H2020 5G Dive Project
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D4.2b: Update to D4.2 with the exploitation plan

Abstract

The progress of the project's communication, dissemination and exploitation activities are reported for the first project year. The plan had to be adapted with additional online presence and video material to handle the effects of the Covid-19 crisis when events were cancelled or made online. Project results are disseminated through publications, presentations and interviews. Workshops and other events with a focus on the topics of the project are organised. Contributions to and interaction with standards organisations are reported on, as well as, the engagement in open source software. An updated exploitation plan is provided. **Except for Section 5, the content of the deliverable is the same as Deliverable 4.2.**

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Disclaimer

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Contents

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List of Acronyms

3GPP	3rd Generation Partnership Project, uniting several telecommunications standard development organisations
CoDEP	Communication, Dissemination and Exploitation Plan
ETSI	European Telecommunications Standards Institute
IEEE	Institute of Electrical and Electronics Engineers
IETF	Internet Engineering Task Force
IRTF	Internet Research Task Force
ITU	International Telecommunication Union
ITU-T	ITU Telecommunication Standardization Sector
OSS	Open source software
SAC	Standardisation Advisory Committee
SDO	Standards Development Organisation

Executive Summary

Achievements in terms of communication, dissemination and exploitation including standardisation are reported for the first project year and compared with the set targets. For each type of activity, the plan for the remainder of the project is updated. The overall purpose with these activities is to fulfil the project's overall Objective 4 on dissemination.

The communication and dissemination plan had to be adapted to handle the effects of the Covid-19 crisis, mainly by enhancing the online presence, for example through videos of presentations and demos. The project consortium set up ambitious dissemination targets, towards which significant progress has been made. Some targets are already met or exceeded.

The project is present online with a public website with information in English and Chinese which has a visit count exceeding 20 000 for the first year. The project also has a twitter channel and is present in other social media. Project members are visible in various video interviews and blog articles. In addition, press releases have been issued, and a project leaflet and poster have been created.

Project results are disseminated with peer-reviewed publications in conferences, workshops, journals and magazines, as well as through various public presentations. Project members engage in the organisation of special issues of journals and the organisation of workshops specialised on the topics of the project, some of which are done in collaboration with other projects. The project also targets exhibition at major events, but some of these have been cancelled.

Contributions to and interaction with five standardisation organisations have taken place during the year, and the number of standardisation contributions already exceed the original target. The main standardisation organisations are 3GPP, IETF, ETSI, IEEE and ORAN Alliance.

Two open source software projects, Zenoh and fog05, are driven by project members in the context of the Eclipse Edge Native WG. These two open source components are central to the development of the 5G-DIVE edge platform.

The exploitation plan is updated based on the current developed technology. The plan relates to the developed proof-of-concepts and to products and services of the partners, as well as, other partner activities. Key innovations in the 5G-DIVE architecture platform and the proof-of-concept prototypes from the first project year are identified.

The deliverable has the same content as Deliverable 4.2, except for the updated Section 5 with the exploitation plan.

1. Introduction

This deliverable reports on the project achievements during the first project year in terms of communication, dissemination, and exploitation including standardisation. The achievements are compared with the targets set in the communication, dissemination and exploitation plan (CoDEP) defined in Deliverable 4.1 [5]. The deliverable finally updates the plans for the remainder of the project. The D4.2b update also includes an updated exploitation plan – the other content is the same as Deliverable 4.2 [7].

The achievements reported in this deliverable are the progress towards fulfilling the project's overall Objective 4 to disseminate and contribute 5G-DIVE results into international research and innovation venues, and to pave the way for their successful exploitation. This overall objective is broken down into three sub-objectives: (1) To develop an outreach communication and dissemination of 5G-DIVE results to all stakeholders including researchers, industrials, and general public; (2) To develop a proactive standardization plan including roadmaps, intellectual property creation, and contribution in relevant standards; and (3) To develop a plan for exploitation of 5G-DIVE results into value creation for all stakeholders during the project lifetime and beyond.

The progress on fulfilling the first sub-objective is largely reported in Sections 2 and 3 on communication, public activities, dissemination and collaboration. The progress on the second sub-objective is addressed in Section 4 on standardisation and open source activities. The progress on the third sub-objective is addressed in Section 5 on exploitation activities. Each section of the deliverable also presents updated plans for the remainder of the project.

The following two subsections comments on the handling of the Covid-19 crisis and summarises the achievements reported in the deliverable.

1.1. Covid-19 Crisis Management

The CoDEP plans of the project (Deliverable 4.1 [5]) were finalised during the beginning of the Covid-19 crisis outside China, but most of the plans were made before the extent of the crisis was known. The project had to make new plans to handle cancelled events, for example, the Mobile World Congress, and to handle the change to online events, for example, the European Conference on Networks and Communications (EuCNC). It currently seems as most events are offering online substitutes, making it possible to participate, albeit in a different way.

It is unavoidable that the communication and dissemination plan for the project is affected and, in some instances, delayed. To enable better online presence, videos of presentations and demos are being recorded. In addition to cancelled and online events, we are affected by delayed schedules in several of the standardisation organisations we participate in. We therefore adjusted some of the dissemination targets in the project amendment approved 06/22/2020. More details on updated plans are presented below in each main section of this document.

1.2. Overview of achievements

Table 1 provides a summary overview of dissemination achievements the first project year. The partners set up ambitious dissemination targets. Significant progress has already been made in the first project year, with some targets already exceeded, especially considering that results dissemination is expected to increase during the second project year.

TABLE 1: OVERVIEW OF ACHIEVEMENTS AND PROGRESS TOWARDS TARGETS.

Category		Current count	Target	Comment
Peer-review publication		15	24	Published or accepted
Presentation/talk		10	12	Demos not included
Press release		9	N/A	
Organisation of workshops and conferences		4	2	
Trade fair (booth, exhibition, etc)		2	2	
Patent		0	3	Results expected second year
Activities with other EU projects		6	4	
Demonstrations		4	4	Some online
Videos		4	N/A	Including presentations and demos
Open source projects		2	1	Fog05 and Zenoh
Standard contribution	adopted	9	5	
	total	32	15	

2. Communication and Public Activities

This section reports communication activities undertaken the first project year until September 30th 2020. The tables include all activities since the beginning of the project, but the text does not repeat what has already been described in D4.1.

2.1. Report on Activities Undertaken and Achievements

Communication and Public activities undertaken until September 30th 2020 are reported in Table 2,

Table 3, Table 4, and Table 5 respectively for activities relating to (1) project portal and social networks, (2) video interviews and blog articles, (3) Video Interviews and Blog articles, and (4) Videos with presentations and demos of project results.

TABLE 2: PROJECT PORTAL AND SOCIAL NETWORKS.

#	Month	Description	Lead partners
1	Oct'19	Release of 5G-DIVE project portal at www.5g-dive.eu.	UC3M
2	Oct'19	Set up of a Twitter account @Dive5g, 5G-DIVE LinkedIn group (https://www.linkedin.com/in/5g-dive-project/) and Instagram account (5g_dive).	UC3M
3	Throughout Y1	Constant update of the project website with contents on the talks, workshops, demonstrations, and events undertaken and planned. Free access has been given to download public presentations and materials from the partners, subject to partner permission.	UC3M, RISE
4	Throughout Y1	Synchronicity between project website and the social media news shared on the project Twitter and LinkedIn accounts.	UC3M, RISE

TABLE 3: VIDEO INTERVIEWS AND BLOG ARTICLES.

#	Month	Description	Lead partners
1	Dec'19	Interview with RNE (Public Spanish Radio) Radar 3.0 program. http://www.rtve.es/alacarta/audios/radar-30-en-radio-5/radar-30-radio-5-fake-news-arma-para-desmoralizar-combatiente-01-02-20/5504059/	UC3M, TID, TELCA
2	Jan'20	Article in "The Conversation" a scientific Spanish blog. The article titled "Como controlar drones y robots industriales gracias al 5G", published. https://theconversation.com/como-controlar-drones-y-robots-industriales-gracias-al-5g-130652	UC3M
3	Feb'20	Video interview provided by the Project Coordinator to Zoom NET TV show by RTVE (Public Spanish TV). https://www.rtve.es/alacarta/videos/zoom-net/zoom-net-5g-dive-entrevista-shou-zi-chew-dreams/5526638/	UC3M
4	May'20	Milan Groshev has participated in What makes it tick? - Community that brings European science & tech to the world with the video	UC3M

		"Networks of robots | 5-Minute Science You Never Knew", [Online] https://youtu.be/pPDaB8fRep8	
5	Sep'20	Arturo Azcorra participated in the 34th meeting for the Digital Economy and Telecomunications, organised by Ametic, Santander and UIMP. [Online] https://economiadigitalsantander.es/agenda/	UC3M

TABLE 4: PRESS RELEASES AND LEAFLETS.

#	Month	Description	URL	Lead partners	Platform
1	Nov'19	Press release	http://ir.interdigital.com/file/Index?KeyFile=400974728	IDCC	Corporate website
2	Nov'19	Press release	https://www.adlinktech.com/en/News_19112702534513426	ADLINK	Corporate website
3	Dec'19	Press release	https://www.sdxcentral.com/articles/news/adlink-tackles-industrial-iot-as-latest-5g-drive-member/2019/12/	ADLINK	SDX CENTRAL
4	Dec'19	Press release	https://www.networks.imdea.org/whats-new/news/2019/5g-dive-presents-its-technology-cooperation-project-national-chiao-tung	UC3M	IMDEA Networks
5	Dec'19	Press release	https://www.networks.imdea.org/es/actualidad/noticias/2019/proyecto-cooperacion-tecnologica-europataiwan-5g-dive-ha-sido-presentado	UC3M	IMDEA networks
6	Dec'19	Press release	https://www.uc3m.es/ss/Satellite/UC3MInstitucional/es/Detalle/Comunicacion_C/1371282496565/1371215537949/Implantacion_de_tecnologia_5G_en_drones_y_robots; https://www.uc3m.es/ss/Satellite/UC3MInstitucional/en/Detalle/Comunicacion_C/1371282498910/1371215537949/Deployment_of_5G_technology_in_drones_and_robots;	UC3M	UC3M
7	Dec'19	Press Release	https://www.uc3m.es/ss/Satellite?blobcol=urldata&blobheader=application%2Fpdf&blobheadername1=Content-Disposition&blobheadername2=Cache-Control&blobheadervalue1=attachment%3B+filename%3D%225G_DIVE_%28Chinese_version%29.pdf%22&blobheadervalue2=private&blobkey=id&blobtable=MungoBlobs&blobwhere=1371568627153&ssbinary=true	UC3M	Alpha Galileo
8	Jan'20	Leaflet	https://5g-dive.eu/wp-content/uploads/2020/03/Leaflet-MWC20_compressed.pdf	UC3M/IDCC/ RISE	5G-DIVE.eu
9	Jan'20	Poster	https://5g-dive.eu/wp-content/uploads/2020/03/Poster-MWC20_compressed.pdf	UC3M/IDCC/ RISE	5G-DIVE.eu
10	Jan'20	Press release	https://money.udn.com/money/story/10860/4270484	ASKEY	UDN/經濟日報

TABLE 5: VIDEOS WITH PRESENTATIONS AND DEMOS OF PROJECT RESULTS.

#	Month	Description	Lead partners
1	May'20	Networks of robots | 5-Minute Science You Never Knew. What makes it tick? - Community that brings European science & tech to the world	UC3M
2	Jun'20	Assessing 5G need for Digital Twin Applications. 5G end-to-end experimentation by verticals in EU projects. Online workshop. [Online] https://5g-dive.eu/wp-content/uploads/2020/06/12.30-13.00-MilanG-Assesing-5G-need-for-Digital-Twin-applicaitons_v2-1.pdf	UC3M
3	Jun'20	EagleEYE: Aerial Edge enabled Disaster Relief Response System. 5G end-to-end experimentation by verticals in EU. Online Workshop. [Online] https://www.youtube.com/watch?v=mauaciCHuVA&feature=youtu.be	NCTU
4	Jun'20	Object Detection Zooming - Remote User. Augmented remote robot control. [Online] https://www.youtube.com/watch?v=vQnLiYmd6vA	IDCC

2.1.1. Web, social media, and project communication material

The project website has been established at the beginning of the project and it is reachable at the following URL: https://5g-dive.eu/. The landing page is reported in Figure 1. In addition, 5G-DIVE is trying to provide Chinese translation to key content in order to improve the visibility and impact of the project, an example of the landing page for the 5G-DIVE site can be found in Figure 2.

FIGURE 1: 5G-DIVE MAIN WEBSITE.

FIGURE 2: 5G-DIVE MAIN WEBSITE (CHINESE).

Statistics until September 2020 have been gathered for the website. They are reported in Figure 3. It can be observed that, since the beginning of the project (i.e., "last 365 days" statistics), the website had almost ten thousand visitors, bringing the total to 21 594 visits.

	Visitors	Visits
Today:	7	13
Yesterday:	22	69
Last 7 Days (Week):	177	400
Last 30 Days (Month):	625	1,420
Last 365 Days (Year):	9,826	21,594
Total:	9,826	21,594

FIGURE 3: OVERALL WEB PAGE HITS.

In detail, as shown in Figure 4, the most popular subpages are the ones related to the consortium events and to project deliverables.

Top 10 Pages

ID	Title	Link	Visits
1	Home Page	/	8,926
2	Consortium	/?page_id=71	740
3	Deliverables	/?page_id=26	699
4	Home Page	/index.php	558
5	Deployment of 5G Technology in Drones and Robots	/?p=800	463
6	Integrated virtualised edge and fog solution enhances low-latency connectivity	/?p=824	445
7	"5G para Drones y Robots" (SPANISH)	/?p=844	384
8	Far EasTone	/?page_id=452	365
9	Project	/?page_id=11	356
10	Contacts	/?page_id=69	310

FIGURE 4: DETAILS OF VISITED WEBSITE PAGES.

The project has been active in other social media such as LinkedIn and Twitter. LinkedIn and Twitter accounts are the following:

- LinkedIn: https://www.linkedin.com/in/5g-dive-project/
- Twitter: https://twitter.com/dive5g

The Linkedin profile is mainly used to advertise the technical work of the project and to follow other activities from different project. Currently Linkedin profile shows 242 connections, and we are involved in 8 communication groups.

To show the activities of the Twitter account, we present Figure 5 with the impressions earned from March 31st to June 8th and Figure 6 from June 8th to September 6th.

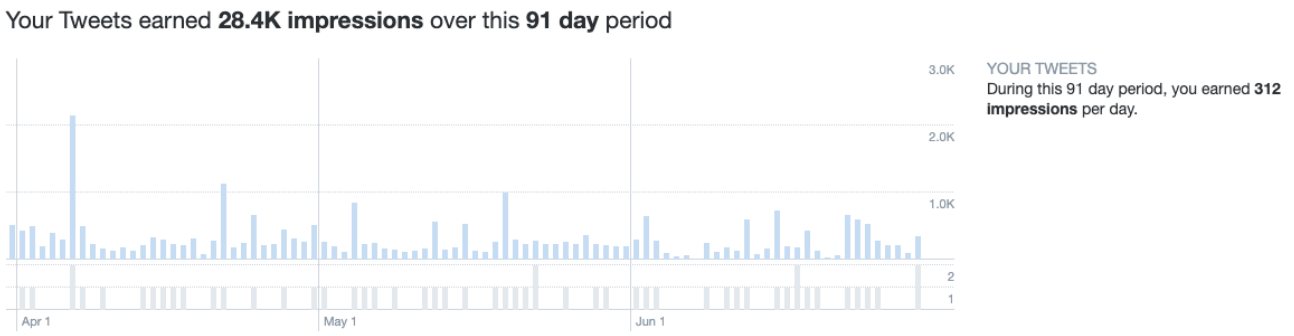

FIGURE 5: TWEET IMPRESSIONS FROM MARCH 31ST TO JUNE 8TH.

During the first period (March 31st 2020 to June 8th 2020) the project tweets gathered 28 400 impressions, with a total of 103 links (mostly directed to 5G-DIVE website), 40 retweets and 97 likes.

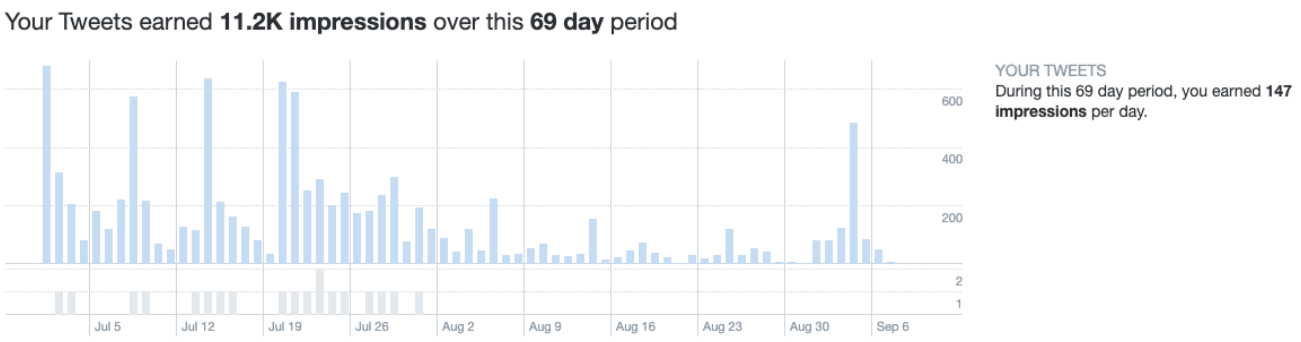

FIGURE 6: TWEET IMPRESSIONS FROM JUNE 8TH TO SEPTEMBER 6TH.

During the period from June 8th 2020 to September 6th 2020, the project Tweets earned 11 200 impressions, with a total of 22 links clicks, 10 retweets and 38 likes. This low activity is typical in the summer period.

2.2. Updated Work Plan

During the second half of the first year, the project communication activities have been severely impacted by the COVID-19 pandemic. During this time, we have tried to push forward online communication activities, fostering the dissemination of the different events we have organised. We have tried to push the dissemination work on webinars and joint activities with other projects.

One of the key upcoming milestones is the demonstration of our developments in an industrial venue, such as MWC. Due to the pandemic we are not sure if this will be possible. Nevertheless, we have already organised one webinar showcasing initial prototype of AI running in a drone and the digital twin software.

The plan for Year 2, considering Communication and Public Activities, include (as also reported in D4.1 [5]):

- Communication of the panel and workshops organised in IEEE Globecom 2020.
- Video and a press release for the first trial scheduled in M14. Videos for subsequent trials are also to be considered.
- Video interviews and second leaflet in time for MWC 2021 in Barcelona if it is to be held.
- Additional video interviews and blog articles more focused on the innovations outcome of the project as they occur in year 2.
- Continuous communication through the project portal, the social networks, and the 5G-PPP communication and dissemination working group.

3. Dissemination and Collaboration Activities

Dissemination and Collaboration activities were undertaken in the first year of the project in order to promote the 5G-DIVE project concepts and initial results to the international R&D community. The activities were also designed to trigger synergy with other related projects and activities. In this chapter, we present the achievement during the first year of the project.

3.1. Report on Activities Undertaken and Achievements

The dissemination and collaboration activities and achievements for the first year of the project, from October 2019 to September 2020, are reported in the following sub-sections.

3.1.1. Peer-reviewed Publications

Table 6 and Table 7 list all the peer-reviewed publications since the start of the project. Only published or accepted publication materials are reported. The project has published or accepted for publications 9 peer-reviewed articles in conferences and workshops, 6 peer-reviewed articles in journals and magazines, and organization of 1 special issue of journals and magazines.

TABLE 6: PEER-REVIEWED PUBLICATIONS IN CONFERENCES AND WORKSHOPS.

#	Type	Month	Description	Lead Partners
1	Workshop	November 2019	Carlos Guimarães, Antonio de la Oliva, Arturo Azcorra. 5G-DIVE: eDge Intelligence for Vertical Experimentation. Global Experimentation for Future Internet – 2019, Coimbra, Portugal.	UC3M
2	Conference	April 2020	Luis M. Contreras, Javier Baliosian, Pedro Martinez-Julia, Joan Serrat. Computing at the Edge: But, what Edge? IEEE/IFIP Network Operations and Management Symposium (NOMS), Budapest, Hungary.	TID
3	Conference	February 2020	Saptarshi Hazra, Thiemo Voigt, Bengt Ahlgren, Chenguang Lu, Daniel Cederholm, Gyanesh Patra. Demo: Multi-Radio Access Technology IoT Gateway. International Conference on Embedded Wireless Systems and Networks (EWSN), Lyon, France.	RISE, EAB
4	Workshop	June 2020	Hergys Rexha, Sebastien Lafond, Jani-Pekka Kainulainen, Giovanni Rigazzi: Towards Very Low-Power Mobile Terminals through Optimized Computational Offloading, CLEEN Workshop at ICC'20, Dublin, Ireland.	IDCC

5	Conference	June 2020	Muhammad Febrian Ardiansyah, Timothy William, Osamah Ibrahiem Abdullaziz, Li-Chun Wang, Po-Lung Tien, Maria C. Yuang. EagleEYE: Aerial Edge-enabled Disaster Relief Response System. EuCNC 2020, Online (Dubrovnik, Croatia)	NCTU
6	Workshop	Sep 2020	Milan Groshev and Carlos Guimarães. Demo: Assessing the need for 5G driven Edge and Fog solution for Digital Twin systems. In ACM WiNTECH, Online (London, UK).	UC3M
7	Conference	Nov 2020	Kiril Antevski, Milan Groshev, Gabriele Baldoni, Carlos J. Bernardos. DLT federation for Edge robotics. IEEE NFV-SDN'20, Online (Madrid, Spain)	UC3M, ADLINK
8	Workshop	Dec 2020	Luigi Girletti, Milan Groshev, Carlos Guimarães, Antonio de la Oliva, Carlos J. Bernardos. An Intelligent Edge-based Digital Twin for Robotics. IEEE GLOBECOM 2020 Workshops on Advanced Technology for 5G Plus (AT5G+), Taipei, Taiwan and Online	UC3M
9	Workshop	Nov 2020	José Takeru Infiesta, Carlos Guimarães, Luis M. Contreras, Antonio de la Oliva. GANSO: Automate Network Slicing at the Transport Network Interconnecting the Edge. NFV-SDN'20 Workshop on Mobility Support in Slice-based Network Control for Heterogeneous Environments (MOBISLICE III), Online (Madrid, Spain)	UC3M, TID

TABLE 7: PEER-REVIEWED PUBLICATIONS IN JOURNALS AND MAGAZINES.

#	Type	Month	Description	Partners
1	Journal	November 2019	Osamah Ibrahiem Abdullaziz, Li-Chun Wang, Shahzoob Bilal Chundrigar and Kuei-Li Huang. Enabling Mobile Service Continuity across Orchestrated Edge Networks. IEEE Transactions on Network Science and Engineering.	NCTU, ITRI
2	Magazine	July 2020	Luca Cominardi, Thomas Deiss, Miltiadis Filippou, Vincenzo Sciancalepore, Fabio Giust, Dario Sabella. MEC support for Network Slicing: Status and Limitations from a Standardization Viewpoint. IEEE Communication Standards Magazine.	ADLINK

3	Journal	March 2020	Luca Cominardi, Sergio González-Diaz, Antonio de la Oliva, Carlos J. Bernardos. Adaptative Telemetry for Software-Defined Mobile Networks. Journal of Network and System Management.	UC3M, ADLINK
4	Magazine	March 2020	Mikhail Afanasov and Luca Mottola. The FlyZone Testbed Architecture for Aerial Drone Applications. ACM GetMobile: Mobile Computing and Communications, vol 24, issue 1.	RISE
5	Journal	August 2020	Luis M. Contreras, Carlos J. Bernardos. Overview of Architectural Alternatives for the Integration of ETSI MEC Environments from Different Administrative Domains. Electronics 9(9)	UC3M, TID
6	Magazine	September 2020	I. Sarrigiannis, L.M. Contreras, K. Ramantas, A. Antonopoulos, C. Verikoukis. Application as a Service Function Chain in a Fog-enabled C-V2X Architecture. IEEE Network.	TID

TABLE 8: ORGANISATION OF SPECIAL ISSUES OF JOURNALS AND MAGAZINES.

#	Month	Journal/Magazine	Special issue name	Partners
1	June 2020	Elsevier Pervasive and Mobile Computing	Special issue on Edge Computing in Pervasive Systems	UC3M

3.1.2. Technical Talks

Table 9 lists all presentation activities delivered in the first year of the project including talks and panels. As reported, 9 talks and 1 panel were delivered at 8 different venues.

TABLE 9: TALKS AND PANELS DELIVERED.

#	Type	Month	Venue	Description	Partners
1	Talk	October 2019	EU-TW 5G/B5G workshop	5G-DIVE: eDge Intelligence for Vertical Experimentation	UC3M
2	Talk	November 2019	IEEE CloudNet	Networking the Cloud, Cloudifying the Network	TID
3	Talk	November 2019	Open Workshop on "Research Activities of Mutual Interest" @ IMDEA Networks (Leganés)	5G-DIVE - eDge Intelligence for Vertical Experimentation	UC3M

4	Talk	June 2020	Online workshop "5G end-to-end experimentation by verticals in EU projects"	DEEP: An Intelligence and Automation Platform for Edge and Fog Computing Environments	UC3M
5	Panel	June 2020	Online workshop "5G end-to-end experimentation by verticals in EU projects"	Introductory and concluding panel discussions	UC3M
6	Talk	June 2020	Online workshop "5G end-to-end experimentation by verticals in EU projects"	Assessing 5G need for Digital Twin Applications	UC3M
7	Talk	August 2020	IWPC - International Wireless Industry Consortium www.iwpc.org	Edge Computing and Networking	IDCC
8	Talk	April 2020	5th IEEE International Workshop on Orchestration for Software Defined Infrastructures (O4SDI), co-located with the 2020 IEEE/IFIP Network Operations and Management Symposium (NOMS 2020), Budapest, Hungary, April 2020 (going virtual)	Towards a standardized transport slicing architecture in operator networks (invited talk)	TID
9	Talk	May 2020	Workshop on The role of computing in the post 5G-era: Architectures and enabling technologies co-located with the 24th International Conference on Optical Network Design and Modelling (ONDM 2020), Castelldefels, Spain, May 2020 (going virtual)	Evolutionary trends in operators' networks for beyond 5G (invited talk)	TID
10	Talk	June 2020	Network Slicing 2020 workshop en IFIP Networking 2020, Paris, France, June 2020 (going virtual)	Transport slicing – ongoing work at IETF with a personal view (invited talk)	TID

3.1.3. Workshops and conferences

In the first year of the project, 4 workshop proposal has been submitted. One workshop has been organized and in Year 1 of the project while another 3 have been proposed and accepted to take place in Year 2.

TABLE 10: WORKSHOPS AND CONFERENCES ORGANIZED.

#	Event	Month	Status	Workshop	Country	Partners
1	Online	June 2020	Completed	"5G end-to-end experimentation by verticals in EU projects", workshop arranged in collaboration with the projects 5Growth, 5G-DIVE, 5G-EVE, 5G-VINNI and 5G-Tours.	Online	UC3M, NCTU
2	IEEE SDN-NFV conference	November 2020	Completed	IEEE Conference on Network Function Virtualization and Software Defined Networks (IEEE SDN-NFV)	Online (Madrid, Spain)	UC3M, TID
3	IEEE SDN-NFV	November 2020	Completed	MOBISLICE III – 3rd edition of Mobility Support in Slice-based Network Control for Heterogeneous Environments (workshop)	Online (Madrid, Spain)	UC3M, TID
4	IEEE Globecom	December 2020	Accepted and later Merged	IEEE GC20 Workshop on "Intelligent Fog and Edge Infrastructures for Future Wireless Systems". https://globecom2020.ieee-globecom.org/workshop/ws-03-workshop-intelligent-fog-and-edge-infrastructures-future-wireless-systems Merged into IEEE GC20 Workshop on Advanced Technology for 5G Plus (AT5G+)	Taipei, Taiwan and Online	UC3M, IDCC, RISE, NCTU

3.1.4. Exhibitions and Demonstrations

In the first year of the project, 4 demonstrations have been showcased, as shown in Table 11

TABLE 11: EXHIBITIONS AND DEMOS.

#	Type	Month	Venue	Description	Lead Partners
1	Demo at conference	February 2020	International Conference on Embedded Wireless Systems and Networks (EWSN), Lyon, France.	Demo: Multi-Radio Access Technology IoT Gateway.	RISE, EAB
2	Booth	February 2020	2020 ICF (Intelligent Community Forum) Top7, Taoyan, Taiwan		ASKEY
3	Web exhibition	February 2020	Anritsu Virtual MWC'20 exhibition	Demo: 5G Industry Verticals Test Bed https://www.anritsu.com/zh-tw/test-measurement/technologies/web-exhibit/mwc/pod#pod-3	IDCC
4	Demo at workshop	June 2020	Online workshop "5G end-to-end experimentation by verticals in EU projects"	Live online demonstration: "Assessing 5G need for Digital Twin Applications"	UC3M
5	Demo at workshop	June 2020	Online workshop "5G end-to-end experimentation by verticals in EU projects"	Recorded demonstration: "EagleEYE: Aerial Edge-enabled Disaster Relief Response System"	NCTU
6	Demo at workshop	September 2020	ACM WiNTECH, Online (London, UK)	Demo: Assessing the need for 5G driven Edge and Fog solution for Digital Twin systems	UC3M

3.1.5. EU Cross-projects Collaboration Activities

During the first year of the project, 5G-DIVE has put an effort towards the collaboration with other EU projects as shown in Table 12.

TABLE 12: EU CROSS-PROJECTS COLLABORATION ACTIVITIES.

#	Venue	Description
1	5G Annual Journal	Project summary article submitted
2	Submitted Workshop proposal for EuCNC'20 (cancelled)	A workshop proposal to EuCNC'20 as a joint action with a number of projects

3	Submitted a Booth proposal with 5GROWTH for EuCNC'20 (cancelled)	A joint booth application was submitted to EuCNC'20.
4	Online workshop	"5G end-to-end experimentation by verticals in EU projects", workshop arranged in collaboration with the projects 5Growth, 5G-DIVE, 5G-EVE, 5G-VINNI and 5G-Tours. (see details in Table 10)
5	WiNTECH 2020	Organization of Poster/Demo track at workshop. Joint with EMPOWER project.
6	IEEE SDN-NFV 2020	Organization of MOBISLICE III workshop together with 5GROWTH project. (see details in Table 10)

3.2. Updated Work Plan

Due to the COVID-19 global outbreak, the most noticeable change in the workplan is that almost all of the future dissemination and collaboration activities will be executed in virtual form. The main objective of the workplan is still the same, which is to generate the maximum impact of the project on all the stakeholders.

Below are the updated dissemination and collaboration activities for Year 2:

- Demonstration of project proof-of-concepts at least at 2 key events including at least 1 in Taiwan.
- Delivery of at least 6 talks at key R&D events.
- Publication (or acceptance for publication) of at least 12 peer-reviewed articles.
- Organization of conferences and workshops:
    - IEEE NFV-SDN in Madrid, Spain (changed to Online) in November 2020.
    - MOBISLICE III workshop at the IEEE NFV-SDN conference in November 2020
    - A workshop at Globecom 2020 in Taipei, Taiwan in December 2020.
- Organization of at least 2 joint collaboration activities with other EU projects.
    - Plans include the organization of a workshop (MOBISLICE III) and a panel (at Globecom'2020)

4. Standardisation and Open Source Activities

This section reports on the 5G-DIVE activities and relevant developments in standards and open source projects. The activities reported include: 1) an update of the status of relevant topics in relevant standards and open source forums; and 2) a report of the contributions from 5G-DIVE consortium partners disseminating work developed recently within the framework of the 5G-DIVE project.

4.1. Standardization Update

The standardization activities in organizations like the 3GPP, IETF, ETSI, IEEE, have all been impacted by the current COVID-19 pandemic, with all meetings turning virtual. The specification work however is still ongoing but at a slower pace than normal. In the below subsections, we report on the activities 5G-DIVE consortium partners have been following with relevance to 5G-DIVE solution.

4.1.1. 3GPP

In 3GPP, we have been monitoring and contributing to four key studies in the System Architecture Working Group2 (SA WG2) as follows:

- **Enablers for Network Automation (eNA) for 5G [1]:** This study focuses on automation use cases related to UE driven analytics. This covers several areas such as i) how to ensure that slice SLA is guaranteed; and ii) which data from the UPF can be used by NWDAF. This also includes NWDAF architecture enhancements such as i) Multiple NWDAF Instances in one PLMN including hierarchies; and ii) roles and inter-NWDAF instance cooperation. It also covers NWDAF features enhancement for real-time communication including: i) Mechanisms for data collection; ii) Service MOS based NWDAF-Assisted UP Optimization; iii) Minimization of the load generated by NWDAF data collection. The study also addresses the interaction between NWDAF and AI Model & Training Service owned by the operator. The current specification is still incomplete and needs further evaluation by SA WG2.
- **Enhanced support of Non-Public Networks (eNPN) [2]:** This study focuses on the requirements of non-public networks. It covers many areas related to NPN such as: i) enhancements to enable support for SNPN along with subscription, ii) support UE onboarding and provisioning for non-public networks, iii) enhancements to the 5GS for NPN to support service requirements for production of audio-visual content and services, iv) the possibility for customizations or optimizations of 5GS when used for NPN considering different deployment scenarios, v) the need for additional exposure capabilities due to support for NPN, vi) support for SNPN and PLMN sharing the same NG-RAN, vii) support for voice/IMS emergency services for SNPN. Several Solutions have been proposed and under investigation to address the aforementioned features but did not yet result into final solutions.
- **Enhancement of support for Edge Computing (EC) in 5GC:** This study covers two main objectives. The first objective is to study the potential system enhancements for enhanced Edge Computing support, including:
    - Discovery of IP address of application server deployed in Edge Computing environment
    - 5GC enhancements to support for seamless change of application server serving the UE

- How to efficiently provide local application servers with information on the data path
- Supporting for traffic steering in N6-LAN deployed in Edge Computing environment
- Supporting PSA change when the application server does not support notifications of UE IP address change
- Supporting I-SMF insertion or reselection based on AF request to route the traffic to application server deployed in Edge Computing environment

The second objective is to provide deployment guidelines for typical Edge Computing use cases, e.g. URLLC, V2X, AR/VR/XR, UAS, 5GSAT, and CDN. 5G-DIVE partners noticeably IDCC and ITRI have been active on this topic and participated in the discovery of IP address of application server. However, the current solutions still under evaluation.

- **Enhancement of network slicing (eNS) [3]:** This study aims at identifying the gaps that need to be filled in providing support in the specifications owned by SA WG2 for the Generic Network Slice Template (GST) attributes. Like abovementioned, eNS is currently working on a complete solution and its evaluation.

4.1.2. IETF and IRTF

Following D4.1, the priorities in IETF/IRTF standardization work did not change. Currently 5G-DIVE is contributing to and/or monitoring progress of the following working/research groups:

- **Service Function Chaining (SFC) WG.** In 5G-DIVE we are working on fog orchestration control and mobility (function migration) for SFC in fog environments. Despite the relative slow-down of activity of this WG in the period from D4.1 (due to the COVID-19 situation), we have achieved to submit multiple contributions to the SFC WG on this topic, as listed in Section 4.2.
- **ANIMA WG.** In 5G-DIVE, we continue exploring dynamic monitoring approaches that can be bootstrapped using GRASP extensions in fog environments. This WG has also experienced a slow-down in their progress due to COVID-19.
- **Distributed Mobility Management (DMM) WG.** The activity of this WG has slowed down quite a bit since D4.1, mainly due to the COVID-19 scenario, but also because the group is in the process of re-scoping its goals and milestones. 5G-DIVE is monitoring and contributing to this WG with SFC mobility solutions (extending the Mobile IPv6 protocol), as listed in Section 4.2.
- **Reliable and Available Wireless (RAW) WG.** This WG was just created before the COVID-19 situation, and it is one of the few that has made more progress despite of the lack of in-person meetings. Some of the use cases and potential technologies currently considered by the RAW WG are very much related to 5G-DIVE. One example is edge robotics, which is very much in scope of RAW. Different contributions, as listed in Section 4.2, have been made.
- **Dynamic Host Configuration (DHC) WG.** We continue actively participating to this WG, as some mechanisms explored in 5G-DIVE might make use of DHCP (for local MAC addressing). A couple of contributions from the project have been adopted and are in the process of becoming RFCs.

- **Network Management Research Group (NMRG).** AI-based network management is a topic covered by 5G-DIVE which is relevant to the NMRG WG. While no contributions have made at this point, we continue monitoring the progress and we plan to participate in the future.
- **COIN proposed research group (COINRG).** The project has contributed to this WG on discovery mechanisms at the edge. This is a relevant topic for 5G-DIVE and we plan to continue monitoring and contributing. We expect one contribution from 5G-DIVE in this area to be adopted in the future.

4.1.3. ETSI

5G-DIVE consortium has been monitoring a number of ETSI ISGs relevant to the targeted solution and where applicable contributing to some of these ISGs as reported in section 4.2. The status of these ISGs is reported briefly hereafter:

- **ETSI MEC ISG** is in its third two-year cycle with focus on the evolution towards cloud native paradigm. Importantly for 5G-DIVE, a new study ETSI GR MEC 036 "Study on MEC in resource constrained terminals, fixed or mobile" has launched recently (July 2020). This study focuses on how resource constrained devices, such as terminal units, mobile hosts and personal devices, can be used to support cloud computing at the edge. This study is led by IDCC, and three joint contributions with UC3M have already been made within the 5G-DIVE solution framework.
- **ETSI ENI ISG** is completing its second two-year cycle focused on data and action interoperability. A plan for third two-year cycle is underway and the ISG is anticipated to continue to be active in 2021-2022. The scope of this third cycle is not publicly available at this stage of writing this document. It is also noteworthy a workshop[1] "ENI-Machine Learning in communication networks" organized on 16 March between two ETSI ISGs, namely ENI and SAI (Securing AI), and ITU-T's Q20/13 and FG ML5G "Machine Language 5th Generation", on AI/ML. This workshop was instrumental in enabling synergies between ETSI ENI and SAI and the ITU-T ML5G which are now set on track to collaborate and complement each other.
- **ETSI NFV ISG:** This group is currently running its fourth two-year cycle, complementing the previous work on a number of areas conforming what is referred as "Release 4" specification. There are several aspects from this release relevant to 5G-DIVE. Among them, the support of lightweight virtualization technologies like OS containers, important when considering resource constrained virtual infrastructures as the ones that could be found at the edge and fog. Also, the analysis of enhancements in NFV for accompanying the deployment of 5G networks, or multi-tenancy aspects (such as isolation or resource sharing) of relevance for cloud-based environments.
- **ETSI ZSM ISG:** In this case, the activity on ZSM is in its second two-year cycle of development. The relevant work in ZSM for 5G-DIVE is mainly concentrated in the activities related to the

[1] https://www.etsi.org/newsroom/blogs/entry/eni-13-progressing-release-2-and-etsi-itu-t-workshop-eni-machine-learning-in-communication-networks

lifecycle management and closed loop design and operations. Also interesting for the project, specifically when looking at potential multi-domain scenarios, is the cross-domain service orchestration and automation that can involve the provision of services through multiple administrative domains.

- **ETSI PDL ISG:** the activity in this group is in its first two-year cycle focused on to address the adoption of blockchain technologies in the telecommunication industry, initially focusing on business use cases, architectures, interfaces and data models. Even it is incipient, it can have an interesting potential for 5G-DIVE use case scenarios extremely sensible to security, robustness and accounting. The idea of leveraging on smart contracts, dealt through distributed ledger mechanisms, as form of relationship among parties is promising when thinking on realistic exploitation of 5G-DIVE outcomes.

4.1.4. IEEE

Following D4.1, the priorities in IEEE standardization work did not change. Currently 5G-DIVE is monitoring progress in three main areas:

- **IEEE 802.1:** 5G-DIVE is monitoring the IEEE 802.1 TSN for possible relevant activities regarding the industrial profile and the IEEE 802.1CQ activity, aiming at the distribution of local MAC addresses to IEEE 802 compliant equipment.
- **IEEE 802.11bc:** Activity within the WLAN group aiming at developing new technologies for the broadcasting of information from the AP or the STAs, relevant for the industrial and drone use cases of 5G-DIVE.
- **IEEE 802.11be:** Activity that will yield to WiFi 7. Apart from the expected increase in the density of users and bandwidth available to end-users, this standard aims at a deeper integration with TSN networks, which may be relevant to the industrial and drone use cases.

4.1.5. ORAN Alliance

The ORAN alliance [4] is promoting the interoperability of disaggregated RAN solutions producing different specifications for virtualization, operation, control and management of them. Apart from the interest in 5G-DIVE for the potential of disaggregated RAN from an architectural point of view, it is of relevance for the project the consideration of AI-based mechanisms for its applicability to radio resource control. Currently 5G-DIVE is monitoring the progress of the following working/research groups:

- **WG1 on Use Cases and Overall Architecture Workgroup.** The architectural approach of disaggregated RAN could be applicable to 5G-DIVE scenarios, where components of the disaggregated RAN could lay on different administrative domains (i.e., vertical premises and operator facilities). The use cases considered so far in ORAN are also inspirational for analyzing additional scenarios in 5G-DIVE, such as for instance RAN sharing cases.
- **WG2 on the Non-real-time RAN Intelligent Controller and A1 Interface Workgroup.** This group considers the introduction of AI/ML mechanisms for the near-RT RAN Intelligent

Controller (RIC), which could be considered as complementary to the same kind of capabilities being developed within 5G-DIVE.

- **WG9 on Open X-haul Transport Work Group.** Because of the fact of disaggregating the RAN, the distinct components of the radio access need to be properly interconnected. This group is specifying the transport connectivity for the full environment and the co-existence with other services in the field, which is important when considering the integration of 5G-DIVE scenarios, leveraging on ORAN, with other services existing in the network.

4.2. Standardization Achievements

Table 13 collects standard contributions associated with the 5G-DIVE project.

TABLE 13: STANDARD CONTRIBUTIONS IN 5G-DIVE.

#	Date	SDO	WG	Title	Authors	ID	Status	Partners involved
1	Nov'19	IETF	ANIMA	Autonomic setup of fog monitoring agents	CJ. Bernardos, A. Mourad	draft-bernardos-anima-fog-monitoring-01	ID-Exists	UC3M, IDCC
2	Nov'19	IETF	RAW	RAW use cases	G. Papadopoulos, P. Thubert, F. Theoleyre, CJ. Bernardos	draft-bernardos-raw-use-cases-01	ID-Exists	UC3M
3	Nov'19	IETF	ALTO	Use of ALTO for Determining Service Edge	LM. Contreras, D. Lachos, C. Rothenberg	draft-contreras-alto-service-edge-00	ID-Exists	TID
4	Nov'19	IETF	TEAS	Considerations for defining a Transport Slice NBI	LM. Contreras, S. Homma, J. Ordonez-Lucena	draft-contreras-teas-slice-nbi-00	ID-Exists	TID
5	Nov'19	IETF	TEAS	Transport Network Slice YANG Data Model	X. Liu, J. Tantsura, I. Bryskin, L. Contreras, Q. Wu	draft-liu-teas-transport-network-slice-yang-00	ID-Exists	TID
6	Mar'20	IETF	RAW	RAW use cases	G. Papadopoulos; P. Thubert; F. Theoleyre; CJ. Bernardos	draft-bernardos-raw-use-cases-03	ID-Exists, Update	UC3M
7	Mar'20	IETF	DHC	SLAP quadrant selection options for DHCPv6	CJ. Bernardos; A. Mourad	draft-ietf-dhc-slap-quadrant-05	ID-Exists, WG adopted	UC3M, IDCC
8	Mar'20	IETF	SFC	Service Function discovery in fog environments	CJ. Bernardos, A. Mourad	draft-bernardos-sfc-discovery-04	ID-Exists	UC3M, IDCC
9	Mar'20	IETF	SFC	Service Function Chaining Use	CJ. Bernardos, A. Rahman, A. Mourad	draft-bernardos-sfc-fog-ran-07	ID-Exists	UC3M, IDCC

				Cases in Fog RAN				
10	Mar'20	IETF	SFC	Distributed SFC control operation	CJ. Bernardos, A. Mourad	draft-bernardos-sfc-distributed-control-operation-00	ID-Exists	UC3M, IDCC
11	Mar'20	IETF	SFC	NSH extensions for local distributed SFC control	CJ. Bernardos, A. Mourad	draft-bernardos-sfc-nsh-distributed-control-00	ID-Exists	UC3M, IDCC
12	Mar'20	IETF	DMM	SFC function mobility with Mobile IPv6	CJ. Bernardos, A. Mourad	draft-bernardos-dmm-sfc-mobility-00	ID-Exists	UC3M, IDCC
13	Mar'20	IETF	DHC	SLAP quadrant selection options for DHCPv6	CJ. Bernardos, A. Mourad	draft-ietf-dhc-slap-quadrant-06	Standards Track (update)	UC3M, IDCC
14	Jul'20	IETF	SFC	Distributed SFC control for fog environments	CJ. Bernardos, A. Mourad	draft-bernardos-sfc-distributed-control-02	ID-Exists	UC3M, IDCC
15	Sep'20	IETF	intarea	IPv6-based discovery and association of Virtualization	CJ. Bernardos, A. Mourad	draft-bernardos-intarea-vim-discovery	ID-Exists	UC3M, IDCC
16	Sep'20	IETF	SFC	NSH extensions for local distributed SFC control	CJ. Bernardos, A. Mourad	draft-bernardos-sfc-nsh-distributed-control	ID-Exists, Update	UC3M, IDCC
17	Sep'20	IETF	SFC	Distributed SFC control operation	CJ. Bernardos, A. Mourad	draft-bernardos-sfc-distributed-control-operation	ID-Exists, Update	UC3M, IDCC
18	Sep'20	IETF	DMM	SFC function mobility with Mobile IPv6	CJ. Bernardos, A. Mourad	draft-bernardos-dmm-sfc-mobility	ID-Exists, Update	UC3M, IDCC
19	Apr'20	3GPP	SA2	23.501 CR2269R2 (Rel-16, 'F'): Enablers for multiple SCPs (23.501)	Oracle Corporation, Verizon UK Ltd, Nokia, Nokia Shanghai-Bell, Samsung, Ericsson, ITRI, CATT, AT&T, ZTE, InterDigital	S2-2003269	Accepted	ITRI, IDCC
20	Apr'20	3GPP	SA2	23.502 CR2208R2 (Rel-16, 'F'): Enablers for multiple SCPs (23.502)	Oracle Corporation, Verizon UK Ltd, Nokia, Nokia Shanghai-Bell,	S2-2003270 (https://www.3gpp.org/ftp/tsg_sa/WG2_Arch/TSGS2_138e_Electronic/Docs/S2-2003270.zip)	Accepted	ITRI, IDCC

					Samsung, Ericsson, ITRI, CATT, AT&T, ZTE, InterDigital			
21	Sep'20	3GPP	SA2	23.748: Update to Solution #39: EAS relocation coordinated with PSA change.	Huawei, HiSilicon, InterDigital Inc., Apple, ITRI	S2-2005982 (https://www.3gpp.org/ftp/tsg_sa/WG2_Arch/TSGS2_140e_Electronic/Docs/S2-2005982.zip)	Accepted	ITRI, IDCC
22	Oct'19	3GPP	SA2	23.748: Application server discovery for enhanced Edge Computing	ITRI	S2-1909645 (https://www.3gpp.org/ftp/tsg_sa/WG2_Arch/TSGS2_135_Split/Docs/S2-1909645.zip)	Merged into S2-1910422	ITRI, IDCC
23	Oct'19	3GPP	SA2	23.748: Key Issue for the discovery of edge application server	Huawei, HiSilicon, Ericsson, Nokia, Futurewei, Sandvine, ITRI, Toyota, CATT, vivo, Deutsche Telekom, OPPO, Tencent, Samsung, LG Electronics, Alibaba Group	S2-1910422 (https://www.3gpp.org/ftp/tsg_sa/WG2_Arch/TSGS2_135_Split/Docs/S2-1910422.zip)	Accepted	ITRI, IDCC
24	Nov'19	3GPP	SA2	23.748: Key Issue on edge relocation (FS_enh_EC)	Qualcomm Incorporated, NTT DOCOMO, AT&T, Nokia, Nokia Shanghai Bell, Samsung, Ericsson, LG Electronics, Sandvine, Interdigital, ITRI, Deutsche Telekom, Lenovo	S2-1912612 (https://www.3gpp.org/ftp/tsg_sa/WG2_Arch/TSGS2_136_Reno/Docs/S2-1912612.zip)	Accepted	ITRI, IDCC
25	Nov'19	3GPP	SA2	23.748: New key issue on 5GS enhancements to	InterDigital Inc., ITRI	S2-1911795 (https://www.3gpp.org/ftp/tsg_sa/WG2_Arch/TS	Merged into S2-1912354	ITRI, IDCC

				support Edge and PSA Relocation		GS2_136_Reno/ Docs/S2-1911795.zip)		
26	Nov'19	3GPP	SA2	23.748: New key issue on deployment consideration to enable seamless change of EC Application Server, serving UEs	InterDigital Inc., ITRI	S2-1911794 (https://www.3gpp.org/ftp/tsg_sa/WG2_Arch/TSGS2_136_Reno/Docs/S2-1911794.zip)	Posted	ITRI, IDCC
27	Nov'19	3GPP	SA2	23.748: Solution for application server discovery based on NEF registration.	ITRI	S2-1911919 (https://www.3gpp.org/ftp/tsg_sa/WG2_Arch/TSGS2_136_Reno/Docs/S2-1911919.zip)	Posted	ITRI, IDCC
28	Jul'20	ETSI	MEC	MEC036 Update to Section 4 Overview	Debashish Purkayastha, Alain Mourad, Carlos Bernardos, Marco Liebsch	MEC(20)000258	Accepted	IDCC, UC3M
29	Jul'20	ETSI	MEC	MEC036 Use case Zero Defect Manufacturing	Debashish Purkayastha, Alain Mourad, Carlos Bernardos , Marco Liebsch	MEC(20)000259	Accepted	IDCC, UC3M
30	Jul'20	ETSI	MEC	Use case Mission critical vehicular and mobile node application	Debashish Purkayastha, Alain Mourad, Carlos Bernardos , Marco Liebsch	MEC(20)000261	Accepted	IDCC, UC3M
31	Sep'20	IETF	SFC	Service Function Chaining Use Cases in Fog RAN	CJ. Bernardos, A. Rahman, A. Mourad	draft-bernardos-sfc-fog-ran-08	ID-Exists, Update	UC3M, IDCC
32	Sep'20	IETF	SFC	Service Function discovery in fog environments	CJ. Bernardos, A. Mourad	draft-bernardos-sfc-discovery-05	ID-Exists, Update	UC3M, IDCC

4.3. Open Source Activities

This section describes open source activities relevant to 5G-DIVE project.

4.3.1. OSM

Open Source Management and Orchestration (OSM) is an open-source project for the development of a network orchestration framework. It was originally focused on NFV MANO, but the scope of the OSM is currently more ambitious. The OSM is the orchestrator of choice in several networks and the OSM is only OSG in ETSI. The OSG provides a reference architecture in advanced network orchestration and it has strong connection with European research projects. Most relevant modules of OSM are service orchestrator, VIM plugin, slicing modules and monitoring system

Contributions to the OSM are made as source code commits or as documentations to the open source project. Each contributing party needs to provide a Contribution Agreement acknowledgement (Apache 2.0 License).

The OSM Releases are done every six months and the releases are named with a number name in capital letters: (ZERO, ONE, TWO.) Current version is OSM Release SIX. The project developers agree on a blueprint for each coming release by deciding on priorities over different evolution proposals

Given the size of the community of active developers and the user plans, continuity till the end of 2022 is practically assured

4.3.2. Eclipse Edge Native WG

Following D4.1, the activities in the Eclipse Edge Native Working Group did not change. Currently 5G-DIVE is contributing with two projects to this working group. The Eclipse fog05 is a main part of the 5G-DIVE's Edge and Fog System (EFS) and will contain the implementation of the Orchestration and Control System (OCS). Eclipse fog05 is an open source project that aims at providing a decentralised infrastructure for provisioning and managing compute, storage, communication and I/O resources available anywhere across the network. Eclipse fog05 addresses highly heterogeneous systems even those with extremely resource-constrained nodes. The latest release of Eclipse fog05 at the time of writing this deliverable is the v0.2.1 and was done in July 28, 2020[2]. For more information please refer to the 5G-DIVE deliverable D2.1 [6].

Another project that is part of the Eclipse Edge Native Working Group is Eclipse Zenoh. The purpose of the Eclipse Zenoh project is to unify data in motion, data in use, data at rest and computations. Eclipse Zenoh carefully blends traditional pub/sub with geo-distributed storages, queries and computations, while retaining a level of time and space efficiency that is well beyond any of the mainstream stacks. The current version of the Eclipse Zenoh contains and initial implementation of the Data Analytic Support Stratum (DASS) inside the DEEP component. Its goal is to bring data-centric abstractions and connectivity to devices that are constrained with respect to the node resources, such as computational and storage, power and network. The latest release of Eclipse Zenoh at the time of

[2] https://github.com/eclipse-fog05/fog05/releases/tag/v0.2.1

writing this deliverable is the v0.4.2 and was done on June 19, 2020[3]. For more information please refer to the 5G-DIVE deliverable D2.1 [6].

ADLINK is founder member of the Eclipse Edge Native Working Group, which is expected to have a pivotal role in establishing the open source Edge Native reference platform and, as such, accelerate the adoption of edge native architectures. Additionally, ADLINK is the leader contributor to the Eclipse **fog05** as well as the Eclipse **Zenoh** projects. In the coming EclipseCon conference to be held virtually in October 19-22, 2020, there is an approved session regarding the integration between Edge robotics with ROS2 and Eclipse Zenoh[4]. This presentation will provide with a clear descriptions of the challenges posed by the current ROS2 and MicroROS2 data-plane and illustrate how these challenges can be addressed by leveraging Eclipse Zenoh to (1) bring peer-to-peer to MicroROSs applications and (2) scale-out ROS2 applications and enable Edge Robotics management monitoring and control by means of a DDS-plugin for the Zenoh routing network. Finally, we will demonstrate edge management, monitoring and control of a robot swarm.

[3] https://github.com/eclipse-zenoh/zenoh/releases/tag/0.4.2-M1

[4] https://www.eclipsecon.org/2020/sessions/edge-robotics-ros2-and-eclipse-zenoh

5. Exploitation Activities

A preliminary exploitation plan for the project was defined in Deliverable 4.1 [5]. The purpose of the exploitation plan is to create value for all stakeholders during the project lifetime and beyond. Several forms of exploitation are planned with a focus on the components developed as part of the project's field trials.

The preliminary work plan from Deliverable 4.2 [7] included activities relating to all aspects of the exploitation strategy as outlined in the following paragraphs.

Identify commercial opportunities in prototypes – A large project effort is spent on prototype systems and their components implemented for the field trials. Commercial opportunities will be identified in these systems and components.

Identify innovations from technology development –Innovations will be identified as they emerge from the technology development undertaken by the technical work packages (WP1/WP2/WP3) and their suitability for patenting will be assessed.

Map innovations to products and services –The innovations will be mapped onto identified products and services, existing as well as new, of industrial stakeholders with the per-partner exploitation plans [5] as a starting point.

Promote exploitation –The exploitation of the project's innovations will be promoted by the various stakeholders, including through the arrangement of an exploitation workshop towards the end of the project.

In the rest of the section the preliminary exploitation plan is elaborated as follows: (1) plans relating to the proof-of-concept prototypes, (2) plans related to partner products and services, and (3) additional partner exploitation plans. Finally, key innovations are identified from the work on the 5G-DIVE architecture and the proof-of-concepts.

5.1. Proof of concepts

5.1.1. Digital Twin PoC

This PoC is one of the use cases targeted under the Industry 4.0 pilot and it is led and developed by UC3M. It focuses on the design, development and implementation of an Intelligent Edge- and Fog-assisted Digital Twin, envisioning scenarios where physical robotic systems are remotely operated by either a human and/or an AI-based agent. Currently, we exploit the use of Robot Operating System (ROS) as a robotics middleware that provides common robotic functionality and common interfaces to interact with a different set of robots. Such approach eases the extension of the developed solution to fit diverse robotic systems with different purposes and capabilities. In this PoC, a robotic arm is used as the robotic system example. The different software components of the robotic arm have been already offloaded towards the cloud-to-thing continuum, being identified their requirements and different deployment approaches (over 5G or 4G) that can enable the proper operation of the robotic arm. Moreover, existing visualization tools have been extended to support our solution and new web and

joystick interfaces are being developed for controlling the robotic arm. Results showcase the feasibility of the developed solution, pointing out for its potential application into real Industry 4.0 environments. In next step, we plan to extend the current integration with (lightweight) Kubernetes and to support a fog05-based integration to automate the creation, provisioning, and management of the associated vertical service, including a full integration with the DEEP platform developed under 5G-DIVE. In addition, the AI/ML capabilities will be applied in both application- and network-level processes to optimize and automate the current solution and to pave the way the introduction of novel features.

5.1.2. Zero Defect Manufacturing PoC

The Zero Defect Manufacturing (ZDM) PoC is designed to investigate and demonstrate data-driven E2E solution that integrates 5G, fog, edge and cloud for product-oriented ZDM. The use case consists of three-part setup namely factory side with production line, an edge side that monitors and supervises manufacturing process and cloud side with data lake-based telemetry collection system. It is demonstrated that the production line can be monitored in real-time and defective items on the production line can be detected by AI-based object detection algorithm that is running on the edge. It is also demonstrated that the edge node can supervise the manufacturing process by sending commands to the controllers in the production line to remove defective items. Meanwhile, telemetry data collected from wireless interfaces both at the factory and edge side as well as from computing nodes at the edge node is stored in a data lake deployed in the cloud. Currently, this demo is executed using two access technologies, namely Wi-Fi and 4G. The next steps of the ZDM PoC will be on (i) establishing 5G connectivity between the production line setup and fog/edge/cloud devices; (ii) enabling intelligent RAN applications on multi-access management; and (iii) improving capabilities and performance of the object detection algorithm.

5.1.3. Massive MTC PoC

As one of the use cases of Industry 4.0 pilot, this PoC is co-developed by Ericsson Research, Lund University and RISE. It is designed to investigate and demonstrate cloud native design of IoT RAN functions in a Cloud or virtualized RAN environment. Currently, we use LoRa and 802.15.4 as examples to study resource pooling and auto-scaling. an end-to-end setup is being developed to support a full-stack IoT application, showcasing the resource pooling aspects on higher-layer network functions with cloud native design. Meanwhile, an emulation system is under development to support studying autoscaling of L1 RAN functions in a large-scale IoT Cloud RAN system, in terms of hundreds of cells running in one Cloud environment. The results show a big potential of resource pooling and autoscaling. In next step, both systems will be integrated with an orchestrator based on Kubernetes and fog05 (following 5G-DIVE integration plan) to automate the system and optimize the autoscaling schemes. In addition, an ML-based authentication scheme based on fingerprinting of RF signals has been developed, showcasing the possibility to use RAN data and ML techniques to improve security. In next step, this will be integrated to the PoC.

5.1.4. Drone Fleet Navigation PoC

Traditionally, drones are navigated through a set of GPS coordinates, which are pre-loaded into the drone navigation software. This scheme, known as Waypoint navigation, does not allow autonomous modification to the flight path. In this PoC, we showcase the enhancing the current navigation system to enable local and remote data processing as well as dynamic change to flight trajectory for the drone fleet. To accomplish this, a coordination mechanism among drones in the drone fleet with edge and fog computing is required. At the edge, the Drone Navigation Server can remotely monitor and control each drone. At the fog, each drone uses fog-to-fog communication to share GPS data with each other to support Drone Collision Avoidance System (DCAS). The DCAS will interact with Drone Navigation Server through mobile network. The developed DCAS at the fog node on each drone will detect potential collisions and takes over the control of the drone autonomously to avoid the collisions using virtual cylinders to detect potential collisions. In our demo scenario, two drones flaw in the ITRI campus with the Drone Navigation Server to control the drones to take off and set the drones to fly to different destinations. During the flight, the drones will be too close, then DCAS on each drone will detect potential collisions and takes over the control of the drone for a period of time. After the potential collision is resolved, the drone control returns to the Drone Navigation Server to continue the mission.

5.1.5. Intelligent Image Processing for Drones PoC

This section elaborates the PoC of intelligent image processing for drones developed by NCTU. It aims to validate and demonstrate the proposed edge-enabled aerial image processing architecture in a virtualized environment. The applications are deployed and orchestrated by Kubernetes in different servers across multiple racks. This architecture enables the scaling capability of the object detection service(s) to satisfy end-to-end real-time requirements of the detection of the objects. In the trial, we have successfully showcasing the capability of this architecture to perform object detection on the edge and detect the objects, including the GPS information in each specific frame. The images are captured from the drone video streams through 4G network. Up to this point, we pre-setup the number of object detection services based on the connected drones. As for the future, we plan to develop an intelligent scaling policy to automatically determine the number of working object detection services based on the real-time detection capability as the number of connected drones are increasing or decreasing. In the step, the network will be updated into 5G along with more number of connected drones on the scenario.

5.2. Existing or New Products, Services and Solutions

The following products/services from the partners that will (or may) get impacted by 5G-DIVE results. Furthermore, as described in Section 4.3.2, ADLINK is the main maintainer and key contributor of Eclipse Zenoh[5] and Eclipse fog05[6] open-source projects, which have direct impacts from 5G-DIVE results. Any product and services that will use any of these two projects will therefore be impacted from 5G-DIVE results.

[5] http://zenoh.io/
[6] https://fog05.io/

5.2.1. Ericsson Cloud RAN

Ericsson Cloud RAN[7] is a cloud-native software solution, running on Intel Xeon processors, that will handle compute functionality in radio access networks. It will add more versatility to network buildouts to address a variety of 5G use cases. The offering enables web-scale technology, and will bring greater scalability, pooling and faster time-to-market for new services. It will deliver network capabilities for both large-scale and centralized 5G deployments. It will allow service providers to address new business opportunities and diverse 5G use cases for indoor, industry, enterprise, stadiums and beyond.

In 5G-DIVE, we focus on investigating the cloud native design for IoT RAN functions, running in a Cloud or virtualized RAN system based on general-purpose COTS hardware, e.g., x86-based processors. The topic fits well to the scope of Ericsson Cloud RAN product. The knowledge and experiences obtained in 5G-DIVE can be exploited to impact the evolution of Ericsson Cloud RAN.

5.2.2. Telcaria SD-WAN solution (Alviu)

Alviu[8] is Telcaria's SD-WAN solution, which is entirely based on SDN technology and commodity hardware, providing zero-touch configuration and fast deployment of branch offices network services. 5G-DIVE innovations, especially the Business and Intelligent Engine support stratum innovations, have been exploited by Alviu, enabling engineers to explore new ways of deploying and managing the O&M of Alviu components. 5G-DIVE will impact TELCA Alviu platform automation, intelligence, and efficiency by making use of some of the key technical innovations devised. Specifically, Alviu will benefit from the research on 5G-DIVE intelligent resource control and orchestration powered by its integrated Intelligent Engine support stratum, which will impact directly on how Alviu processes and gains insights from telemetry data and orchestrates efficiently its resources.

5.2.3. ITRI Intelligent Multi-Access Edge Computing

ITRI Intelligent Multi-Access Edge Computing (iMEC) is the generic x86 computing platform deployed between 3GPP Random Access Network and Core Network. The main functionality is to perform traffic breakout mobile users' data flows to localized application servers, rather than to those on the Internet. By doing so, the footprints of users' flows are dramatically shortened, giving low-latency and undisrupted bandwidth performance to mobile users. iMEC is consist of two main part. One is the Serving Gateway: A specialized and localized LTE serving gateway. It not only interacts with other LTE components using standard 3GPP signals, but also directly outputs service flows to localized services. The other is the virtualized computing environment for VM-based and Container-based application servers.

[7] https://www.ericsson.com/en/networks/offerings/5g/cloud-ran
[8] https://www.telcaria.com/docs/sd-wan/Alviu_Brochure.pdf

In 5G-DIVE, iMEC accommodates the video stream server and the AI computer vision server for drone operators to locate the person in need of help in the disaster field. Both low latency and high bandwidth properties are must-have for drones to transmit high resolution video back to control center.

5.2.4. Askey 5G USB Dongle

By 2021 Q1, Askey will launch a new "5G NR Sub-6 USB Dongle" product. The EV sample will be ready in sometime around in February or March next year of 2021. It's USB Type C interface with USB3.0 spec and will be a better solution than we proposed WWLC610 M.2 5G NR Module, which is being used in the present 5G ODU mounted on the Drone we did on our field trial on ADS in 5G DIVE.

Askey suggests to integrate above mentioned USB Dongle with Drone at Action Phase III as the 5G NR Transceiver in our 5G DIVE plan. By doing so, we expect to curtail more loading as much as weight on Drone. It is hoped that we could extend the time when Drone flying in the air on public safety scouting missions. The use of this dongle will allow ASKEY to validate its design for drone-based applications, potentially opening a new flow of revenue for the company.

5.3. Additional partner exploitation plans

In D4.1 [5], a partner-specific plan was provided. In general, the plan is still valid up to date. In this section, an update is provided. One common perspective is regarding the exploitation of the developed PoCs and the corresponding results. Each PoC development work has produced at least 1 demonstrator which will be used to promote the development innovation and research results internally within the companies and externally in conferences, industrial events etc., contributing to increase the impact of the project.

5.3.1. UC3M

UC3M is planning to exploit the results of the project in order to extend its current experimentation capabilities on top of 5TONIC. Two activities are currently planned that are direct result of project's results. On the one hand, UC3M is working together with Telefonica in order to build a federation proof of concept of ETSI MEC with the University Carnegie Mellon (UCM) Living Edge Laboratory. This laboratory is the main hub of innovation for the Open Edge Consortium. The experiment may include the federation of different MEC implementation from different vendors in a roaming use case.

On the second hand, UC3M is taking benefit of the Digital Twin use case to open the door to the establishment of new relations with some verticals in the area of I4.0. Currently UC3M is discussing the application of this technology with INNOVALIA and the PSA group.

Finally, as an academic institution, UC3M aims at gathering all the know-how developed within the project and provide it to the society by developing Master and Bachelor programmes. Specifically, the 5G-DIVE project may contribute to the Master on Connected Industry, in addition to the Master in 5G already indicated in the DoA.

5.3.2. ADLINK

ADLINK Technology's main goal is to supply data connectivity solutions, tools and professional services they need to build systems with the required: platform coverage, performance, scalability, efficiency, flexibility and robustness. As mentioned earlier, ADLINK is the main maintainer and key contributor of Eclipse Zenoh and Eclipse fog05 open-source projects, which have direct impacts from 5G-DIVE results.

Conversely, 5G-DIVE impact to Eclipse Zenoh as the DASS implementation is regarding the support of tailored requirements of the applications targeted in each vertical pilot, such as the digital twin, zero-defect manufacturing and drone fleet navigation applications. Similarly, 5G-DIVE impact on Eclipse fog05 as the OCS implementation is compose by two mains contributions, supporting a set of functional and non-functional requirements for an edge/fog virtual infrastructure manager and orchestration stack for the different deployment units (e.g. containers, binary applications, VMs) needed for the vertical pilots in the edge/fog environment. More information on Eclipse Zenoh can be found at http://zenoh.io/ and in the source code repository https://github.com/eclipse-zenoh/zenoh. More information about Eclipse fog05 can be found at http://www.fog05.io and in the source code repository http://github.com/eclipse/fog05.

5.3.3. EAB

The update is about exploitation of the develop PoC testbed. The first demonstrator regarding a large-scale emulation system of IoT Cloud/virtualized RAN has been developed. It was demonstrated in Ericsson Research Day 2020 to promote the results inside Ericsson. It was also demonstrated in GlobeCom 2020 in Taiwan to promote the results in public. Another demonstrator regarding the end-to-end system based on Cloud native design of 802.15.4 is also developed. Both demonstrators have been shown in the mid-term audit of 5G-DIVE. After that, the PoC will be further developed. The plan is to use the develop PoC to develop new orchestration schemes, e.g., to optimize autoscaling of IoT services, as well as exploring the possibility to enhancing the system with ML techniques. We will continue to use the developed PoC in both internal and external demo events, which would help promote and transfer the research results internally and externally.

5.3.4. ULUND

The results and knowledge from 5G-DIVE are exploited both internally, as input to research and teaching, and externally as in input to other projects and through knowledge transfer to other collaborative partners. In 5G-DIVE, Lund University performs the research work in close cooperation with Ericsson AB. ULUND is responsible for developing PoC testbed i.e., a large-scale emulation system of virtualized IoT RAN, as part of the work on the mMTC use case. We will continue to collaborate with Ericsson AB and other 5G-DIVE partners to further develop the emulation testbed with more comprehensive cloud native features. We plan to contribute to demo events and scientific publications to promote the results to public, also as part of a PhD thesis work.

5.3.5. TID

Telefónica I+D (TID), as a part of the Telefónica Group, is in charge of the innovation and the strategic vision of emerging network technologies and solutions, with focus on the application of new ideas, concepts and practices to the operations of the group as well as the development of 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, leveraging on new technologies and the deployment of 5G. Recent steps in that direction have been the creation of two new transversal affiliates, namely Telefónica TECH and Telefónica INFRA, complementing the operations in different countries (in Europe and Latam).

Different aspects of the Telefónica network, linked with 5G-DIVE activities, are subject of this transformation:

- Exposition of network capabilities that could be consumed by verticals through the generic concept of network slicing, as developed in 5G-DIVE WP2.
- Smooth integration of Non-Public Networks (i.e., vertical networks) with public networks from the operator side, with architectures compatible with the one from 5G-DIVE defined in WP1.
- Development of smart mechanisms for operation of vertical networks, following the role of System and Service Provider developed in 5G-DIVE WP1.
- Leverage on the know-how acquired through the development of the different use cases in 5G-DIVE WP3.

5G-DIVE results will facilitate such evolution, impacting on one hand in the transversal technology companies of the group (TECH and INFRA) but also in the wholesale offerings of each particular Operational company across the Telefonica global footprint. Specially, 5G-DIVE provides timely know-how to anticipate needs and requirements to be supported by the network assets. 5G-DIVE project is disseminated internally into the Telefonica group thanks to the key position of TID for the definitions of the technological guidelines of the company.

5.3.6. TELCA

Telcaria is an SME providing advanced services to network operators and equipment manufacturers worldwide. We partner with network operators to redesign their products towards NFV/SDN based network infrastructure and cloud-computing applications. Telcaria foresees to exploit from 5G-DIVE project, the experience of developing some key components in 5G-DIVE, to acquire the know-how of integrating components deployed over the heterogeneous edge and fog infrastructure into a common platform, to automate business processes and decisions by leveraging Artificial Intelligence in an edge and fog computing system. In the short term, Telcaria expects to exploit 5G-DIVE BASS by integrating the intelligence engine algorithms into its product portfolio, required by the increasing necessity of automating the O&M of the applications deployed and improving overall system behavior. Moreover, in the medium term, the experience gained from such developments is of significant value for strategic consulting and trials for new services that Telcaria could offer.

5.3.7. III

III is the main maintainer and key contributor of the core network for ADS use cases in Taiwan demo site. For the additional exploitation plan from III, include deploying the III Core on both KVM platform and kubernetes platform for integration and demo site. Also, support a PoC testbed in both internal and external demo events. One is in NCTU for drone fleet on the workshop in Taiwan to promote the results in public, and this End-to-end demo scenario is also demonstrated in IEEE Globecom 2020 5G-DIVE project booth.

5.3.8. ITRI

In principle, the exploitation plans include technology transfer to large and small (SME) industrial partners, showcasing as part of testbeds, patents and engaging in standardization. Besides, ITRI organized a workshop in NCTU for Drone disaster relief based demonstrated 5G-DIVE platform and end-to-end system Field trials. It was also demonstrated in GlobeCom 2020 in Taiwan to promote the results in public. We will continue to use the developed PoC in both internal and external demo events especially for public safety agencies, which would help promote and transfer the research results internally and externally.

5.3.9. NCTU

In general, our exploitation plans include technology transfer of EagleEYE to large and small (SME) industrial partners. Showcasing EagleEYE as one of the end-to-end solutions for aerial-based disaster relief system. We will continue to use and develop EagleEYE for academia and research purposes until the end of the project duration, where a final version of EagleEYE will be fully released for the general public to use and further develop.

5.3.10. RISE

RISE, Research Institutes of Sweden, as a government-owned research institute has the overall purpose to promote innovation and competitiveness of industry and society as a whole. In general, we exploit the results from research projects by knowledge transfer in close collaboration with partners, by publishing open source software, by spin-offs and by scientific publications.

In 5G-DIVE, we exploit results in close collaboration with Ericsson as part of the work on the Massive MTC use case. Some of the developed software on softwarised IoT protocol stacks will be published as open source as contributions to the Contiki NG embedded operating system, which is used in many products around the world. The project work on edge orchestration using fog05 for mobile robotics contributes to the iDrOS drone operating system which is also being published as open source software.

5.3.11. IDCC

IDCC has already been actively following and contributing to 3GPP, IETF and ETSI MEC standards with a particular focus on features relevant to 5G-DIVE. Also, IDCC's I4.0 ZDM test bed platform has been used to showcase 5G-DIVE project. For example, the test bed platform has been recently

demonstrated in GlobeCom 2020 in Taiwan to promote the results in public. The test bed platform and the above standardization activities will keep being the pillars of IDCC exploitation plan for the second year.

5.3.12. AAU

As a public Finnish university our exploitation of the project results is mainly through the technology transfer to the industrial players of the project. AAU exploits the 5G-Dive technology to primarily strengthen its research know-how and education offer. We exploit the developed architecture and software in close collaboration with IDCC in scientific publications, education material for our master degree programmes in IT, and also exploit the 5G-Dive concepts in transferring the built technology in future joint research activities.

5.3.13. FET

In 5G-DIVE project, FET has to fulfil the previous agreement to provide available radio spectrum (2600MHz) for the trials in first year. FET will use the gained knowledge to shape the definition of 5G deployments and services in the next years, with a special focus on private networks tailored to vertical applications. Thus, FET aims to leading the development of the IoT industry in Taiwan while connecting with the international trends.

5.4. Key Innovations Identified in Year 1

In this section, we show the identified innovation elements in Year 1. In the following, Table 14 lists the innovation elements regarding 5G-DIVE architecture design and DEEP platform components, while Table 15 presents the innovation elements identified so far from the developed PoCs of different use cases.

TABLE 14: IDENTIFIED INNOVATION ELEMENTS REGARDING 5G-DIVE ARCHITECTURE AND DEEP PLATFORM

	Innovation elements identified in Year 1	Partner
5G-DIVE Architecture	Architecturally, a DEEP platform is added to the Edge/Fog system: • Composed of BASS, DASS and IESS, aiming to a streamlined and flexible management hiding the underlying complexity of Edge/Fog infrastructure, supporting the vertical industries in day-by-day operations management, automation of businesses processes and provisioning of intelligent capabilities. • Follows an add-on approach for increased flexibility and for being Edge/Fog Computing Infrastructure agnostic. Architecture design with higher abstraction and improved usability, automation, and performance: • Vertical Service Abstraction: provides an abstraction layer, together with vertical-oriented interfaces. • Data Distribution and Unification: defines a data distribution and data unification mechanisms.	All

	• AI/ML-based Intelligence: facilitates the definition, training and cross-validation of AI/ML models.	
DEEP platform components	BASS • Novel MANO automation for business processes, i) not requiring highly-skilled operators, ii) seamlessly optimizing of the deployed services and iii) declarative vertical service control, leveraging the ability to describe desired states, so the vertical only need to know the desired state, not how to deploy and manage it. • Consistent deployment of vertical services: conditional ordered deployment of the components of a vertical service. • Pluggable MANO platforms, where Kubernetes has been integrated in the first year, and Fog05 will be integrated in the second. • Vertical KPIs-driven scaling: providing the capability to scale services with Vertical defined KPIs. SLA Closed loops will be jointly coupled with the deployment of the different vertical services, optimizing the deployment and its life cycle.	TELCA
	DASS • A named data networking-based framework for decentralised data sharing and management. o Unifies data in motion, data in-use, data at rest and computations. o Data pub/sub with geo-distributed storages, queries and computations. o Supports intermittent and constrained devices. o Data routing over heterogeneous transport.t and network technologies/domains • Contribution to the open-source Eclipse Zenoh project, which is part of the Eclipse Edge Native Working Group.	ADLINK
	IESS (about developed intelligent engines in IESS) • Automated retraining flow of AutoML/AutoAI against target accuracies/losses. • Pluggable AutoML/AI platforms. In the first year, we have integrated H2O.ai. • Storage of the models in a standard format to be used inside the DEEP platform. • Developed various intelligent engines used for different use cases o Intelligent Engine 1: real-time drone image processing for detecting persons in need of help. o Intelligent Engine 2: a DRL based SLA enforcer algorithm developed in a simulated environment. o Intelligent Engine 3: a contrastive-learning based deep learning model for device identification from their radio characteristics.	TELCA, NCTU, RISE, UC3M, IDCC, AAU

TABLE 15: IDENTIFIED INNOVATION IN DIFFERENT USE CASES

Pilot	Innovation elements identified in Year 1	Partner
Industry 4.0	Digital Twin PoC • Digital Twin edge native design. o Digital Twin stack design over Fog devices, Edge and Cloud. o DASS integration for publishing robot sensor data. o Low-latency remote control in Digital Twin systems over 5G. o Resource pooling for potential resource savings. o Understanding radio network impact to Digital Twin systems.	UC3M, TELCA
	Zero Defect Manufacturing PoC • Data-driven E2E solution integrating 5G, Fog, Edge and Cloud. o AI-based object detection adapting to the latency requirements considering cloud, edge, constrained edge/fog. o Telemetry data from UE and network/computing nodes exposed to an AWS-based data lake. o Data framework for enabling intelligent RAN applications. focusing on multi-access management in factory, e.g., 5G and WiFi.	IDCC
	Massive MTC PoC • Cloud/Edge native design of mMTC. o End-to-end testbed based on IEEE 802.15.4. ▪ Showcasing higher-layer network function resource pooling possibilities. ▪ IQ data exposure to DASS for IESS RF security services. o A large-scale emulation testbed based on LoRa. ▪ Showcasing RAN function resource pooling and performance impact in a large scale. ▪ Resource orchestration and service autoscaling of RAN and higher-layer network functions.	EAB, ULUND, RISE
Autonomous Drone Scout	Drone Fleet Navigation PoC • Edge native design for drone collision avoidance. o Collaborative approach between on-board application and Edge navigation service considering the latency constraints for drone collision avoidance.	ITRI/ASKEY
	Intelligent Image Processing for Drones PoC • Edge native design for drone image processing. o Object detection on Edge with decentralized design with autoscaling.	NCTU

6. Conclusions

This deliverable reported on the execution and overall achievements of the project's communication, dissemination and exploitation plan (CoDEP) that was defined in project Deliverable 4.1 [5]. The Covid-19 crisis made it more difficult and required the adaptation of the plans for more online presentation. Despite this, a significant progress has been made towards the dissemination targets.

The project has been active during the first year with communication and public activities. The Covid-19 re-planning meant that we put effort into producing videos of presentations and demos. The statistics show that the project has a quite active website where the consortium events and deliverables are the most popular content.

The project partners have published several scientific papers during the year. These efforts will be increased during the second project year, when more results become ready. The plans for participating in exhibitions have not been completely fulfilled due to cancelled events, but some have been replaced with online substitutes. The project has engaged in several cross-project collaboration activities, not least for organising workshops and other events. Several of these activities have been subject to re-planning due to Covid-19, but despite some difficulty, have largely been following plan.

The standardisation activities of the project cover the standardisation bodies 3GPP, IETF, ETSI, IEEE and ORAN Alliance. Several contributions have already been made to 3GPP, IETF and ETSI. Releasing and contributing to open source software are very important means of disseminating the project results. Project partners are driving two such projects.

The preliminary work plan for exploitation activities from D4.2 was elaborated with details relating to the developed proof-of-concept prototypes, to partner's products and services, as well as, to additional partner activities. Key innovations from the current progress of the 5G-DIVE architecture platform and from the proof-of-concepts were identified.

7. References

[1] 3GPP TR 23.700-91, 3rd Generation Partnership Project; Technical Specification Group Services and System Aspects; Study on enablers for network automation for the 5G System (5GS); Phase 2 (Release 17).

[2] 3GPP TR 23.700-07, 3rd Generation Partnership Project; Technical Specification Group Services and System Aspects; Study on enhanced support of non-public networks (Release 17).

[3] 3GPP TR 23.700-40, 3rd Generation Partnership Project; Technical Specification Group Services and System Aspects; Study on enhancement of network slicing; Phase 2 (Release 17)

[4] O-RAN Alliance. website: https://www.o-ran.org/

[5] B. Ahlgren (ed.). Y1 CoDEP including standardization plan. 5G-DIVE project Deliverable 4.1, March 2020.

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