for NFV in edge & fog scenarios	PhD	Ongoing
Multi-domain VNF mapping algorithms	Master	Defended
Development of a RNIS API based on Publish/subscribe using OAI	Master	Defended
Análisis de un orquestador NFV/SDN para redes de operador	Bachelor	Defended
Service Function Chaining en NFV: Evaluación práctica con OpenStack	Bachelor	Defended

TABLE 17: ACADEMIC ACTIVITIES IN Y2

Title	Level	Status
eNB split functions (Distributed Unit --- DU --- and Central Unit --- CU) virtualization and its impact on fronthaul available latency budget.	PhD	Ongoing
Resource Orchestration in Virtualized Networks through SDN-enabled OpenStack	PhD	Ongoing
Software Defined Networking based mobility management in small cells	PhD	Ongoing
Mechanisms to integrate and enhance NFV and MEC	PhD	Ongoing
Design and optimization of solutions for discovery and federation for NFV in edge & fog scenarios	PhD	Ongoing
Enhanced Connectivity in wireless mobile programmable networks	PhD	Defended
Development of an Orchestrator interface for OpenAirInterface5G (OAI)	Master	Ongoing
Development of a prototype 5G RAN orchestrator	Master	Ongoing

TABLE 18: ORGANIZATION OF EVENTS IN Y1

Title	Event
1st Workshop on Control and Management of Vertical Slicing including the Edge and Fog Systems (COMPASS).	Co-located with IEEE Wireless Communications and Networking Conference (WCNC) 2018, April, Barcelona. Jointly organized with 5G-CORAL project.
Organization of the "5G technology for automotive domain" workshop in Turin including industrial and academic presentations.	Industry-academia workshop organized in FCA, July 2017

Co-organization of a special session on 5G Mobile Transport Networks jointly with the 5G-Crosshaul project	Organized at Wireless World Research Forum (WWRF) 39 meeting in Barcelona, October 2017. More information available at: http://wwrf39.ch/WWRF.html
Organization of IEEE VNC 2017	2017 IEEE Vehicular Networking Conference (VNC), Nov. 2017, Torino

TABLE 19: ORGANIZATION OF EVENTS IN Y2

Title	Event
Workshop on Experimentation and Measurements in 5G, December 2018, Heraklion, Greece	Co-located with the 14th ACM International Conference on emerging Networking Experiments and Technologies (CoNext). Jointly organized with 5G-CORAL project.
2nd Multi-provider, multi-vendor, multi-player orchestration: from distributed cloud to edge and fog environments in 5G, June 2018, Ljubiana, Slovenia.	Co-located with European Conference on Networks and Communications (EUCNC 2018).
Workshop 'From cloud ready to cloud native transformation: What it means and Why it matters', June 2018, Ljubiana, Slovenia.	Co-located with European Conference on Networks and Communications (EUCNC 2018).
2nd Workshop on Control and Management of Vertical Slicing including the Edge and Fog Systems (COMPASS), June 2018, Valencia, Spain	Co-located with IEEE International Symposium on Broadband Multimedia Systems and Broadcasting (BMSB)
Vertical-Oriented Service Programmability: Design and Optimization of 5G Cell-Less Networks, Bologna, Italy 2018.	Co-located with IEEE International Symposium on Personal, Indoor and Mobile Radio Communications (PIMRC)
Emerging 5G Business Models: Opportunities for SMEs and large companies - lessons from 5G PPP (5G-EBM) Workshop, June 2019, Valencia, Spain.	Co-located with European Conference on Networks and Communications (EUCNC 2019).
Seventh International Workshop on Cloud Technologies and Energy Efficiency in Mobile Communication Networks (CLEEN 2019), Marrakech, Morocco, 2019	Co-located with IEEE Wireless Communications and Networking Conference (WCNC).

TABLE 20: PARTICIPATION TO EVENTS IN Y1

Title	Type	Event
Connected Car and Digital Transformation	Keynote	IEEE Vehicular Networking Conference (VNC), Nov. 2017, Torino, Italy.
5G and Verticals: The Connected and Automated Driving (CAD) Case	Panel	IEEE Wireless Communications and Networking Conference (WCNC) April 2018, Barcelona, Spain.
RS-FCN: Resource Slicing for Future Clouds and Networks	Talk	IEEE International Conference on Computer Communications (INFOCOM), April 2018, Honolulu, USA

All conference and workshop publications have been presented in their corresponding venue	Talk	Several international conferences and workshops (see publications table)

TABLE 21: PARTICIPATION TO EVENTS IN Y2

Title	Type	Event
5G Networks for Industry Verticals	Keynote	IEEE 5G Summit Tanger
Mobile Edge Computing (MEC): a 5G Enabler	Keynote	IEEE 5G Summit Marrakech (http://www.5gsummit.org/marrakesh/)
Overbooking 5GNetworks	Keynote	IEEE CSCN'18
"5G Mobile Platforms for Industry Verticals"	Keynote	IEEE Globecom'2018 (Backnets workshop)
Panelist at RAN WORLD 2018 in the Network Slicing Panel, where 5G-TRANSFORMER's vertical slicer architecture was presented	Panel	RAN WORLD 2018 (http://www.ranworldevent.com/ran-world-2018-agenda)
Panelist at GLOBECOM'18 Industry Panel on "5G Network Slice Management"	Panel	IEEE Globecom 2018 (https://globecom2018.ieee-globecom.org/program/industry-program#ip04)
Network Slicing Landscape: A holistic architectural approach, orchestration and management with applicability in mobile and fixed networks and clouds	Tutorial	IEEE Netsoft 2018 (http://netsoft2018.ieee-netsoft.org/program/tutorials/)
Cloud Native for Vertical Services	Talk	EuCNC 2018
Entry point of verticals to 5G systems: the 5G-TRANSFORMER vertical slicer	Talk	Webinar in telecomsradar (https://telecomsradar.com/webinar/entry-point-of-verticals-to-5g-systems-the-5g-transformer-vertical-
Service Orchestration and Federation for Verticals in 5G	Talk	Webinar in telecomsradar.com (https://telecomsradar.com/webinar/service-orchestration-and-federation-for-verticals-in-5g/)
5GEx concepts and how they evolve together with 5G-Crosshaul into 5G-TRANSFORMER	Talk	Webinar in telecomsradar.com (https://telecomsradar.com/webinar/5gex-concepts-and-how-they-evolve-together-with-5g-crosshaul-into-5g-transformer/)
Presentation of the 5G-TRANSFORMER Project	Talk	10ª Conferencia del Programa Marco de Investigación e Innovación de la UE en España (10th Conference of the EU Research and Innovation Framework Program in Spain)
Presentation of 5G-TRANSFORMER	Talk	"5GDay: OSM & 5GResearch", colocated with 5th OSM MANO hackfest
An Experimental View on 5G Research Projects for Edge Cloud: From the Lab to the Field	Talk	IEEE Future Network Workshop

All conference and workshop publications have been presented in their corresponding venue	Talk	Several international conferences and workshops (see publications table)

2.2.1 Common Dissemination Booster (CDB)

The Common Dissemination Booster (CDB) [9] is a service from the European Commission which encourages projects to come together to identify a common portfolio of results and shows them how best to disseminate to end-users, with an eye on exploitation opportunities. 5G-TRANSFORMER has formed a CDB group, named "CDB04-5G-Transformer", with 5G-Crosshaul and 5G-Coral: all projects deal with the orchestration and management of services, which may encompass different transport domains as well as services residing at the edge, the three projects also deal with federation of different administrative domains (or at least, combination of heterogeneous domains) and slicing with special focus on vertical applications. The application was approved for all the five services available in the CDB portfolio. The original timeline is reported in Figure 4 where the initial time "0" refers to the kick-off meeting held on May 14, 2018. However, it has been conveniently adapted, in particular service 5 to reach June 2019, during which EUCNC19 and the SME exploitation workshop is taking place.
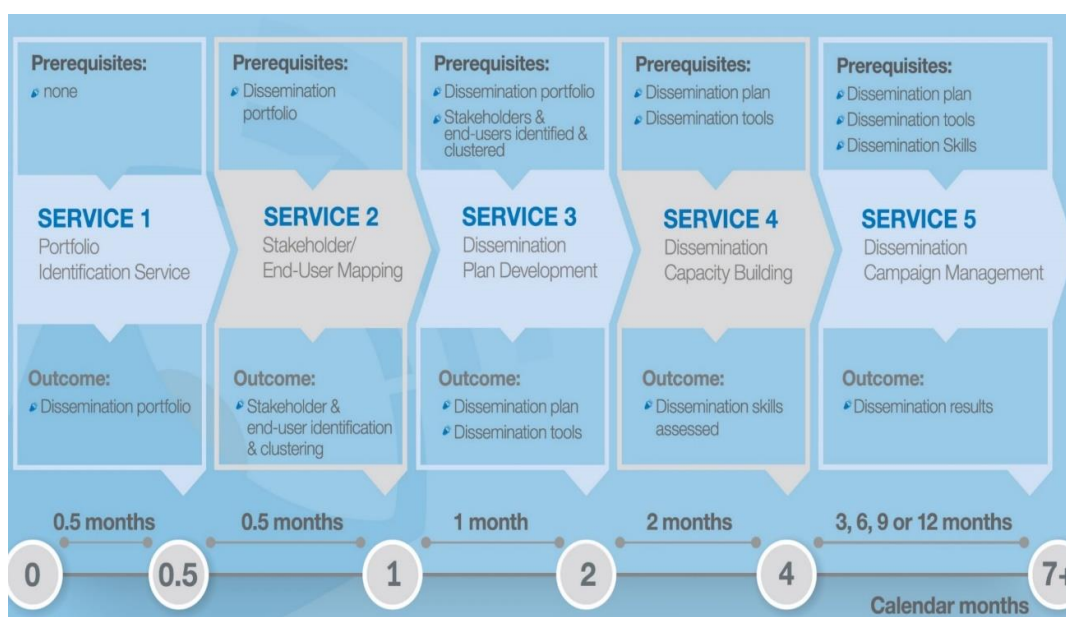
FIGURE 4: COMMON DISSEMINATION BOOSTER SERVICE RANGE AND TIMELINE

As part of the CDB, all services have been completed since CDB activities kick-off in May 2018 except for those related with Service 5, which is ongoing and will last until EUCNC 2019. The following paragraphs explain the undertaken activities in each of the services.

2.2.1.1 Service 1. Portfolio Identification

Service 1 consisted in identifying dissemination activities that can be done in common among all projects of the "CDB04-5G-Transformer", which is the name for the whole CDB including all projects. A series of discussions were set up to put in common a list of such services according to the following objectives:

- Objective 1: Communication outcomes of the three projects to the widest possible audience, including non-technical audiences.

- Objective 2: Ensure technical dissemination reaches the relevant industrial and academic communities.
- Objective 3: Maximize the impact of project outcomes through coordinated exploitation activities.
- Objective 4: Plan the activities for the dissemination and exploitation of results after the end of the funding lifecycle.

The main conclusions of Service 1 "Portfolio Identification" for the CDB04-5G-TRANSFORMER Group are:

- Capitalize on the ground-breaking results of 5G-Crosshaul by strengthening the links between the projects in communications messages and common dissemination actions. Highlight the key results for 5G and the EU 5G PPP with its focus on vertical industries. Leverage partner reputations and showcase the 5G PPP collaborative spirit.
- Produce a concise joint dissemination plan that can evolve with the projects. Identify events of mutual benefit and other actions where you can leverage commonalities. Focus initially on more technical events and subsequently reach out to vertical stakeholders.
- Be prepared to evolve our communications, websites and social media campaigns towards the ultimate end-users as the on-going projects reach greater maturity. Make sure you understand their information needs and knowledge of 5G so your messages and discussions are easily understood.
- Showcase the important work being done on standardization, including the involvement of partners from the verticals. Each project can have their own visual and "boost" it with a common image that can be promoted across the 5G PPP, standards groups and other industry networks.

In this direction, a self-assessment questionnaire filled in by each of the projects was used to identify the complementary research challenges among the projects in order to look for synergies in terms of dissemination as well as the differentiators of each of the projects, their positioning, and strengths and weaknesses. As a conclusion, some recommendations were generated.

2.2.1.2 Service 2. Stakeholder/End-User Mapping

The main task of Service 2 was stakeholders and dissemination network mapping (the specific title is CDB Service 2: Stakeholder User Mapping).

The main outcomes of this service for the CDB04-5G-TRANSFORMER group are:

- Identifying priority stakeholders and gauging current levels of engagement, interest and influence.
- Defining actions to improve and increase levels of engagement. Specific actions are matched against the barriers to engagement and dissemination.
- Providing practical dissemination networks for each priority stakeholder group, thus lowering barriers to engagement.
- Offering practical tips on the most effective dissemination channels for use by the Project Group based on an analysis of current practices and appeal to the stakeholder groups.

The main conclusions of Service 2 were:

STAKEHOLDER ENGAGEMENT (influential to very influential)

Industry engagement: Dedicate efforts on direct engagement with priority stakeholders and increase this over time. Common stakeholders include: large enterprise (supply side/value chain); Start-ups and SMEs (innovators/value chain); vertical industries (large and small businesses).

5G-Transformer also indicates mainstream press and media as a target group. Engagement with local/national media outlets will benefit the Project Group directly or indirectly.

Academia and Industrial Research: The main recommendation here is to increase buy-in within the Project Group academia/industrial research partners to increase visibility and engagement across the industry to increase awareness and build branding and reputation.

Standardisation and Open Source: The CDB-team also recommends showcasing contributions to the major standards organisations and open source communities for 5G.

They are also important building blocks towards the exploitation of results.

NEW DISSEMINATION ASSETS FOR CDB04-5G-TRANSFORMER

The dissemination networks are a core asset for facilitating and increasing engagement with the priority stakeholders, while boosting actions for strategic dissemination and exploitation of results.

The recommended dissemination channels will help the Project Group improve its approach to communicating project innovations, increase visibility and facilitate engagement with priority stakeholders outside the Project Group.

2.2.1.3   Service 3. Dissemination Plan Development

Service 3 developed a plan to increase dissemination based on the work done in previous services. The objective of this Plan is to help CDB04-5G-TRANSFORMER share results across wider geographies and variety of stakeholders detailed in the Service 2 report.

Specific objectives of the Plan are:

- Extending reach to stakeholders by leveraging the extensive network provided in CDB Service 2 and enabling the project group to boost exploitation potential. Actions include building up a community of stakeholders from relevant vertical industries and SMEs with a targeted engagement plan. Other actions seek to identify opportunities for increasing visibility with the press and media (telecommunications, national and local press). Identifying opportunities for joint demo presentations at large-scale industry events.
- Creating stronger dissemination and exploitation links between the ground-breaking research from 5G PPP phase 1 project, 5G-Crosshaul, and continued successful co-operation between industry and research experts in 5G-TRANSFORMER and 5G-CORAL.

Building on the skills development in CDB Service 4 and the implementation of the plan in CDB Service 5, this report will pave the way to increased impacts at:

- 5G events technical events, e.g. EuCNC 2019/7th Global 5G event.

- An SME workshop capturing benefits for this important stakeholder group in the 5G ecosystem.

2.2.1.4 Service 4. Dissemination Capacity Building

Service 4 consisted on providing the skills to the projects community to appropriately do dissemination. After a questionnaire was circulated to the key people involved in dissemination, an online course on the needed skills was prepared for them. The course consists of three modules:

- First, the strategy module consisted in learning to define objectives, the target stakeholders, the value proposition, the channels, timeline, and roles.
- Second, the implementation module focused on the tools to use, including social media, organization of events, or video preparation.
- Third, the monitoring module focused on measuring the impact.

2.2.1.5 Service 5. Dissemination Campaign Management

The goal of Service 5 is to ensure that the dissemination campaign is performed according to the dissemination plan in the targeted events, in this case, EUCNC 2019 and the SME workshop (i.e., the exploitation-oriented workshop of 5G-TRANSFORMER). As of the time of writing this deliverable, this service is ongoing.

2.3 Exploitation

One of the objectives of WP6 is to identify the potential exploitation of the results, outcomes, and concepts developed in the project. The key innovations, commercial-grade products, services, solutions and patents are the aspects that are tracked, since the beginning of the project, to identify exploitation opportunities.

The exploitation direction for **vertical industries** partners has been mostly directed in the slicing capabilities of the system, based on the VS for the blueprint definition and for the access to the underlying lower layers.

In this scenario, **operators** in the consortium, have gained from the project the opportunity to understand how to move from a conventional "bit pipe" business to a service business by exploiting the slicing concept for providing (virtual) infrastructure to vertical industries, as a service.

Equipment vendors in the project have been particularly involved in the design and development of system orchestration and in the evolution of mobile, transport, and computing layers providing exploitation opportunities for their control planes, fronthaul/backhaul network portfolios, and MEC products.

The project benefits from the involvement of three **SMEs**, which have significantly gained value from the work in the project. In fact, exploitation plans for SMEs are relevant and with large potential as they can benefit from the advent of SDN/NFV technologies to implement their innovative ideas in a common framework, especially in the context of the 5GT-VS and 5GT-SO blocks.

At the end of the second year, WP1/W2/WP3/WP4 have identified thirteen innovations presenting exploitation opportunities in and beyond the project lifetime. Table 22 reports such innovations, classified according to the WP where they emerged. The last column of the table reports the organizations that are, as single company or in cooperation with academia, interested in exploiting the innovations.

TABLE 22: KEY INNOVATIONS EMERGED AT THE END OF Y2

#	WP	Innovation	Leading Partners
1	WP1	**5G-TRANSFORMER Architecture** Novel architecture extending ETSI MANO based on two new functional building blocks, 5GT-VS and 5GT-SO, interworking with the 5GT-MTP extended from 5G-Crosshaul.	NECLE
2		**Slicing for Vertical Services** A system allowing the creation of vertical suited slices including integrated fronthaul/backhaul and computing resources (e.g. MEC/Cloud Services), using ETSI NFV NSDs as network slice templates.	NOK-N
3	WP2	**MTP Single Logical Point of Contact** The MTP is a novel building block, in the ETSI architecture, that operates as a single logical point of contact and resources orchestrator to manage the combined complexity of transport, radio, and datacenters, and abstracting such resources towards the 5GT-SO. MTP manages multi-domain transport, multiple radio split options and multiple VIMs.	TEI, CTTC
4		**MTP platform for supporting MEC services** Integration and deployment of the MEP in an NFV environment at the MTP and abstraction of the MEC resources toward the 5GT- SO.	EURECOM
5		**Abstraction Module for MTP** Abstraction functions module allowing to keep scalability and stability of the solution, while guaranteeing the resources optimization, where the resource domains are heterogeneous in technology.	TEI, CTTC
6	WP3	**Arbitrator** The arbitrator has the role of prioritizing resources among vertical service instances and mapping them to multiple deployment options.	POLITO
7		**Translator** Usage of translation rules to bridge among the abstract view of verticals and the specific definition of network slices.	NXW
8		**Network Slice Manager** Network Slice Manager, with the use case NSaaS and the management of the network slices.	B-COM

9		**Vertical Slicer** Vertical slicer, allowing verticals to define their service based on a catalogue of blueprints defined by the service provider or infrastructure operator and mapping them to network slice instances according to SLA requirements.	NXW
10	WP4	**Service Monitoring Platform** Service monitoring platform for providing monitoring services including definition service-specific monitoring metrics and their provision to verticals and mobile network operators. Integration of this service as part of distributed cloud services/MEC.	NXW
11		**Enhanced Service Orchestrator for heterogeneous infrastructures** Enhanced service orchestrator platform able to support heterogeneous technologies like MEC, various cloud infrastructures, including both private and public clouds, integration of cloud and WAN transport technologies by development of the appropriate MEC/WIM/VIM plugins.	MIRANTIS
12		**Federation** Federation mechanisms between 5G-TRANSFORMER platforms owned by different administrative domains and integration of vertical provided infrastructure through abstraction, advertising and interfaces.	TID

Table 23 summarizes the commercial products and services that are related to technologies in the scope of the project and that are possible receivers of the project outcomes.

TABLE 23: MAPPING BETWEEN BUILDING BLOCKS AND THE RELEVANT PARTNERS' PRODUCTS AND SERVICES

Block	PoC/Product/Service/Solution	Partner
5GT-VS	Smart Platform/Smart Stadium/Fan Engagement Solution	ATOS
	Cloud Solutions	ATOS
	Smart T-Shirt	SAMUR
	FCA car models	CRF
	Chordant	IDCC
	Converged Unifier Gateway (UGW)	BCOM
	Consultancy and training services	NXW
	Symphony	NXW
	Sealux	NXW
	NFV Mano Portfolio (Sebastian)	NXW
Service Orchestrator	E2E NFV Management and Orchestration portfolio	NECLE
	Backhaul Resource Manager (BRM)	NECLE
	Network Slice Orchestrator (OVNES)	NECLE
	Mirantis Cloud Platform (MCP)	MIRANTIS
	Cloudify	MIRANTIS

Mobile Transport and Computing Platform	5G BTSs (Base Transceiver Station)	NOK-N
	Airframe	NOK-N
	Airframe data center	NOK-N
	NFV-based packet core	NOK-N
	MEC Platform	NOK-N
	NEC Control Platform	NECLE
	NEC iPASOLINK	NECLE
	Fronthaul 6000	TEI
	Ericsson Cloud Infrastructure	TEI
	EdgeHaul	IDCC
	Virtlet Platform	MIRANTIS

In addition to bringing project outcomes in specific commercial products, the demos and test-beds planned in the context of WP5 are expected to activate a fruitful ecosystem for experimentation where verticals, manufacturers, SMEs, operators, and academia can share requirements, constraints, feasibility of specific features and functionalities.

Exploitation opportunities of the telecom operator partners Telefonica (TID) and Orange are reported in Section 3.3.4.

The 5G-TRANSFORMER project addresses an area which provides significant opportunities for **patent** creation also leveraging on a strong background of over 40 patents, related to 5G-TRANSFORMER topics, filed by partners before joining the project.

At the end of Y2, partners have filed three patents that may lead to subsequent licensing opportunities, depending on the specific exploitation strategies of the relevant partners. Table 24 reports the three patents filed at the end of Y2.

TABLE 24: LIST OF PATENT APPLICATIONS REPORTED AT THE END OF Y2

#	Patent Application Number and Title	Partner
1	PCT/IB2019/052094 - "Method for restoring the connection of a telecommunications network" (previously registered in Italy as "Metodo per il ripristino della connessione di una rete di telecomunicazioni")	SSSA
2	PCT/US18/46747 - "Methods for advertising and selecting network slices dual-connectivity and multi-subscriber scenarios in 5G"	IDCC
3	PCT/EP2018/066481 - "Multi-access edge computing, MEC, system and method for operating the same".	NEC

An additional invention disclosure "Optimized method of continuity check in IP networks" has also been internally approved for filing by NOK-N, pending formal application for filing.

2.4 Standardization

As described in the DoA, Objective 8 (Dissemination, standardization and exploitation of 5G-TRANSFORMER), we have a commitment to producing at least 10 adopted contributions to Standard Development Organizations (SDOs), such as 3GPP, IETF, ETSI, IEEE, ITU and ONF.

According to the Y2 Standardization plan, meeting cycles from SDOs relevant to 5G TRANSFORMER were to be analyzed to determine the best way to maximize 5G TRANSFORMER input to overall Standardization activities, thereby improving our

contribution rate into these forums. As part of this analysis it was also made evident that our main inputs are generated primarily towards the following Standardization groups:

- ETSI NFV,
- ETSI MEC,
- IETF, and
- 3GPP SA2.

Given the maturity reached in the generation of relevant contributions to the main standardization bodies, 5G-TRANSFORMER has maintained a healthy and steady rate of relevant dissemination into key SDOs. This has been achieved by focusing the efforts of the SAC team in the writing and presentation of these contribution into the SDO groups as outlined above, while requiring minimum disruptions to the rest of the project activities, just as planned for Y2.

Note that we include figures for the whole project (i.e., both Y1 and Y2 are shown in separate tables) but we clearly specify what numbers belong to what reporting period.

A detailed description of specific contributions that were brought to the SDOs specified above is outlined in Table 25 and Table 26 below. The table provides a description of how specific standardization contributions were prepared, discussed and ultimately presented in the relevant standards fora by 5G-TRANSFORMER partners, related to specific 5G-TRANSFORMER components.

To achieve this, we provide the specific contribution ID, e.g., 3GPP Technical Document (Tdoc) number, IETF draft or ETSI MEC contribution number. In addition, we specify how the content of such contribution relates to technology that is developed within 5G-TRANSFORMER. Finally, we indicate the status of these contributions, highlighting whether each contribution was "agreed/adopted/approved" or whether it was "rejected"/"presented"/"not yet adopted" or "noted".

TABLE 25: DETAILED DESCRIPTION OF STANDARDS DISSEMINATION ACHIEVEMENTS IN Y1, HIGHLIGHTING THE RELATIONSHIP BETWEEN CONTRIBUTIONS TO SPECIFIC SDOS AND 5G-TRANSFORMER COMPONENTS

SDO	Contribution ID	Contribution Summary	Outcome	Relation to 5G-T	Date
		First Year of 5G TRANSFORMER			
IETF(DMM WG)	Proxy Mobile IPv6 extensions for Distributed Mobility Management https://tools.ietf.org/html/draft-ietf-dmm-pmipv6-dlif-04	A solution based on Proxy Mobile IPv6 is proposed in which mobility sessions are anchored at the last IP hop router, called Mobility Anchor and Access Router (MAAR). The MAAR is an enhanced access router, also able to operate as a local mobility anchor or mobility access gateway, on a per prefix basis.	Adopted	5G Mobile Transport and Computing Platform, deliverable D2.3 [5], implements a mechanism to provide Mobility support (clause 7.3.1.3) to aggregate resource base on virtual coverage. The virtual coverage encompasses radio and Core Network resources, including information on CN gateways. The cross-abstraction manager in the MTP considers the simultaneous anchoring of flows abstracting resources from a particular coverage area composed by ordered geographical points	10/05/2018
IRTF (NFVRG)	Network Virtualization Research Challenges https://tools.ietf.org/html/rfc8568	Survey of the different efforts taking place at IETF and IRTF with regards to network virtualization, automation and orchestration in contrast with efforts taken by other SDOs	Adopted	5G Mobile Transport and Computing Platform and Service Orchestrator, in conjunction with the Vertical Slicer leverage on the concepts of network slicing and network virtualization to provide slices tailored to needs (e.g., networking and computing requirements) of different vertical industries and to allow per-slice management of virtualized resources as described in deliverable D1.3 [6]. Furthermore, this RFC identifies multi-domain orchestration as one challenge that needs to be tackled by the IETF community. Multi-domain orchestration is one key contribution of the 5G	03/07/2017

				TRANSFORMER project, as seen not just in deliverables, e.g., D4.3 [8] but alson in other standardization contributions e.g., IETF Multi-domain Network Virtualization (https://tools.ietf.org/html/draft-bernardos-nmrg-multidomain-00).	
IETF (NMRG)	Multi-domain Network Virtualization https://tools.ietf.org/html/draft-bernardos-nmrg-multidomain-00	Analysis of the problem of multi-provider multi-domain orchestration, by first scoping the problem, then looking into potential architectural approaches	Not yet adopted	The 5GT Service Orchestrator addresses the problem of multi-provider/multi-domain orchestration by providing service scaling, network service composition, service federation, enhanced placement algorithms considering location constraint and MEC support, and enhanced service monitoring platform which provides monitoring data to the 5GT-SO for automated service scaling and SLA management, as described in deliverable D1.3 [6]	05/03/2018
IRTF (INTAREA)	IPv6-based discovery and association of Virtualization Infrastructure Manager (VIM) and Network Function Virtualization Orchestrator (NFVO) https://tools.ietf.org/html/draft-bernardos-intarea-vim-discovery-01	The contribution describes mechanisms allowing dynamic discovery of virtualization resources and orchestrators in IPv6-based networks. New IPv6 neighbor discovery options are defined	Not yet adopted	5G Mobile Transport and Computing Platform and in particular its Enhanced Placement feature, as described in deliverable D2.3 [5] addresses the issue of where to put VNF in multi-VIM domains	05/03/2018
IETF (COMS BoF)	COMS Architecture https://datatracker.ietf.org/doc/draft-geng-coms-architecture	The contribution defines the overall architecture of a COMS based network slicing system. COMS works on the top level	Not yet adopted	At its core, the 5G TRANSFORMER project, leverages on the concept of network slicing for providing slices tailored to needs (e.g., networking and computing	05/03/2018

		network slice orchestrator which directly communicates with the network slice provider and enables the technology-independent network slice management		requirements) of different vertical industries and to allow per-slice management of virtualized resources. Multiple enhancements and novelties have been included to satisfy the requirements to support heterogeneous network slicing as described in deliverable D1.3 [6]	
IETF (COMS BoF)	Problem Statement of Common Operation and Management of Network Slicing https://datatracker.ietf.org/doc/draft-geng-coms-problem-statement	This contribution discusses the general requirements and problem statement of supervised heterogeneous network slicing	Note yet adopted	The Vertical Slicer, through its Vertical Services Monitoring, supports monitoring of Vertical Service (VSI) their corresponding Network Slice Instances (NSI). The 5GT-VS interacts with the 5GT-SO to collect monitoring data about the established NFV network services and correlates or aggregates these data in order to produce metrics and KPIs for network slices and vertical services, as described in deliverable D3.3 [7]	05/03/2018
IETF (CCAMP WG)	A YANG Data Model for Microwave Topology https://datatracker.ietf.org/doc/draft-ietf-ccamp-mw-topo-yang/		Adopted	Definition of an information model and the related data model specified in deliverable D1.3 [6]	05/03/2018
IETF (CCAMP WG)	A framework for management and control of microwave and millimeter wave interface parameters https://datatracker.ietf.org/doc/draft-ietf-ccamp-microwave-framework	This contribution describes the required characteristics and use cases for control and management of radio link interface parameters using a YANG Data Model	Not yet adopted	5G Mobile Transport and Computing Platform, addresses the representation of network resources through Logical Links (LL) which define the link interconnecting two IP endpoints. The information model for a logical link, includes the IP address of terminating nodes and information related to the bandwidth and the latency induced by such connectivity.	05/01/2018

IETF (CCAMP WG)	A YANG Data Model for Microwave Radio Link https://datatracker.ietf.org/doc/draft-ietf-ccamp-mw-yang	This contribution defines a YANG data model to describe the topologies of microwave/millimeter	Adopted	5G Mobile Transport and Computing Platform has adopted YANG data models as information models defined to express relevant information parameters, thus enabling the exchange of this information through the adoption of a proper protocol, as described in deliverable D1.3 [6]	03/03/2018
3GPP SA2	(S2-183925-S2-183923)	New Key Issue: Identify scenarios when Network Slices cannot coexist within a single PLMN	Approved	Vertical Slicer, e.g., Verticals may impose requirements on what slices should be mutually exclusive (i.e., cannot be accessed simultaneously). The Vertical Slicer should be aware of this property. E.g., when managing policies per tenant, as specified in deliverable D3.3, in particular as part of the Policy Management and Arbitrator components.	16/04/2018

TABLE 26: DETAILED DESCRIPTION OF STANDARDS DISSEMINATION ACHIEVEMENTS IN Y2, HIGHLIGHTING THE RELATIONSHIP BETWEEN CONTRIBUTIONS TO SPECIFIC SDOS AND 5G-TRANSFORMER COMPONENTS

SDO	Contribution ID	Contribution Summary	Outcome	Relation to 5G-T	Date
		Second Year of 5G TRANSFORMER			
ETSI NFV	IFA013	The contribution proposes a mechanism to associate specific policies to NFV NSIs	Accepted	The contribution allows the 5GT-VS to associate specific policies to NFV NSIs such that 5GT-SO could orchestrate different NSIs accordingly. Policies are needed to implement some of the SLA requirements, as described in deliverable D3.3 [7], and in particular as part of the Policy Management component	22/10/2018
ETSI NFV	IFA007ed321, IFA008ed321, IFA010ed321, IFA013ed321)	The contribution proposes a mechanism to associate specific policies to NFV NSIs	Accepted	The contribution allows the 5GT-VS to associate specific policies to NFV NSIs such that 5GT-SO could orchestrate different NSIs accordingly. Policies are needed to implement some of the SLA requirements. This is in line with deliverable D3.3 [7], and in particular as part of the Policy Management component	22/10/2018
3GPP SA2	Contribution to 3GPP SA2#127 meeting in Vilnius, LT. Technical Document (Tdoc): S2-187289	This contribution addresses KI1 "Mutually exclusive access to Network Slices" and in particular, identifying whether improvements to existing Release 15 System procedures are needed when controlling the access to mutually exclusive Network Slices, including aspects of both UE and network"	Noted	Verticals may impose requirements on what slices should be mutually exclusive (i.e., cannot be access simultaneously). The Vertical Slicer should be aware of this property. E.g., when managing policies per tenant, in line with deliverable D3.3 [7], and in particular as part of the Policy Management and Arbitrator components	02/07/2018

3GPP SA2	Contribution to 3GPP SA2#127 meeting in Vilnius, LT. Technical Document (Tdoc): S2-187248	This contribution proposes a new Kew Issue addressing system impacts when handling access to network slices, for UEs that have already been authenticated for PLMN access using 3GPP SUPI, but that require an additional level of authentication and authorization using User Identities and Credentials for specific slices	Approved	The arbitration features in the vertical slicer may need to consider slices that require Slice specific additional authentication, when selecting slices based on tenant policies as described in deliverable D3.3, [7]	02/07/2018
3GPP SA2	Contribution to 3GPP SA2#128bis meeting in Sophia Antipolis, FR. Technical Document (Tdoc): S2-188484	This contribution addresses KI1 (Key Issue) 1 "Mutually exclusive access to Network Slices" and in particular, identifying whether improvements to existing Release 15 System procedures are needed when controlling the access to mutually exclusive Network Slices, including aspects of both UE and network"	Approved	Verticals may impose requirements on what slices should be mutually exclusive (i.e., cannot be access simultaneously). The Vertical Slicer should be aware of this property. E.g., when managing policies per tenant, described in deliverable D3.3 [7], and in particular as part of the Policy Management and Arbitrator components	20/082018
3GPP SA2	Contribution to 3GPP SA2#129 meeting in Dongguan, China. Technical Document (Tdoc): S2-1811600	This contribution proposes and update to Solution 1.6 "Enabling access control to network slices that cannot be access simultaneously" in 3GPP. Solution 1.6 provides the evaluation of this solution	Approved	Verticals may impose requirements on what slices should be mutually exclusive (i.e., cannot be access simultaneously). The Vertical Slicer should be aware of this property. E.g., when managing policies per tenant, described in deliverable D3.3 [7], and in particular as part of the Policy Management and Arbitrator components	15/10/2018
3GPP SA2	Contribution to 3GPP SA2#129 meeting in Tenerife, SP. Technical	This Change Request (CR) proposes normative text to implement Slice-specific	Postpone d	The arbitration features in the vertical slicer may need to consider slices that require Slice specific additional	20/02/2019

	Document (Tdoc): S2-1901747	secondary authencation, ensuring that the UE is first successfully registered to the Network before Slice Specific Authentication and Authorization is executed		authentication, when selecting slices based on tenant policies, as per SLA agreement, within section 2.1, in deliverable D3.3 [7]	
3GPP SA2	Contribution to 3GPP SA2#129 meeting in Tenerife, SP. Technical Document (Tdoc): S2-1901746	This Change Request (CR) proposes normative text to implement Slice-specific secondary authencation, ensuring that the UE is first successfully registered to the Network before Slice Specific Authentication and Authorization is executed	Postponed	The arbitration features in the vertical slicer may need to consider slices that require Slice specific additional authentication, when selecting slices based on tenant, as per SLA agreement, within section 2.1, in deliverable D3.3 [7]	20/02/2019
ETSI MEC	MEC(18)000298	MEC024 errata of use case 5.1 and exemplary figure	Accepted	The Vertical Slicer and Service Orchestrator should be aware what MEC resources are needed to be accessed when allocating resources to tenants when managing policies per tenant, as described in deliverable D3.3 [7]	24/07/2018
ETSI MEC	MEC(18)000299	MEC024 key issue on slice-awareness of the MEAO		The Vertical Slicer and Service Orchestrator deliverables D3.3 and D4.3 [8] should be aware what MEC resources are needed to be access when allocating resources to tenants when managing policies per tenant, described in deliverable D3.3 [7], and in particular as part of the Policy Management component	24/07/2018
ETSI MEC	MEC(18)000300	MEC024 key issue on slice-awareness of the MEP	Accepted	The Vertical Slicer and Service Orchestrator deliverables D3.3 [7] and D4.3 [8] should be aware what MEC resources are needed to be access	24/07/2018

				when allocating resources to tenants when managing policies per tenant, described in deliverable D3.3 [7], and in particular as part of the Policy Management component	
ETSI MEC	MEC(18)000301	MEC024 key issue on slice-awareness of the MEPM-V	Presented	The Vertical Slicer and Service Orchestrator deliverables D3.3 [7] and D4.3 [8] should be aware what MEC resources are needed to be access when allocating resources to tenants when managing policies per tenant, described in deliverable D3.3 [7], and in particular as part of the Policy Management component	24/07/2018
ETSI MEC	MEC(18)000326	MEC024 - Some Clarifications for the use case 5.2	Accepted	The Vertical Slicer and Service Orchestrator deliverables D3.3 [7] and D4.3 [8] should be aware what MEC resources are needed to be access when allocating resources to tenants when managing policies per tenant, described in deliverable D3.3 [7], and in particular as part of the Policy Management component	31/07/2018
ETSI MEC	MEC(18)000329r1	MEC024 - Use case on dedicated instances of MEC components in a network slice	Accepted	The Vertical Slicer and Service Orchestrator deliverables D3.3 [7] and D4.3 [8] should be aware what MEC resources are needed to be access when allocating resources to tenants when managing policies per tenant, described in deliverable D3.3 [7], and in particular as part of the Policy Management component	31/07/2018

ETSI MEC	MEC(18)000339	MEC024 - Use case on multiple tenants in a single network slice	Accepted	The Vertical Slicer and Service Orchestrator deliverables D3.3 and D4.3 [8] should be aware what MEC resources are needed to be access when allocating resources to tenants when managing policies per tenant, described in deliverable D3.3 [7], and in particular as part of the Policy Management component	03/08/2018
ETSI MEC	MEC(18)000340	MEC024 - Use case on MEC applications shared among NSIs	Presented	The Vertical Slicer and Service Orchestrator deliverables D3.3 [7] and D4.3 [8] should be aware what MEC resources are needed to be access when allocating resources to tenants when managing policies per tenant, described in deliverable D3.3 [7], and in particular as part of the Policy Management component	02/08/2018
ETSI MEC	MEC(18)000430	MEC024 - Overview of Network Slicing Concept in ETSI NFV	Accepted	The Vertical Slicer and Service Orchestrator deliverables D3.3 [7] and D4.3 [8] should be aware what MEC resources are needed to be access when allocating resources to tenants when managing policies per tenant, described in deliverable D3.3 [7], and in particular as part of the Policy Management component	12/10/2018
ETSI MEC	MEC(19)000038	MEC024 - Draft v2.0.6 - Editorial Changes	Accepted	The Vertical Slicer and Service Orchestrator deliverables D3.3 [7] and D4.3 [8] should be aware what MEC resources are needed to be access when allocating resources to tenants when managing policies per tenant,	05/03/2019

				described in deliverable D3.3 [7], and in particular as part of the Policy Management component	
ETSI MEC	MEC(19)000039r2	MEC024 - Section 7 - Conclusions and recommendations	Accepted	The Vertical Slicer and Service Orchestrator deliverables D3.3 [7] and D4.3 [8] should be aware what MEC resources are needed to be access when allocating resources to tenants when managing policies per tenant, described in deliverable D3.3 [7], and in particular as part of the Policy Management component	05/03/2019
ETSI MEC	MEC(19)000067r1	MEC024 - Editorial changes and references formatting	Accepted	The Vertical Slicer and Service Orchestrator deliverables D3.3 [7] and D4.3 [8] should be aware what MEC resources are needed to be access when allocating resources to tenants when managing policies per tenant, described in deliverable D3.3 [7], and in particular as part of the Policy Management component	29/03/2019
ETSI MEC	MEC(19)000068	MEC024 - Scope text proposal (Section 1)	Accepted	The Vertical Slicer and Service Orchestrator deliverables D3.3 [7] and D4.3 [8] should be aware what MEC resources are needed to be access when allocating resources to tenants when managing policies per tenant, described in deliverable D3.3 [7], and in particular as part of the Policy Management component	29/03/2019
ETSI MEC	MEC(19)000122	MEC024 - Efficient E2E multi-slice support for MEC-enabled 5G deployments	Accepted	The Vertical Slicer and Service Orchestrator deliverables D3.3 [7] and D4.3 [8] should be aware what MEC	09/04/2019

				resources are needed to be access when allocating resources to tenants when managing policies per tenant, described in deliverable D3.3 [7], and, in particular, as part of the Policy Management component	
3GPP SA2	Contribution to 3GPP SA2#133 meeting in Reno, (NV) USA. Technical Document (Tdoc): S2-1905305, merged into S2-1906591	This Change Request (CR) proposes normative text to implement Slice-specific Authentication and Authorization, where the Network holds policies to indicated whether Slice Specific Authentication and Authorization should be run on more than one Access Network (e.g., 3GPP and Non-3GPP)	Agreed	The arbitration features in the vertical slicer may need to consider slices that require Slice specific additional authentication, when selecting slices based on tenant. In particular, whether Slice Specific Authentication should be run simultaneously for the same S-NSSAI when the UE access the system through 2 or more Access Networks. This is considered in the implementation of Service Level Agreements, described within section 2.1, in deliverable D3.3. [7]	17/05/2019
3GPP SA2	Contribution to 3GPP SA2#133 meeting in Reno, (NV) USA. Technical Document (Tdoc): S2-5306 merged into S2-1906592	This Change Request (CR) proposes normative text to implement Slice-specific Authentication and Authorization, where the Network holds policies to indicated whether Slice Specific Authentication and Authorization should be run on more than one Access Network (e.g., 3GPP and Non-3GPP)	Agreed	The arbitration features in the vertical slicer may need to consider slices that require Slice specific additional authentication, when selecting slices based on tenant. In particular whether Slice Specific Authentication should be run simultaneously for the same S-NSSAI when the UE access the system through 2 or more Access Networks. This is considered in the implementation of Service Level Agreements, described within section 2.1, in deliverable D3.3. [7]	17/05/2019

3 Update of the CoDEP

This section outlines the Communication, Dissemination and Exploitation Plan (CoDEP) and updates it for the last six months of the project. Section 3.1 describes the communication plan, Section 3.2 presents the dissemination plan, and Section 3.3 describes the plan on exploitation, including products and services, patent and licensing. Section 3.4 presents the plan for standardization. It is noted that the CoDEP follows what was initially presented in D6.2 and some update has been introduced mainly regarding the exploitation plan.

3.1 Communication

This section follows the communication plan of 5G-TRANSFORMER as described in D6.2. The 5G-TRANSFORMER communication activities target society at large and groups not specialized in the topic of the project as planned. In this respect, 5G-TRANSFORMER strives to convey its vision, concept, objectives, and results among the various targeted audiences. Table 27 lists each target audience, the scope of activity, timing and the corresponding metrics to measure the progress and success for the last 6 months of the project. This table is similar to the one introduced in D6.2, with minor modifications where more emphasis about press release effort is considered to reach the society at large. This will allow to continue promoting the 5G-TRANSFORMER project.

TABLE 27: COMMUNICATION ACTIVITIES IN 5G-TRANSFORMER

Audience	Activity	Timing	Metric
General audience	A project **website** will be designed, implemented and maintained. **Social media** accounts will also be created. They will include information about concepts, vision, objectives and expected outcomes as well as public documents deriving from the project work, which will be regularly updated, offering links to other relevant sites and links to partner' websites.	Initial content, and after that, event-driven	Number of unique visits, Pages most visited, Papers most download, LinkedIn and Twitter metric
General audience (mostly technical)	**Project brochures and videos** with information on the project scope and results, demonstrations carried out, and any relevant event related to the project activities.	Initial content, and event-driven	Number of downloads and number of times video played
Other research projects	**Collaboration with other EU and international research projects** (e.g., through 5G PPP working groups, or working groups of other platforms, such as networld2020, will also be key towards a coordinated action inside the 5G PPP and with other H2020 projects related with the vertical industry involved in the project. One of the expected results is the joint production of white papers.	5G PPP WGs and ad hoc bi-lateral collaboration	Number of meetings attended (target: at least two per year) Number of joint documents generated (target: at least two per year) More than 12 meetings already achieved

Grad and undergrad students	Introducing 5G-TRANSFORMER concepts and results to **lecture materials** prepared by academic partners for undergraduate and graduate students.	Potential input every semester	Number of courses related with project topics
Society at large	Press releases in newspapers and magazines. Generic **communication activities for society at large** will be undertaken by partners in various forms. For instance, open days taking place in the premises of the partners will serve to explain and demonstrate projects results and their implications to the general public. In a similar way, participation in the Science Week where lectures to approach technology to society will also be exploited in this direction. Appearance in general media will also be exploited as communication channel to a wider audience	Pre-scheduled yearly events plus ad hoc continuous actions	Published press releases (target: two global press releases, backed by all partners per year) Number of events organized/attended (target: at least one organized per year) More than 35 press release already achieved

3.2 Dissemination

This section follows the dissemination plan of 5G-TRANSFORMER as described in D6.2. For the remaining 6 months of the project, the dissemination plan will continue focusing on publication of research results, technology demonstration, organization of events (targeting, particularly, Verticals and SMEs), and participation to events. Table 28 summarizes the different actions for the last 6 months of the project. For each action, the first column indicates the target audience, the second provides details on the activities involved, the third shows the timing of each activity, i.e., whether it takes place in a continuous, periodic, or event-driven manner, and the fourth presents the metrics that will be applied to measure the success of the action. This table is similar to the one introduced in D6.1 and D6.2, with slight modifications regarding the targeted metric:

TABLE 28: DISSEMINATION ACTIVITIES

Audience	Activity	Timing	Metric
Academic and industrial researchers	**Publications**: 5G-TRANSFORMER partners will publish their works in high-profile conferences, magazines and journals in the fields of communications/network softwarization, such as IEEE INFOCOM, ACM MOBICOM, IEEE ICC/Globecom, as well as journals like ACM/IEEE Transactions on Networking, IEEE Transactions on Network and Service Management, IEEE JSAC - Network Softwarization Series, IEEE Communications Magazine, and Elsevier Computer Networks. All the above are established, highly regarded venues	Continuous	Average of 5 papers in the last six months.

	for academic and industry publishing; they have recently experienced an increase in the number of authors and attendees coming from the industry. Note that project partners have regular presence in the above conferences/journals and are active in their organization. Moreover, the partners will participate and disseminate the project results in very specific workshops, such as those dedicated to vertical industry.		
Industry and Academic	**Technology demonstration:** In the last six months, 5G-TRANSFORMER partners aim to increase their efforts to demonstrate the project components in exhibitions booths at flagship conferences (e.g., ACM MobiCom, ACM MobiSys, IEEE INFOCOM) and scientific/technological fairs. The consortium members are planning to continue having an exhibition at the EuCNC conference. Moreover, the partners will target venues such as the Mobile World Congress (MWC), as well as vertical oriented events, such as ITS World Congress and European Media Summit. Furthermore, partners will participate to industry-oriented gatherings on 5G and the related technologies, such as MEC Congress and 5G World events.	Event-driven, approximately once every six months	Technology demonstration in at least one event in the last six months
Industry and Academia	**Organization of events:** 5G-TRANSFORMER partners will continue organizing one workshop co-located with a major event, and subsets of the partners will participate in the organization of at least one other event per year. The 5G-TRANSFORMER workshop will be held in conjunction with one of the following events: EuCNC'19, IEEE WCNC'19, IEEE ICC'19, IEEE INFOCOM'19, IEEE Globecom'19.	Event driven (one workshop over the project's duration; participation in the organization of one event per year).	Organization of one event dedicated to SME and Vertical industry
Industry and Academia	**Participation to events:** 5G-TRANSFORMER partners will continue participating to events, by giving talks in form of technical presentation, keynote and panels in events such as EuCNC'19, IEEE WCNC'19, IEEE ICC'19, IEEE INFOCOM'19, IEEE Globecom'19.	Event driven	Average of 5 talks in the last six months

3.2.1 Common Dissemination Booster

Following the service sequence of the CDB (Figure 5), for the last six months of the project, the plan is to implement Service 5 targeting two milestone events for the project: EUCNC19 as a whole, in which there is substantial presence of the project (booth, demonstrations, talks, paper, co-organization of events), and more specifically, the SME exploitation workshop. The material prepared for these events will be extensively used during the last period of the project to increase its visibility and impact.
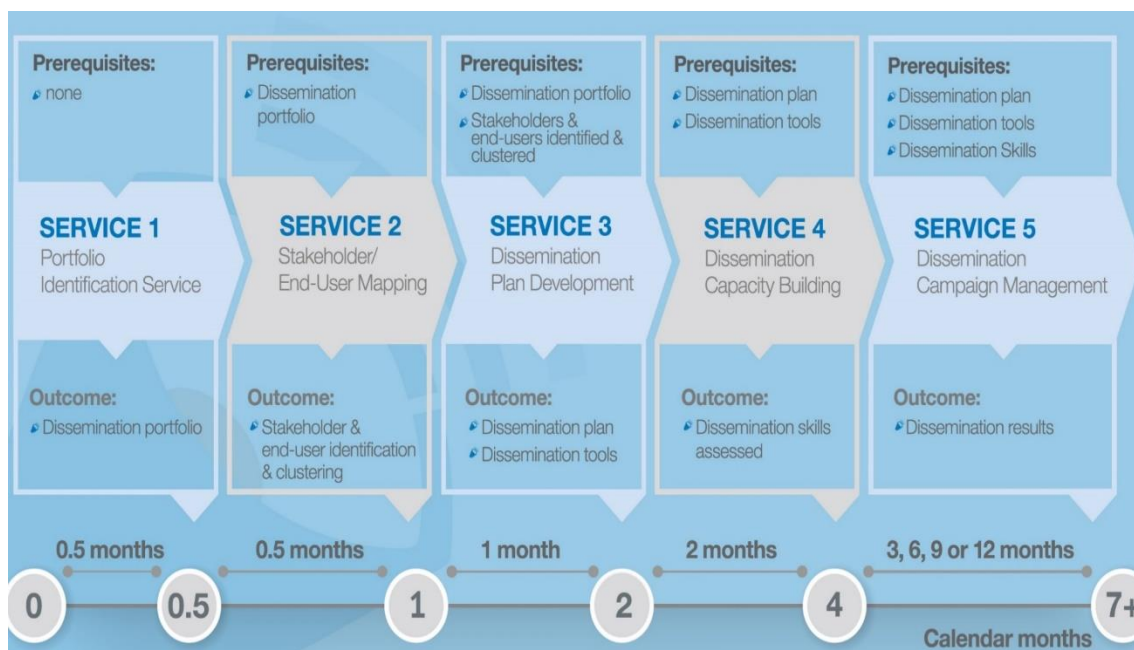

FIGURE 5: COMMON DISSEMINATION BOOSTER SERVICE RANGE AND TIMELINE

3.3 Exploitation

In the last six months of the project, the focus and effort will be dedicated on completing and consolidating all key innovations developed in the first two years of activities and to outline the relevant potential for exploitation in the last period and beyond the project lifetime, also leveraging on the developments and learnings achieved in the project test beds and trials.

The project benefits from the involvement of three SMEs, and SMEs have largely benefited from the work in the project and to have the opportunity to develop software components and gain know-how in NFV, SDN, and MEC areas, working on the 5GT-VS and 5GT-SO blocks. Know-how is an important exploitable asset for SMEs that can also sell consultancy services as 3rd party developers for ICT solutions and training courses.

As indicated in Table 23, exploitation opportunities in products and services can be considered by vertical industries, equipment vendors, SMEs, operators and network providers. Partners in the consortium have identified, in their product portfolio or service offering, the potential targets for exploiting project results.

3.3.1 Vertical Slicer (VS)

ATOS

Since 1989 ATOS has a global business unit which is dedicated exclusively to the provision of IT products and services to event owners, venue operators and rights holders. It is partner of Olympic & Paralympic Games, will mostly focus on the media distribution vertical industry. The expected increase of bandwidth requirements, coming from the advent of 4K/8K and High Dynamic Range (HDR) streams, has posed to ATOS the challenge of transporting more data in an extremely dense environment. In this scenario, ATOS has identified the need of the sport market to support massive content distribution within venues and stadiums, where in a relatively small area and for a limited number of hours during the week, there could be up to 50K viewers downloading and uploading media content.

To answer these needs, outcomes of the project will be considered to improve ATOS Smart Platform, Smart Stadium offering and Fan Engagement solutions. In these solutions, the media and entertainment content could be distributed through a 5G-TRANSFORMER like infrastructure instead of through a traditional CDN. This could enhance the service offered providing a flexible on-demand content distribution based on dynamic allocation of VNFs to support specific user needs. ATOS, which is also a Cloud Infrastructure Provider, has identified the opportunity to exploit technologies developed in the project to integrate its Cloud Infrastructure with the transport networks of operators.

ATOS is also planning a demo at TRL6 for Q3 2019 in an European Golf Tournament, at the time of release of the current deliverable the demo is still under discussion in the consortium. ATOS expects to take advantage of the developed software, integration, experience gained and, mainly, from the results of the demo. The exploitation plan could be later updated as a result of the above-mentioned facts.

SAMUR

SAMUR-Civil Protection, in close collaboration with the Subdirección General de Informática y Nuevas Tecnologías de la Dirección General de Emergencias y Protección Civil, in Spain, has defined and proposed a concrete use case to be developed and tested during the project, which consists of a "Smart T-Shirt/watch", designed to save lives in cases of a medical emergency thanks to 5G technology. The "Smart T-Shirt/watch" would measure the heart rate by means of sensors that, in case of potentially lethal arrhythmia, would generate an automatic alert to a nearby ambulance, through the mobile phone via Bluetooth. In turn, the mobile phone, would send this alert to the nearest useful hospital for the patient, without having to go through a communications center, significantly reducing the response time to a life-threatening emergency. The system also would locate, through an App, a volunteer near the incident to perform cardiopulmonary resuscitation (CPR) on the patient while waiting for the ambulance. The system will also automatically deploy/scale required servers and network capacity to provide assistance to the teams deployed in the emergency.

Centro Ricerche Fiat (CRF)

During the first stage of the project CRF explored several automotive services relevant for 5G which span from safety to entertainment and involves automated (partially or full) as well as autonomous vehicles. To better analyze the needs of the automotive domain versus the incoming communication technology, four main scenarios (urban, rural, highway, and transversal) and several use cases quite different for their peculiar features

have been considered, outlining the key aspects that mostly impacts on 5G. This analysis allowed to collect the main automotive requirements and related KPIs to be kept into account by the novel 5G solution implemented by 5G-TRANSFORMER. Moreover, the results of this analysis have been presented at several conferences as well as at 5GPPP automotive WG and are the starting point for future exploitation in FCA projects aimed at implementing future 5G connected vehicles.

In a second stage, the focus has been on a relevant class of automotive services, namely, the Extended Virtual Sensing (EVS), which aim at enhancing the sensor measurements aboard vehicles with the information collected by the network infrastructure and exploit it to implement more robust safety as well as improved passengers/driver comfort. In particular, for the implementation of the PoC in 5G-TRANSFORMER, the EVS application for vehicle collision avoidance has been selected. The PoC, currently under development, is based on a MEC architecture that allows minimizing the latency and it is going to be integrated with 5G-TRANSFORMER functionalities for supporting the automatic deployment of the EVS automotive application and the scalability of the service to ensure the SLA that will be shown at EUCNC. During next stages, the EVS PoC will be a valuable vehicle for the internal exploitation and the starting point for the implementation of further flexible and dynamic connected services for safety and entertainment enabled by 5G-TRANSFORMER platform functionalities.

InterDigital (IDCC)

Chordant™, launched by InterDigital (IDCC) in 2017, offers a platform with solutions that enable operators, companies and public authorities to address the fundamental challenges in Smart City deployments. The platform allows verticals to enable their own solutions by consolidating, exposing, and monetizing their data. It supports diverse types of devices, data and services, along with standards-based architecture and APIs that hide complexity from application developers, so they can focus on creating applications for cities, consumers and enterprises.

For such specific characteristics, Chordant™ has been indicated by IDCC as potential target for exploitation of results in the 5GT-VS area. 5GT-VS, in fact, hides the complexity of the underlying network to the verticals, in a similar way the Chordant™ platform does.

As for the 5G TRANSFORMER approach, the IDCC platform supports diverse types of devices, data and services, along with standards-based architecture and APIs that hide complexity from application developers, so they can focus on creating applications for cities, consumers and enterprises.

BCOM

BCOM plans to exploit the outcomes of 5G transformer project to pursue evolution of its experimental Wireless Edge Factory (WEF, and previously named Convergent Unifier Gateway, UGW) which integrates computing and networking capabilities in a single node. 5G-TRANSFORMER results have then an impact on the functionality of the WEF by bringing both expertise and knowledge on the slice concept, architecture and development of slicing. BCOM developed slice manager which performs the Live Cycle Management (LCM) for commission/decommission/activation/deactivation of network slices instances, to match with vertical needs and requirements. BCOM is now leading this expertise and share it to all partners when required at different stages of the project. BCOM is also able to exploit and follow up standard for ETSI NFV IFA005 interface and has developed plugin adaptor for VIM based on Open Stack, so that NFVO (Network Function Virtualized Orchestrator) can communicate directly with the VIM (Virtualized

Infrastructure Management) whatever the type of technologies used to manage the infrastructure. 5G transformer allows BCOM to provide partner (Orange) with its WEF embedding vEPC functions and services in order to contribute to the MVNO use case of the project. Finally, BCOM benefits 5G transformer researches to exhibit its vEPC module for WIFI and Lora connectivity during EuCNC 2019 exhibition.

As a final exploitation, BCOM is pushing the WEF into a product state, transferring this technology to Partners of BCOM, i.e., large industrial companies and SMEs, or other companies in a period of 3 years. All works and researches carried out within 5G transformer project will be also used for different EU projects, such as 5G-EVE.

Nextworks (NXW)

NXW aims at exploiting the project results to enhance its know-how in NFV, SDN and MEC areas and apply it to consultancy services as 3rd party developer for ICT solutions and training courses on NFV products, cloud and MEC services. Moreover, the knowledge acquired on vertical requirements in 5G will be transferred to the product division to drive company products for automation, A/V entertainment and building management towards IoT-based and virtualized services exploiting cloud and MEC technologies. Target products are Symphony and Sealux, smart-home platforms where the re-engineering of product components towards NFV-based deployments can provide more efficient, flexible, and customizable IoT-based solutions that exploit cloud technologies for the delocalization of storage, control and backend functions.

In 5G-TRANSFORMER, NXW has developed SEBASTIAN, a 5GT-VS prototype released as open source software under the Apache 2.0 license. The 5GT-VS is a core component of the 5G-TRANSFORMER architecture that allows to bridge the gap between the vertical's perspective about service design and lifecycle management and the NFV modelling of the service combined with its infrastructure-dependent deployment and runtime management. The 5GT-VS concepts and prototype are an important asset for NXW, allowing the company to evolve and complete its NFV MANO portfolio. The stack of NFV MANO components developed by NXW includes, beyond SEBASTIAN, also an NFV Orchestrator, an OpenStack-based VIM, a control plane for network slices, a multi-NFVO catalogue and a Service Development Kit for designing services.

In this portfolio, SEBASTIAN has a central role since it is the key to enhance two fundamental aspects of service provisioning. In fact, on one hand it simplifies the modelling, automated deployment and runtime operation of services. This can be directly applied to a range of NXW products for smart-home and smart-city management, to facilitate and further automate their provisioning in virtual environments, also exploiting MEC capabilities. On the other hand, SEBASTIAN provides a complete tool for the intelligent management and sharing of network slices, a functionality that is gaining more and more attention from network operators to limit the Total Cost of Ownership of their infrastructures. In this context, the development of the 5GT-VS prototype has provided NXW personnel with hands-on experience in the area of network slicing management and vertical services definition. This expertise allows the company to offer more effective consultancy services in the NFV and network slicing area, specifically targeting customers like service providers or small operators who are interested in delivering custom virtual infrastructure solutions providing simplified tools and interfaces towards a wide range of vertical industries.

The development and demonstration activities performed in 5G-TRANSFORMER around SEBASTIAN (in international conferences and exhibitions like EuCNC 2018, ECOC 2018, ICT 2018, EuCNC 2019, MobiHoc 2019) constitute an important reference

to present the company expertise to potential customers, thus increasing competitiveness and differentiation from competitors. This will be particularly relevant to reach potential customers who are developing their own proprietary NFV MANO and network slicing solutions and, thus, may search for specialized skills to enhance their portfolio with innovative concepts. The demonstration in public exhibitions of Proof of Concepts around the NFV MANO and slicing solutions implemented by NXW, including also SEBASTIAN, are excellent opportunities to present the new ideas developed by the company, demonstrating their technical feasibility and potential benefits. Moreover, the expertise acquired in NFV and MEC technologies is continuously feeding current consultancy activities with ETSI, where NXW is participating in several Specialist Task Force (STF) within ETSI NFV and MEC groups (e.g. for the 2018-2019 period: ETSI STF 551 on MEC Testing Framework; ETSI STF 569 on MEC API Conformance Test Specification; ETSI STF 557 on NFV API Conformance Test Specification and ETSI 563 on OpenAPI Specification for NFV).

NEC

See section 3.3.2 for NEC exploitation of integrated 5GT-SO + 5GT-VS.

3.3.2 Service Orchestrator (SO)

NEC

NEC will use the integrated 5GT-SO + 5GT-VS to evolve the current end-to-end NFV Management and Orchestration portfolio, impacting the Mobile Radio Access Networks and Mobile Wireless Networking business units. NEC Backhaul Resource Manager (BRM) and NEC Network Slice Orchestrator (OVNES) will be extended with MEC integration, NFV placement functionalities and end-to-end network slicing algorithms. In addition, NEC will use the project results to demonstrate the benefits of the proposed architecture both to its internal development groups and to potential customers, e.g., European network operators.

MIRANTIS

Mirantis Cloud Platform (MCP) is a comprehensive multi-cloud software stack built with an operations-centric approach. It continuously delivers automated infrastructure updates and intelligent application delivery through a CI/CD pipeline toolchain while also providing proactive monitoring and analytics to ensure maximum availability. MCP can include OpenStack and/or Kubernetes to offer bare metal, VMs and containers, along with Ceph, OpenContrail and Calico for software-defined storage and networking. Having cutting-edge field experience in the NFV-related development, deployment and integration projects, in scope of the 5G-TRANSFORMER, Mirantis will do exploitation and trailing in both 5GT-SO and 5G-MTP (see next section).

For 5GT-SO, considering Cloudify as foundation platform for the 5G-TRANSFORMER Service Orchestration layer, Mirantis will develop a set of plugins and extensions to enable Cloudify communication with the underlying infrastructure, like 5G-TRANSFORMER 5G-MTP component or Public cloud providers (i.e. AWS).

Additionally, Mirantis will perform integration of the 5G-TRANSFORMER Monitoring platform with the Cloudify orchestration platform. As some project features like 5GT-SO federation are not available at the open source world yet, Mirantis jointly with partners will develop appropriate functionality and integrate it into the 5G-TRANSFORMER platform.

Considering numerous new add-ons and functionality to be introduced during development phase of the 5GT-SO component, Mirantis will create build of the 5G-TRANSFORMER 5GT-SO component and relevant Continuous Integration/Continuous Delivery (CI/CD) pipeline.

3.3.3 Mobile Transport and Computing Platform (MTP)

Nokia (NOK-N)

Nokia will consider the project results on MEC integration to increase flexibility of its 5G-BTSs (Base Transceiver Station) deployed as VNFs, allowing better resource utilization and supporting different slice and service types on the BTSs. From the project, NOK-N will gain a better understanding of deployment and integration scenarios of its products into operator and vertical environments. In addition, 5G-TRANSFORMER will impact the following NOK-N portfolio:

- Airframe. The cloud-based base station may be extended with the interfaces towards the MTP to improve its control by a Virtual Network Function Manager (VNFM) for deployments with multiple network slices, considering the non-virtualized part of the BTS as a physical network function shared among network slices.
- Airframe data center. The cloud platform may be extended with interfaces and functionality for the compute part of the MTP and be better used in regional data centers and for deployment of vertical services.
- NFV-based packet core. These VNFs may be extended with service-aware monitoring as defined in 5G-TRANSFORMER. With or without this extension, the VNFs may be deployed directly from templates of network services.
- MEC Platform. The MEC software platform may be extended with the interfaces and functionalities defined within 5G-TRANSFORMER to support network slicing. It would become more useful for vertical industries and is relevant also for the Airframe Open Edge Server.

NEC

NEC will exploit the project results to improve its Control platform, including extensions on already commercialized OpenFlow solutions, Enterprise Radio Access Network (E-RAN), vEPC (Virtualized Evolved Packet Core: vMME and vS/P-GW) and vMVNO-GW; Management extensions to NEC iPASOLINK wireless transport equipment including mmWave and microwave; and control interfaces to products on the roadmap such as openRAN solutions.

Ericsson (TEI)

As world leader in manufacturing of radio cellular networks, Ericsson has, since the beginning of the project, identified clear exploitation opportunities especially related to the smoothest possible integration of radio, transport, and cloud layers.

The Ericsson team that has mainly contributed to the project is part of Ericsson Research (ER). ER is an internal organization, dedicated to medium- and long-term research, in continuous interaction with the product lines and with the product development units.

One important element has been the presence of vertical actors in the consortium that have posed realistic and heterogeneous requirements to better assess the radio and transport architecture in terms of challenging values for the main performance parameters like e.g. availability, latency, throughput.

A significant step in the direction of exploiting project result in a realistic environment, in tight synergy with one key Ericsson customer, a mobile cloud robotic demo has been exhibited by Ericsson with Telefonica in the 5Tonic lab in Madrid. The demo "Fronthaul & Backhaul Convergence" has exploited the 5GT-MTP building block of 5G-TRANSFORMER to orchestrate radio, transport, and cloud and to enable the creation and operation of a real 5G based service for industry verticals applications and, in the specific, demonstration for cloud robotics in the eIndustry scenario.

In the cloud segment, Ericsson Cloud Infrastructure portfolio delivers proven, open and standards-based solutions to service providers. The foundation is the pre-integrated Ericsson NFVI solution following ETSI architectural principles. Main values for service providers include fast initial deployment, short time to market for new services and low total cost of ownership. Ericsson NFVI is evolved with edge computing and container management capabilities making it possible to deploy current and emerging IoT applications across centralized and distributed sites in a distributed cloud model. The Ericsson Cloud Infrastructure solution has a modular architecture which facilitates capturing exploitation opportunities coming from the project. Ericsson Cloud Execution Environment module is the virtual infrastructure manager (VIM), based on OpenStack and OPNFV, in our market leading NFVI solution. This telecom grade VIM has been deployed with more than 50 operators around the world and provides efficient operations and optimized performance for virtual network functions while securing an always available cloud and NFVI environment.

The impact of 5G-TRANSFORMER outcomes on Ericsson product portfolio is also relevant for the Ericsson Fronthaul 6000 platform. This product comes in a passive version which provides transport of up to 24 CPRI services over a single fiber and in an active version which implements managed CPRI, eCPRI, OBSAI and Ethernet networking over WDM - when passive solution is not enough and management, demarcation and high availability through ring protection are important requirements. Fronthaul 6000 active solution provides the high-capacity and low-latency performances that meet even the most stringent transport requirements of LTE, LTE-advanced, and 5G. For the Fronthaul 6000 optical-based transport solution an evolution is possible to support the control plane envisioned by 5G-TRANSFORMER.

In this direction, 5G-TRANFORMER has defined an underlying 5G transport network able to provide an agnostic support of radio traffic transmission, in both fronthaul and backhaul segments, supporting current and future radio interfaces (CPRI, eCPRI, and beyond) while complying with broadband, critical, and massive communications needs.

InterDigital (IDCC)

IDCC EdgeHaul is a mmWave fronthaul and backhaul transport solution featuring support for SDN-based control and management. The 5G-TRANSFORMER 5GT-MTP goals, i.e. the integration of MEC with transport network resources and the support of various vertical traffic requirements, are clearly relevant to EdgeHaul and present several potential exploitation paths, including:

- The extension of EdgeHaul to support network slicing over the mmWave transport, e.g. utilizing the dynamic configuration of VLAN tags to isolate and prioritize traffic from different verticals.
- The integration of EdgeHaul and Edge Computing through a co-location of EdgeHaul nodes and MEC platform(s).
- The extension of EdgeHaul to support FOG RAN architectures and platforms that are inherently distributed in nature.

MIRANTIS

Mirantis has provided a platform for automatic 5G-TRANSFORMER 5GT-MTP layer deployment using an OPNFV reference scenario, which integrates and automatically provisions OpenStack, SDN Controller (Opendaylight) and relevant software components. Further, this scenario might also be enhanced with the Kubernetes container management platform for lightweight MEC applications. This will enable automatic 5GT-MTP and virtualization layer deployment across multiple locations. As a separate development activity, Mirantis can empower Virtlet (https://github.com/Mirantis/virtlet/blob/master/ACKNOWLEDGE.md) and CRI Proxy (https://github.com/Mirantis/criproxy/blob/master/ACKNOWLEDGE.md) upstream code development with 5G-TRANSFORMER specific focus and overall code stabilization. As a result, the Virtlet platform will be trialed for the 5G-TRANSFORMER MEC and NFV workloads and use cases, including instantiation and service function chaining.

3.3.4 Exploitation Opportunities for Service Providers/Operators

Orange and Telefonica (TID), the two operators in the consortium, have been involved in all facets of the project, including the definition of concepts such as orchestration and federation of resources and in the evolution of the radio/transport network. As a result, 5G-TRANSFORMER has presented exploitation opportunities for both.

Telefonica I+D (TID)

Telefónica I+D TID, as a part of the Telefónica Group, oversees innovation and strategic vision of emerging network technologies, with focus in applying new ideas, concepts and practices in addition to developing advanced products and services. TID is integrated in the Telefónica Global CTO Unit, then promoting the results and ideas inside the group strategic roadmap.

Telefónica is involved on a transformation of its networks, in preparation to the advent of 5G. Different aspects of the Telefónica network are subject of this transformation:

- Simplification of the transport network, flattening the network and transitioning it to full programmability and automation.
- Deployment of a common NFVI architecture in all the affiliates, named UNICA[1].

Telefónica, as international telecom group, with more than 15 networks worldwide (mainly in Europe and Latin America), need to efficiently face the challenge of facilitating vertical services that can expand more than one network (i.e., spanning more than one Telefónica affiliate), or may require to deploy capabilities outside Telefonica footprint (i.e., in a federation with other network providers).

5G-TRANSFORMER results facilitate the evolution of the wholesale services of Telefónica in several ways:

- Define a way of commercializing UNICA NFV infrastructure by offering their intended capabilities to third parties (e.g., service providers) leveraging in a 5G-TRANSFORMER-like environment, opening new opportunities of generating incomes.
- Supports the transition to end-to-end programmable networks, including interconnection with facilities and capabilities from third parties.

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[1] https://www.telefonica.com/documents/23283/140082485/Telefonica_Virtualisation_gCTO_FINAL.PDF/bb870423-cc0f-409f-6638-53af4cf2b24b?version=1.0

- Permits to explore new business cases focused on cost efficiencies, like the ones represented by the 5G-TRANSFORMER use cases.
- Facilitates the identification of gaps in standard solutions as ETSI Open Source MANO (OSM), essential for supporting multi-provider interworking with minimal integration costs, then reducing OPEX.
- Enables automated service provision of services among Telefónica's affiliates.
- Creates a realistic multi-provider environment exemplified by the 5G-TRANSFORMER showcases from where to extract operational lessons.
- Provides know-how to anticipate needs and requirements to be supported by the network assets, assisting Telefónica at the time of elaborating product specifications released as commercial RFIs and RFQs.

5G-TRANSFORMER project has been disseminated internally into the Telefonica group thanks to the key position of TID for the definitions of the technological guidelines of the group.

Orange

Orange is one of the world's leading telecommunications operators and a leading provider of telecommunication services to multinational companies, under the brand Orange Business Services. In March 2015, the Group presented its new strategic plan, Essentials2020, which focuses on its customers' expectations to ensure that they experience the best of the digital world and the power of its high-speed broadband networks.

The information and communication technology (ICT) sector, in recent years, has gone through major changes in its value chain, significantly increasing the number of players. New economic models developed by large Web players are coming into existence, while manufacturers of consumer electronics are moving towards value-added services. In this context, innovation will be a major source of growth for Orange.

Orange will first use 5G-TRANSFORMER outcomes to design jointly relevant applications with vertical industry players, to build European ecosystems around these applications and to demonstrate that a shared infrastructure can support several vertical networking applications and services in parallel. It is crucial to consider the needs and concerns of citizens and enterprises during this design and test phase, and Orange will propagate the ones of its customers.

Orange will leverage the project assets to consider addressing new Business to Business (B2B) markets, providing vertical actors with "ad-hoc" SLA in terms of bandwidth and connectivity but also IT resources (compute/storing). Orange aims at open innovation with traditional partners (telco manufacturers, academics, SMEs, etc.) but also end users such as verticals. Innovating with vertical industries is one of the key assets of the 5G-TRANSFORMER project; thus, it this will be used to promote 5G Innovation directly with partnering companies.

Orange approach, based on anticipation and support, was illustrated during the corporate annual Business Summit through the announcement of several joint innovation 5G projects with companies that are market leaders in key sectors of the economy, such as the manufacturing industry, energy or transport, and that have an eye on the future[2].

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[2] https://www.orange.com/en/Press-Room/press-releases/press-releases-2019/Orange-is-bringing-together-French-companies-to-test-and-develop-5G-uses

5G-TRANSFORMER will also be the place to benchmark and select technologies and architectures for future standards and infrastructure enablers to build "on demand" Network Slices over a federation of Operators' infrastructures domains. This selection is key for Orange to ensure that future 5G services will offer the best experience to our customers and will be sustainable (in terms of energy, costs and social issues) and operationally manageable.

Orange will also continue to use and promote research projects results in various standardization bodies such as 3GPP and ETSI NFV as well as TM Forum for network management issues. Key positions handled by Orange delegates in those standardization bodies (e.g. Working Group Chair in ETSI NFV ISG) will help in promoting our approaches.

Overall, Phase 2 projects will contribute to the constituency of open 5G experimental platforms which will be reused for trials and pilots in future phases of 5G development, e.g. the 5G-EVE project for phase 3 will re-use technical building blocks from 5G-TRANSFORMER to build real scale experimentation, leveraging on Orange open research platform. 5G-TRANSFORMER techno-economic studies will also help Orange to assess future 5G deployment scenarios and infrastructure investments and to build the rolling plan according to related business.

Lastly, Orange will directly contribute to the dissemination in research community through the collaboration on several research papers and external demonstrations like in the EUCNC conference.

3.3.5 Exploitation towards other projects

The survivability of results can also be enforced by using results, like software components, for other projects. Code already implemented in 5G-TRANSFORMER 5GT-VS will be used in 5G-PPP phase 2 projects SliceNet, BLUESpace, 5G-EVE.

The field trials of the next-coming H2020 5Growth project will also leverage on the experimental platform developed 5G-TRANSFORMER projects.

3.4 Standardization

This section is based on the Standardization plan of 5G-TRANSFORMER as described in D6.2, and in particular, in accordance to the Standardization Activity Roadmap (SAR). As such, for the remaining 6 months of the project, the Standardization plan will continue focusing on SDOs and groups that 5G-TRANSFORMER identified from the outset as being key to the 5G-TRANSFORMER project, based on its mixture of technology enablers, including SDN, MEC and NFV. These groups encompass ETSI-NFV, ETSI MEC, IETF, 3GPP and ITU-T amongst others, as outlined in section 2.4 of this document, where strong evidence of a successful dissemination outcome can be found.

The SAC will continue ensuring that 5G-TRANSFORMER Standardization efforts clearly reflect specific outcomes from the various activities to be completed during the next 6 months.

Despite the fact that 5G-TRANSFORMER has already met the target and objectives in terms of Standardization commitments, as described in section 2.4, partners as well as the SAC leadership are committed to maintaining a strong participation in the key SDOs that 5G-TRANSFORMER has identified as being key the project. To this end, the SAC will continue coordinating Standardization activities within the project, either through planned conference calls or direct one on one discussions with the Project Standardization leads who are also integral part of the SAC.

The following activities are planned for the remaining 6 months of the project, to keep a significant level of participation and overall impact of 5G-TRANSFORMER into key SDOs, where significant entails that at least 2 additional contributions be approved/agreed/accepted:

1. Identify which new capabilities of the current 5G-TRANSFORMER feature set may address objectives outlined in relevant Study Items and Work items from key SDOs described above or whether New Studies should be proposed
    a. SAC leads should work with partners to identify these capabilities, e.g., what aspects of the key features provided by 5GT-VS/5GT-SO/5GT-MTP are relevant to studies and work items currently being addressed in key SDO forums
    b. SAC leads should identify the relevant SDO where technology supporting these capabilities can disseminate into.
    c. Coordination and monitoring will take place either through planned meetings or ad-hoc as needed amongst SAC members and partners.
2. Analyze possibilities to continuing our thrust on existing topics we are already participating e.g., Network Slice Management (ETSI MEC/ESTI NFV, 3GPP), Service Orchestration in multi-domains (IETF).
3. Determine the need and periodicity of SAC meetings, considering SDOs release cycles and deadlines and remaining time available to bring contributions
    a. E.g., given the short time and meetings cycles, determining how many SAC meetings are potentially needed, required, or how many are even possible?
    b. Determining whether ad-hoc one on one engagements, planned meetings or a combination of them is preferable.

4 References

[1].   IPR Helpdesk. "IPR glossary". Available at: https://www.iprhelpdesk.eu/glossary

[2].   A. Ruete. "Communicating Horizon 2020 projects." Available at: https://ec.europa.eu/easme/sites/easme-site/files/documents/6.Communication-AlexandraRuete.pdf

[3].   5G-TRANSFORMER. "Communication, Dissemination, and Exploitation achievement of Y1 and plan for Y2". Deliverable D6.2, June 2018.

[4].   5G-TRANSFORMER. "Initial Communication, Dissemination, and Exploitation Plan (CoDEP) draft including Standardization roadmap". Deliverable D6.1, November 2017.

[5].   5G-TRANSFORMER. "Final design and implementation report on the MTP (including reference implementation)". Deliverable D2.3, June 2019.

[6].   5G-TRANSFORMER. "Refined architecture", Deliverable D1.3, June 2019.

[7].   5G-TRANSFORMER. "Final design and implementation report on Vertical Slicer (including reference implementation)", Deliverable D3.3, June 2019.

[8].   5G-TRANSFORMER. "Final design and implementation report on Service Orchestration, Federation and monitoring platform", Deliverable D4.3, June 2019

[9].   European Commission. Common Dissemination Booster (CDB). Information available   at: http://ec.europa.eu/research/participants/data/ref/h2020/other/comm/170927_cdb_en.pdf

5 Annex I. Survey of overall satisfaction of attendees to events (co-)organized by 5G-TRANSFORMER

The metric of the CoDEP related with event organization, is the degree of satisfaction of the attendees. In this section, we present as an example, the result of the poll for the first and second COMPASS workshop (Figure 6, Figure 7), held in April 2018 with IEEE WCNC and in June 2018 with IEEE BMSB, respectively. We observe that a huge percentage of the attendees was satisfied with the technical content and organization of the event. Other events listed in the dissemination section obtained similar results.
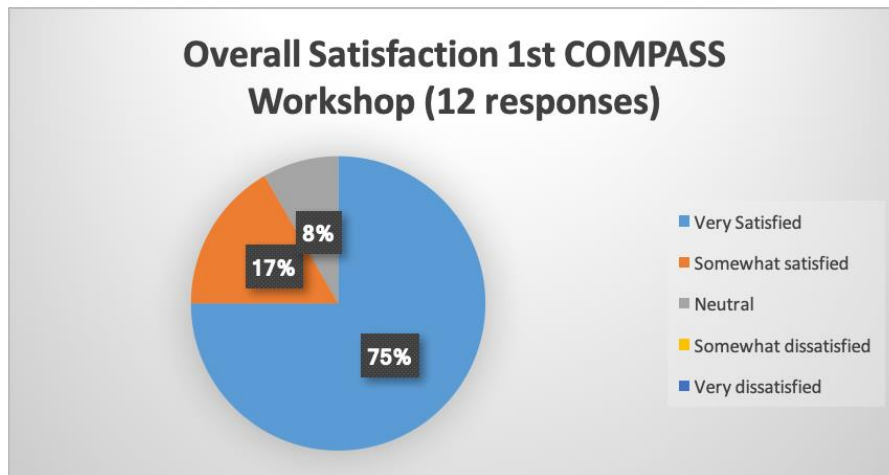

FIGURE 6: SURVEY ON OVERALL SATISFACTORY OF 1ST COMPASS WORKSHOP. 12 PERSONS HAVE ANSWERED TO THE SURVEY
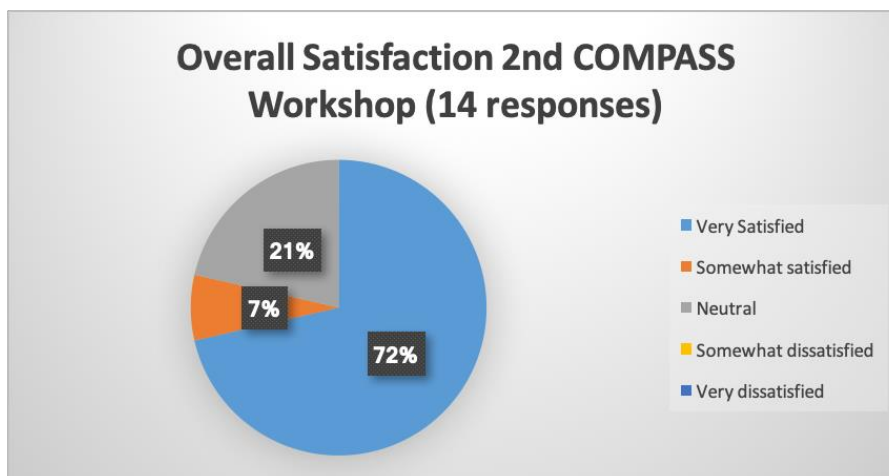

FIGURE 7: SURVEY ON OVERALL SATISFACTORY OF 2ND COMPASS WORKSHOP. 14 PERSONS HAVE ANSWERED TO THE SURVEY

6 Annex II. Statistics of Web and Social Media

In this annex, sample metrics obtained for the website and the social media of the project are presented. Overall, the visits/hits and other social media metrics (impressions, retweets, etc.) keep increasing, which result in an increased awareness of the community of the 5G-TRANSFORMER results.

6.1 Statistics of the 5G-TRANSFORMER website

Figure 8 shows the Top 10 most visited pages of the 5G-TRANSFORMER website in two different periods. The first period is from January to March 2019. The second period is from September to December 2018. One can observe that the more specific technical content (e.g., deliverables, papers) is the one attracting more attention, though the rest of the content also receives remarkable visits. In summary, we have observed around 12000 visits from January to March 2019 with the second most visited page reaching more than 470 visits. While in period from September to December 2018, the observed visits and second most visited page are around 10000 and 600, respectively.

Top Pages ▲

ID	Title	Link	Visits
1	Project	/	1,386
2	Deliverables	/index.php/deliverables/	474
3	Journals and Magazines	/index.php/dissemination/publications/journals-and-magazines/	440
4	Demos	/index.php/dissemination/demos/	344
5	Communication	/index.php/communication/	273
6	Project	/index.php/communication/index.php	222
7	Consortium	/index.php/consortium/	209
8	Conferences	/index.php/dissemination/publications/conferences/	196
9	Video Gallery	/index.php/dissemination/video-gallery/	193
10	Contacts	/index.php/contacto/	182

(a) January to March 2019

**Top Pages**   ▲

1 - Project
/   Visits: 2,399

2 - Deliverables
/index.php/deliverables/   Visits: 647

3 - Demos
/index.php/dissemination/demos/   Visits: 396

4 - Project
/index.php/comments/feed/index.php   Visits: 346

5 - News
/index.php/news/   Visits: 317

6 - Video Gallery
/index.php/dissemination/video-gallery/   Visits: 298

7 - Publications
/index.php/dissemination/publications/   Visits: 278

8 - Consortium
/index.php/consortium/   Visits: 277

9 - Communication
/index.php/communication/   Visits: 231

10 - Open Source
/index.php/dissemination/open-source/   Visits: 219

(b) September to December 2018

FIGURE 8: TOP VISITED PAGES OF THE 5G-TRANSFORMER WEBSITE

Figure 9 shows a sample hit statistics chart. In particular, the hit statistics from January to March of 2019 are presented in Figure 9(a). While Figure 9 (b) shows the hit statistics from September to December 2018. Figure 10 illustrates a summary of the last 365 days, where the visitors are more than 16 500 with more than 38 000 visits.
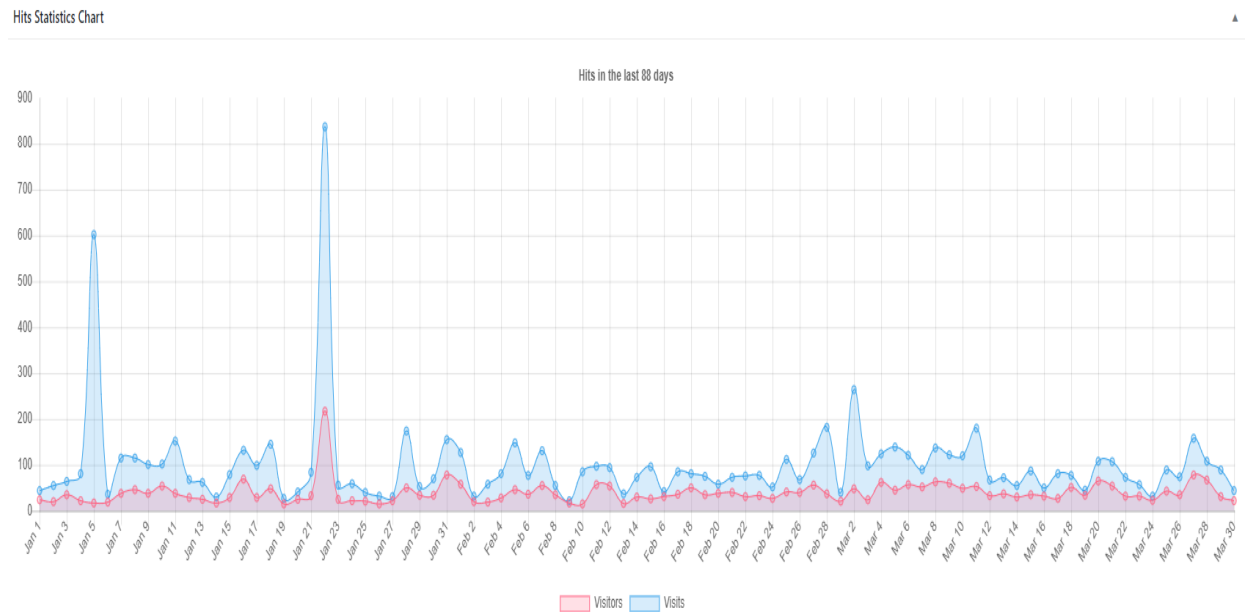
(a) January to March 2019
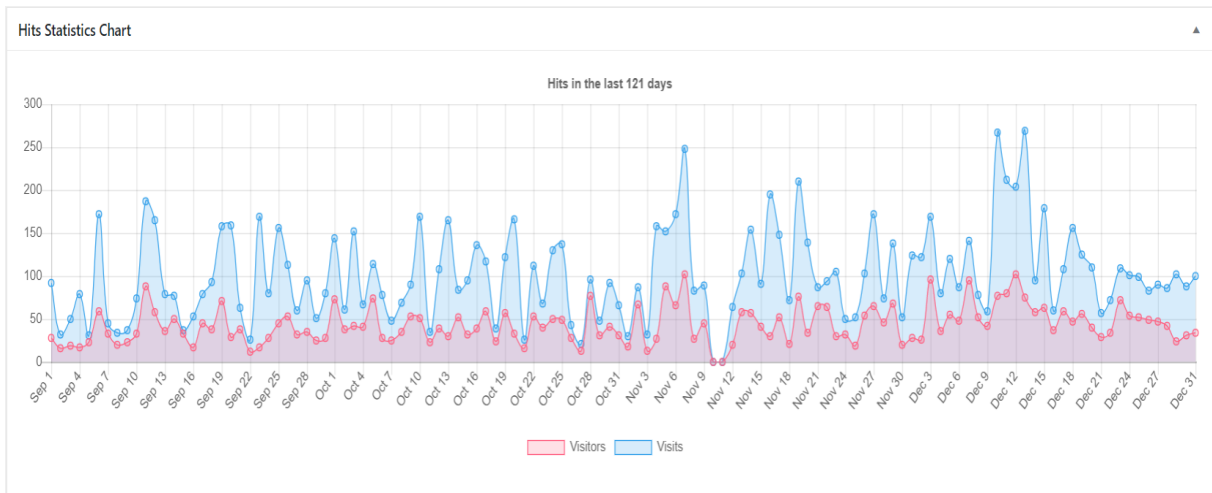
(b) September to December 2018

FIGURE 9: HIT STATISTICS CHART

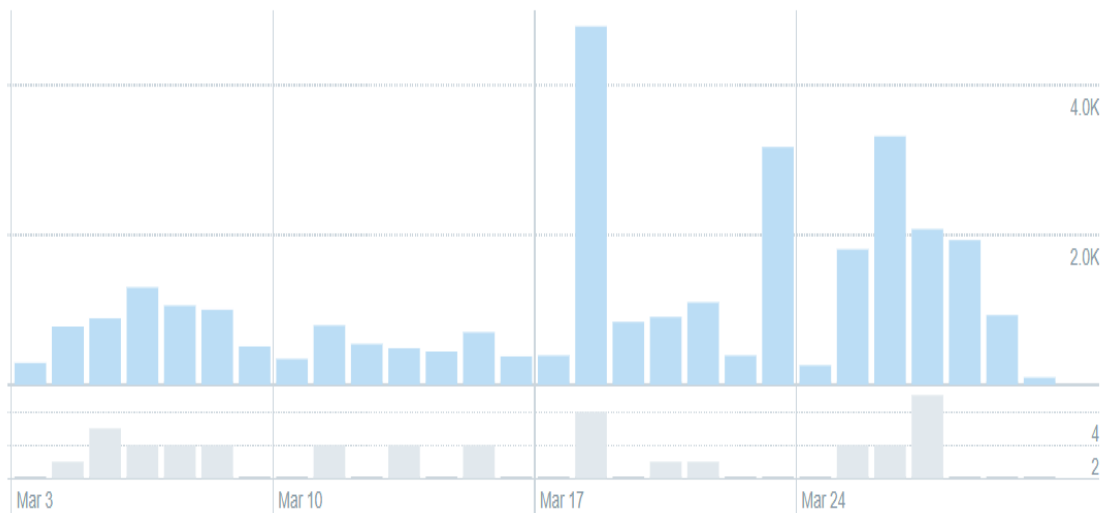FIGURE 10: SUMMARY OF WEB STATISTICS FOR THE LAST 365 DAYS

6.2 The statistics of 5G-TRANSFORMER Twitter

In this section, the Twitter impact statistics are presented especially the impact from monitored information of published content as shown in Figure 11. In Figure 12 (a) to (d), the statistics of published content prove that the popularity of the 5G-TRANSFORMER project is increasing. In particular, the number of followers and the interactions with the tweets steadily increase and obtain 40 new followers. The Tweet search of 5G-TRANSFORMER tweeter increase and reach to 31.7K in one month (in this case March 2019) and 76.1K in three months (Jan.-Mar. 2019).
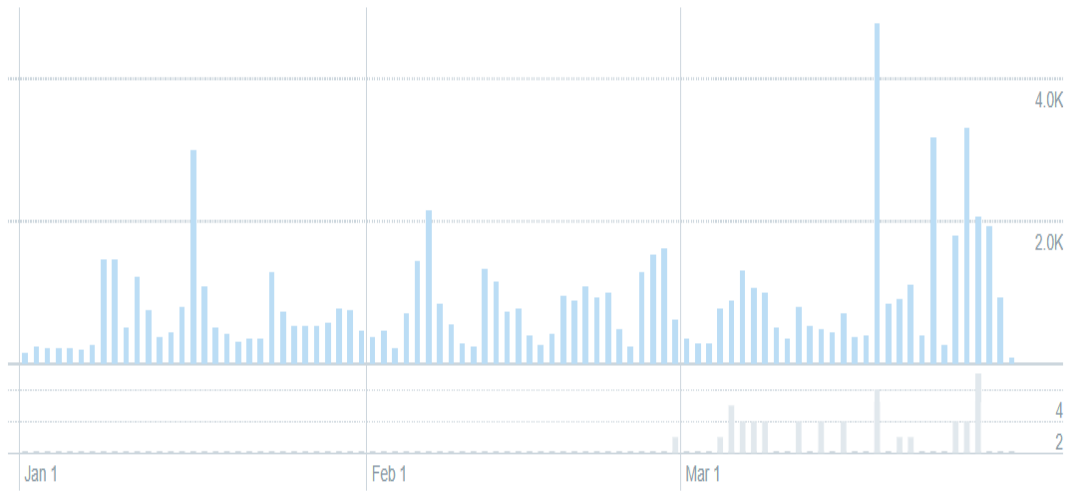
FIGURE 11: HIT STATISTICS DURING THE **S**ECOND YEAR: STATISTICS OF THE 5G-TRANSFORMER **T**WITTER ACCOUNT

(a) Sample Twitter account activity (impressions): March 2019

Your Tweets earned **76.1K impressions** over this **89 day** period

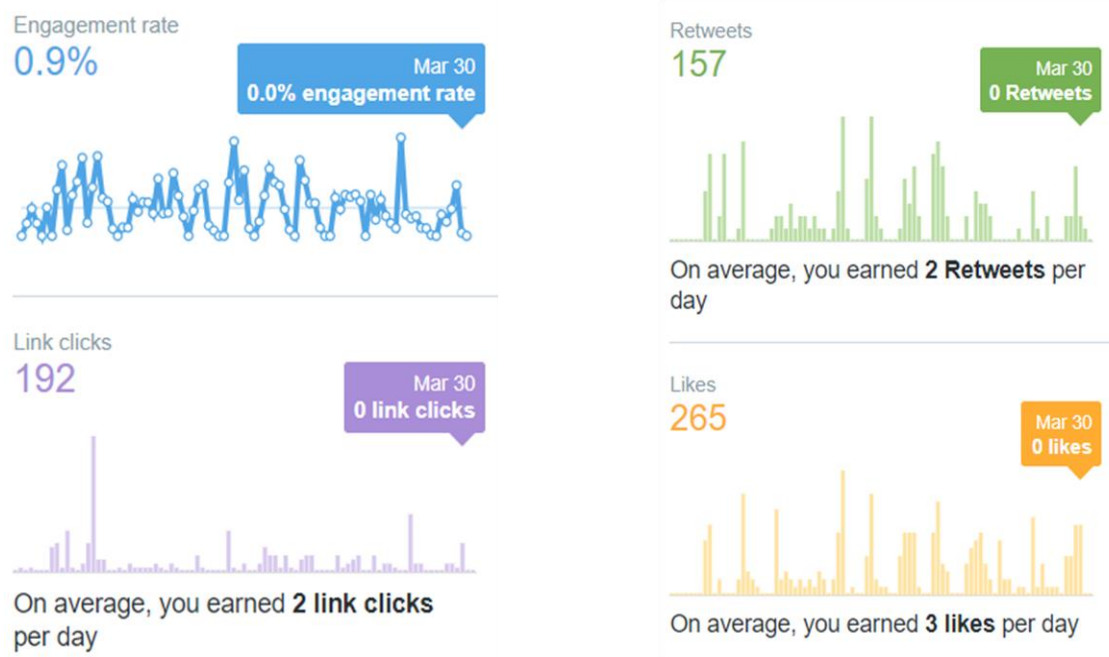(b) Overall view of Twitter impressions between January to March 2019

Interests

Interest name	% of audience	
Tech news	99%	
Weather	97%	
Science news	96%	
Technology	95%	
Space and astronomy	91%	
Comedy (Hobbies and interests)	90%	
Government	89%	
Computer reviews	84%	
Politics	83%	
Sports news	81%	

(c) Sample Twitter information: Top interests

(d) Sample Twitter activity statistics during January and March 2019

FIGURE 12: SAMPLE TWITTER STATISTICS JANUARY-MARCH 2019

6.3 Instagram, Youtube, LinkedIn

In the course of 5G-TRANSFORMER, the aforementioned materials in 5G-TRANSFORMER have posts in other social media (Instagram, LinkedIn and YouTube). The same trend as in Twitter is observed in the rest of social media, though with a lower intensity. For instance, in Instagram, as of March 2019, the project has 73 publications and 416 publication visualizations from LinkedIn followers. Furthermore, the 5G-TRANSFORMER high-level video had more than 261 visualizations between January and March 2019 and the watch time is more than 460 minutes (in addition to those during the events in which it was played, such a Mobile World Congress 2019). More technical videos will be recorded and published on the YouTube channel for some of the demonstrations of the project (e.g., EUCNC 2019). More statistics of top most visited videos of YouTube are shown in Figure 13.

Video		Impressions	Impressions click-through rate	Views		Average view duration	Watch time (minutes)	
Total		2,480	2.8%	261	100.0%	1:46	464	100.0%
5G-TRANSFORMER: 5G Mobile Transport Platform for V...		598	2.8%	86	33.0%	2:09	186	40.1%
5G network slices for media vertical services		199	3.5%	31	11.9%	2:22	74	15.9%
Using cloudify and public & private clouds to deploy and...		41	2.4%	19	7.3%	3:17	63	13.5%
5G network slices for mobile communication services		291	6.9%	49	18.8%	1:00	49	10.6%
5G TRANSFORMER, 5G Mobile TRANSport platFORM fo...		708	1.0%	24	9.2%	1:18	31	6.8%
Cloud Robotics		469	2.6%	27	10.3%	0:52	24	5.1%
nxw_atos_instantiation		0	n/a	3	1.1%	4:15	13	2.8%
Edge Robotics- Courtesy of Imdea Networks		31	6.5%	10	3.8%	0:56	9	2.0%
nextworks_atos_v1-3		0	n/a	2	0.8%	4:03	8	1.7%

FIGURE 13: SAMPLE YOUTUBE FROM JANUARY TO MARCH 2019