H2020 5G Dive Project
Grant No. 859881

D4.1: Y1 CoDEP including standardization plan

Abstract

A plan is defined for communication, dissemination and exploitation, including standardisation and open source activities. Communication and public activities include a web site, social media presence and press releases. Video interviews, magazine articles, leaflets and posters are used to promote the project vision and initial results. Dissemination and collaboration activities focus on professional communities, ranging from scientific publication to demonstration and interaction with other EU projects. Standardisation plans cover seven standardisation organisations (SDOs), with a roadmap mapping project development to the timeline of some major SDOs. Dissemination through open source software (OSS) includes three OSS projects, of which project members have a leading role in one. A preliminary plan for exploitation focusses on the components of the field trials.

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Disclaimer

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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

A communication, dissemination and exploitation plan (CoDEP), including standardisation and open source activities is defined, with the aim at fulfilling the project overall Objective 4 to disseminate and contribute 5G-DIVE results into international research and innovation venues to pave the way for their successful exploitation.

Communication and public activities are planned using many channels, for example, a project portal web site, social network accounts and press releases. Furthermore, video interviews, magazine articles, leaflets and posters are used to promote the project vision and initial results. These activities already show a good progress towards the set communication targets.

The dissemination and collaboration activities focus on professional communities, scientific as well as industrial. The activities range from scientific publication to demonstration and interaction with other EU projects. Examples of the latter are jointly arranged workshops and panels, and joint exhibition booths.

A Standardisation Advisory Committee (SAC) with representation from many project partners has been formed for leading the planning and work on standardisation activities. The plan covers seven standardisation organisations (SDOs), and identifies specific working groups, technical committees, study groups, etc, relevant for the project, and where project members have the possibility to provide input, directly or indirectly. The SDOs are 3GPP, IETF/IRTF, ETSI, IEEE, ITU-T, O-RAN and GSMA. A roadmap is defined mapping project development to standardisation activities and relating the progress of the project with the timeline of some major SDOs.

The plan for dissemination through open source software (OSS) includes three OSS projects, of which project members have a leading role in one. The projects are Open Source Management and Orchestration (OSM), Open Network Automation Platform (ONAP) and Eclipse Edge Native WG with Zenoh and fog05.

In summary, a comprehensive CoDEP plan is defined and has started to be executed. The plan will be updated and reported against in project Deliverable 4.2.

1. Introduction

This deliverable defines a communication, dissemination and exploitation plan (CoDEP) for the project, including a roadmap of the coordinated standardisation activities. It is thus a plan for fulfilling the project's overall Objective 4 to disseminate and contribute 5G-DIVE results into international research and innovation venues 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 first sub-objective is largely addressed in Sections 3 and 4 on communication, public activities, dissemination and collaboration. The second sub-objective is addressed in Section 5 on standardisation and open source activities, and finally sub-objective 3 is addressed in Section 6 on exploitation activities. While not the purpose of the deliverable, we also report current status, where applicable.

2. Covid-19 crisis management

This deliverable was finalised during the Covid-19 crisis, but most of the plans were made before the extent of the crisis was known. We are prepared to re-plan as needed to handle the effects of Covid-19 mitigation measures, and in particular making new plans due to cancelled events. Important events for the project are the Mobile World Congress, that already was cancelled, EuCNC, that will be an online event, and Computex, which currently is rescheduled from June to September. Other events are also offering online substitutes, including Globecom in Taipei in December.

It is therefore unavoidable that the communication and dissemination plan for the project will be affected and, in some instances, delayed. We are looking for possible ways to improve the online presence of the project. We anticipate that some dissemination targets will need to be adjusted, and that project presentation material has to be adapted to online presentation, for example with videos of demos and presentations, and that new online material has to be created, for example, short `video pills' and webinars. More details of updated plans will be reported as part of Deliverable 4.2.

3. Communication and Public Activities

Communication activities undertaken in the first 6 months of the project have been steered towards ensuring an up-to-date communication on the project concept and first results to the large public through various tools including web portal, social networks, video interviews, leaflets, and magazine articles. This chapter provides first the Year 1 plan set for communication activities and reports next on the subsequent achievements.

3.1. Work Plan

The focus in Year 1 has been put on raising and fostering awareness of the 5G-DIVE project vision, concept, objectives, and first initial results, amongst the various stakeholders (R&D community, market players, and the general public). The following objectives were set:

- Deployment of the project portal for an up-to-date communication on all events and milestones from the project to the wide community.
- Deployment of social networks accounts to complement with the project portal.
- Delivery of video interviews and magazine articles for promoting the project vision, concept and initial results.
- Issuing of a press release announcing the project kick-off.
- Preparing a first project leaflet reflecting on the project concept and first results. The aim of this poster and leaflet was to be showcased at the Mobile World Congress (MWC'20). Due to its cancelation we will upload them and make them public through the web and dissemination social channels.

Building on the momentum reached in Year 1, and the anticipated technology development including trials in Year 2, the project plans to accompany these developments with the adequate communication activities including:

- Video and a press release for the first trial scheduled in M12. Videos for subsequent trials are also to be considered.
- Video interviews and second leaflet in time for MWC 2021 in Barcelona.
- 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.

3.2. Report on Activities Undertaken and Achievements

Following the project start on October 1st, 2019, activities have been undertaken towards fulfilling the objectives set above. These are reported in Table 1, Table 2, and Table 3, respectively for activities relating to (1) project portal and social networks, (2) video interviews and blog articles, and (3) press releases and leaflets.

TABLE 1: 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 2: VIDEO INTERVIEWS AND BLOG ARTICLES.

#	Month	Description	Lead partners
1	Feb'20	Video interview provided by the Project Coordinator to Zoom NET TV show by RTVE (Public Spanish TV). To be published in Feb'20. https://www.rtve.es/alacarta/videos/zoom-net/zoom-net-5g-dive-entrevista-shou-zi-chew-dreams/5526638/	UC3M
2	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
3	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

TABLE 3: 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
11	Feb'20	Press release	https://theconversation.com/como-controlar-drones-y-robots-industriales-gracias-al-5g-130652	UC3M	The Conversation

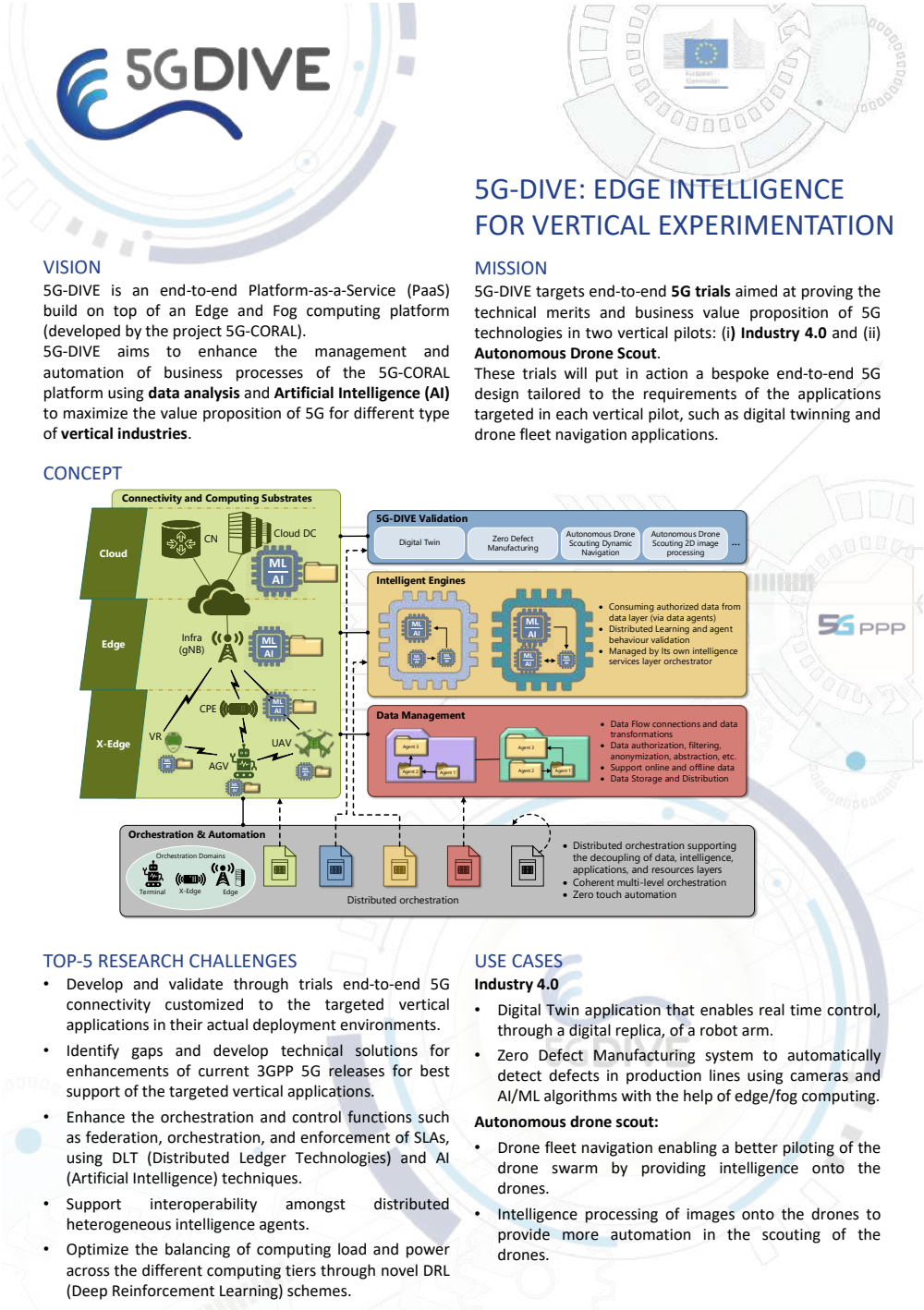


FIGURE 1: ILLUSTRATION OF THE FIRST 5G-DIVE LEAFLET.

As explained above, the objective of preparing the leaflet and poster was to showcase them at the different booths of partners at MWC'20. Due to its cancellation, we are disseminating them through the web and social channels. We will continuously update them to account for the latest developments in the project. Figure 1 shows the leaflet designed, while Figure 2 presents the first version of the poster.

5G-DIVE: Edge Intelligence for Vertical Experimentation

MISSION

5G-DIVE targets end-to-end **5G trials** aimed at proving the technical merits and business value proposition of 5G technologies in two vertical pilots: (i) **Industry 4.0** and (ii) **Autonomous Drone Scout**.
These trials will put in action a bespoke end-to-end 5G design tailored to the requirements of the applications targeted in each vertical pilot, such as digital twinning and drone fleet navigation applications.

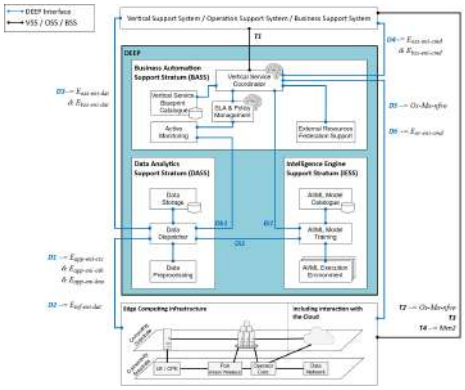
VISION

5G-DIVE is an end-to-end Platform-as-a-Service (PaaS) build on top of an Edge and Fog computing platform (developed by the project 5G-CORAL). 5G-DIVE aims to enhance the management and automation of business processes of the 5G-CORAL platform using **data analysis** and **Artificial Intelligence (AI)** to maximize the value proposition of 5G for different type of **vertical industries**.

5G-DIVE ELASTIC PLATFORM (DEEP)

5G-DIVE architecture aims at providing a higher-level of abstraction to its customers (e.g., the verticals) by providing a set of supporting strata that would enable enhanced business automation and ease the provisioning of intelligence capabilities into the vertical services. In doing so, 5G-DIVE positions itself on top of Edge Computing Infrastructures, allowing the shift from an Infrastructure-as-a-Service (IaaS) service model towards an end-to-end Platform-as-a-Service (PaaS) service model.
The above concept is materialized in a new building block called 5G-DIVE Elastic Edge Platform (DEEP), which spans as an add-on on-top of existing Edge Computing Infrastructures while underpinning vertical industries OSS/BSS systems. The DEEP building block envisions three supporting strata which offer unique capabilities tailored to the support of the vertical industries OSS/BSS systems with the goal of enhancing day-by-day operations and business processes:

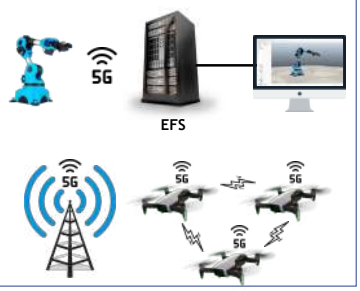
I. **Data Analytics Support Stratum (DASS):** offers the necessary support for pre-processing, storage and sharing data generated from vertical services operation which can be potentially enriched with a variegated set of context information, both from the local environment and the virtualization infrastructure.
II. **Intelligence Engine Support Stratum (IESS):** allows vertical industries to augment their applications and operations with AI techniques, including machine learning support for complex systems, event predictions, pattern recognition, anomaly detection, etc.
III. **Business Automation Support Stratum (BASS):** offers the necessary support to the vertical industries to achieve the automation of their business processes by allowing to plug their OSS/BSS systems in the platform.



5G-DIVE USE CASES

Industry 4.0:
- **Digital Twin application:** a robotic arm will be controlled remotely in real time using a digital twin located at the EFS, demonstrating the 5G performance and exploiting the low latency and computing capabilities of the Edge and Fog
- **Zero Defect Manufacturing:** real-time 4K video analysis of production lines to detect possible manufacturing defects, demonstrating the high bandwidth and low latency capabilities of 5G Fog computing environments

Autonomous Drone Scout:
- **Drone fleet navigation:** evolved navigation system that enables local processing of information and dynamic modification of the trajectory of the drones by a controller using advanced coordination mechanisms (centralized or distributed)
- **Intelligent processing of images in the Drones:** integration of drones into the 5G-DIVE platform as volatile moving resources taking benefit of the Data Analytics and Intelligence Engine strata allowing:
  - Image stitching to map a certain area automatically with the help of the Drone fleet
  - Pattern recognition of certain events such as the detection of fire in buildings or the detection of human live risks



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Project Coordinator: Dr. Antonio de la Oliva (UC3M)
Technical Managers: Dr. Alain Mourad (IDCC), Dr. Maria Yuang (NCTU)

FIGURE 2: FIRST VERSION OF THE 5G-DIVE POSTER

4. Dissemination and Collaboration Activities

Dissemination and Collaboration activities were conducted in the first six months of the project in order to promote the 5G-DIVE project concepts and initial results to the international R&D community. In addition, the activities were also designed to trigger synergy with other related projects and activities. In this chapter, we present the plan we set with emphasis on Year 1 and the reports for respective achievements for dissemination and collaboration activities.

4.1. Work Plan

The high-level objectives for dissemination and collaboration activities were defined as follows:

- To raise and hasten awareness of the project vision, concept, objectives and first initial results among the R&D community. The dissemination and collaboration activities will be steered towards generating impact through peer-reviewed publications, presentations, talks, demonstrations, panels, workshops and events.
- To establish synergy links with other related projects, within the 5G-PPP program, with the aim of promoting a coherent overall 5G architecture and developing consistent technology building blocks.

From the above high-level objectives, the project has set specific and measurable goals for dissemination and collaboration activities in Year 1. These include:

- Submission of at least **12 peer-reviewed scientific articles** for publication at reputed scientific journals and conferences.
- Delivery of at least **6 presentations/talks** promoting the project vision, concept, objectives and initial results at selected R&D event, and industry summits.
- Organization of **1 workshop** event.
- Organization of **1 exhibition and/or demonstration** at flagship event or trade show.
- Presentation of **2 demonstrations** at conferences and other events.
- Execution of **2 joint activities** with other EU projects.

Moving forward, the focus in Year 2 will be more on results and trials compared to Year 1 where the focus was on project concept and initial results. In particular, for some dissemination activities that can be measured, we aim to specify target numbers to achieve in Year 2 similar to what we have done in Year 1. These numbers in Year 2 account for the results achieved in Year 1 and for any scheduled activity in Year 2 that was prepared in Year 1 (e.g. submitted papers, scheduled talks, submitted workshop proposal, etc.). We therefore plan in Year 2 to boost the numbers targeted to talks, articles, demonstrations, and workshops such as:

- Demonstration of project proof-of-concepts at least at 1 key event 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.
- Presentation of 4 demonstrations at conferences and other events.
- Organization of at least 1 workshop.

- Studying the possibility of organizing a joint workshop with 5GROWTH and a panel for GLOBECOM'20, to be held in Taipei.
- Studying the possibility of organizing a joint workshop with 5GROWTH for IEEE SDN/NFV conference, to be held in Madrid in November 2020.

4.2. Report on Activities Undertaken and Achievements

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

4.2.1. Peer-reviewed Publications

Table 4 and Table 5 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 4 peer-reviewed articles in conferences and workshops, and 2 peer-reviewed articles in journals and magazines for the first six months of the project.

TABLE 4: 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.	Telefonica
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	Accepted in February 2020 for publication in 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

TABLE 5: 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	Accepted for publication	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

4.2.2. Public Presentations

Table 6 lists all presentation activities delivered in the first six months of the project including talks and panels. As reported, 3 talks were delivered at 3 different venues.

TABLE 6: 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	Telefonica
3	Talk	November 2019	Open Workshop on “Research Activities of Mutual Interest” @ IMDEA Networks (Leganés)	5G-DIVE - eDge Intelligence for Vertical Experimentation	UC3M

4.2.3. Workshops

In the first 6 months of the project, one workshop proposal has been submitted. Latest information is that it will become an online event.

TABLE 7: WORKSHOPS ORGANIZED.

#	Event	Month	Status	Workshop	Country
1	EuCNC'20	June 20	Planned	A workshop proposal as a joint action with the following projects has been submitted: - 5G-RANGE (Brazil) - 5G-Allstar (Korea) - 5G-Enhance (Japan) - 5G-DRIVE (China) - PriMO-5G (Korea) - 5G-CONNI (Taiwan) - FASTEN EU-BR (Brazil) - Thor (Japan) - EMPOWER (EC/USA CSA)	Croatia

4.2.4. Exhibitions and Demonstrations

In the first six months of the project, 2 demonstrations have been showcased, as shown in Table 8. Due to the initial stage of the project, these demonstrations are focused on the evolution of a common 5G-CORAL/5G-DIVE use case.

TABLE 8: EXHIBITIONS AND DEMOS.

#	Type	Month	Venue	Description	Lead Partners
1	Conference	February 2020	International Conference on Embedded Wireless Systems and Networks (EWSN), Lyon, France.	Demo: Multi-Radio Access Technology IoT Gateway.	RISE, EAB
2	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

4.2.5. EU Cross-projects Collaboration Activities

During the first six months, 5G-DIVE has put an effort towards the collaboration with other EU projects as shown in Table 9. This section presents a summary of all the different activities performed in the first six months of the project.

TABLE 9: EU CROSS-PROJECTS COLLABORATION ACTIVITIES.

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

3	Submitted a Booth proposal with 5GROWTH for EuCNC'20	A join booth application has been submitted to EuCNC'20. Both projects share a component of Industry 4.0 so we believe the join booth can be a good way of exploiting similarities.

5. Standardisation roadmap and open source activities

5G-DIVE aims at maximizing the impact of its innovations on present and future standardization and industry forums in order to pave the way for commercial exploitation opportunities. This section presents first the plan for the standardization and open source activities and first achievements. The plan targets contributions to influence major global SDOs, for example 3GPP Releases 17 and 18, ETSI MEC release 3, ETSI NFV, ETSI ENI, ITU-T FG ML5G, and open source forums such as ONAP and Eclipse Edge Native WG.

To create the roadmap and to achieve bi-directional standard dissemination, the project has established a Standard Advisory Committee (SAC) with members from partners involved in the work in standardisation organizations. 5G-Dive SAC aims to formalize a process that ensures materialization of 5G-DIVE innovations into concrete actions and tangible results. The objective of the SAC is Ensure **timely** and **thorough** Standards dissemination into key SDOs to 5G-DIVE WPs and vice versa.

Figure 3 illustrates the operational model of the 5G-DIVE SAC. Standards experts and open source contributors collect information from their corresponding organizations. The WPs of 5G-DIVE are using the SAC information, for instance, when designing the 5G-DIVE architecture. As the work progresses, SAC updates WPs with latest standard activities while WPs contribute technical concepts to SAC. These technical contributions are contributed to Standards and Open Source projects as mentioned above.

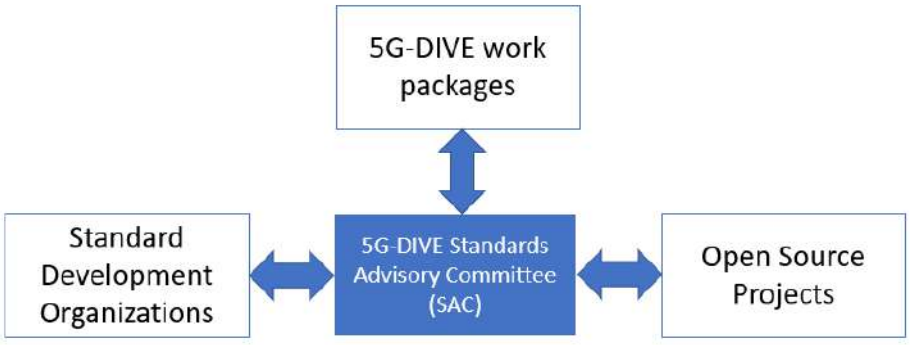

FIGURE 3: OPERATIONAL MODEL OF 5G-DIVE SAC.

The targets for the 5G-DIVE project on standard contributions is (1) 10 adopted contributions and (2) participation in at least in one open source project.

5.1. Standardization work plan

The project has set the following three objectives for the standardization activities:

1. Create and maintain a project standardization activity roadmap. This roadmap will capture the standardization activities that may influence or get influenced by the project technological innovations. It will keep track of existing or upcoming industry specifications or recommendations that may affect the project technological choices and identify opportunities for the project to contribute its proposed solutions to present and future standardization groups.

2. Disseminate the project into the standardization forums to raise awareness and help create an opportunity for standardization exploitation.
3. Contribute through the partners (individually or jointly) with project-related technology proposals into the relevant standardization forums, standardization-related workshops, panels, and summits.

The above objectives remain applicable over the whole project duration. With focus on Year 1, it is anticipated that the activities will first involve the creation of the project standardization activity roadmap. As the design of the project solutions progresses, we anticipate seeing more efforts spent on standardization dissemination and contributions.

5.2. Expected SAC impact

5G-DIVE project builds on 5G-CORAL and therefore the standardization plan departs from the baseline standardization activities and results from 5G-CORAL. 5G-DIVE targets contributions to various SDOs and Open Source projects during the lifetime of the project and after the project officially finishes, especially as partner companies continuously engage in standardization works. Figure 4 illustrates the timeline for standard impact from 5G-DIVE and 5G-CORAL. The timeline illustrates how 5G-DIVE standards and open source project impact is expected to start on Q1 2020, right after the post standard impact of 5G-CORAL impact is finished. The post 5G-DIVE open source impact is expected to continue until early 2022 and Standards impact is expected to continue to late 2022.

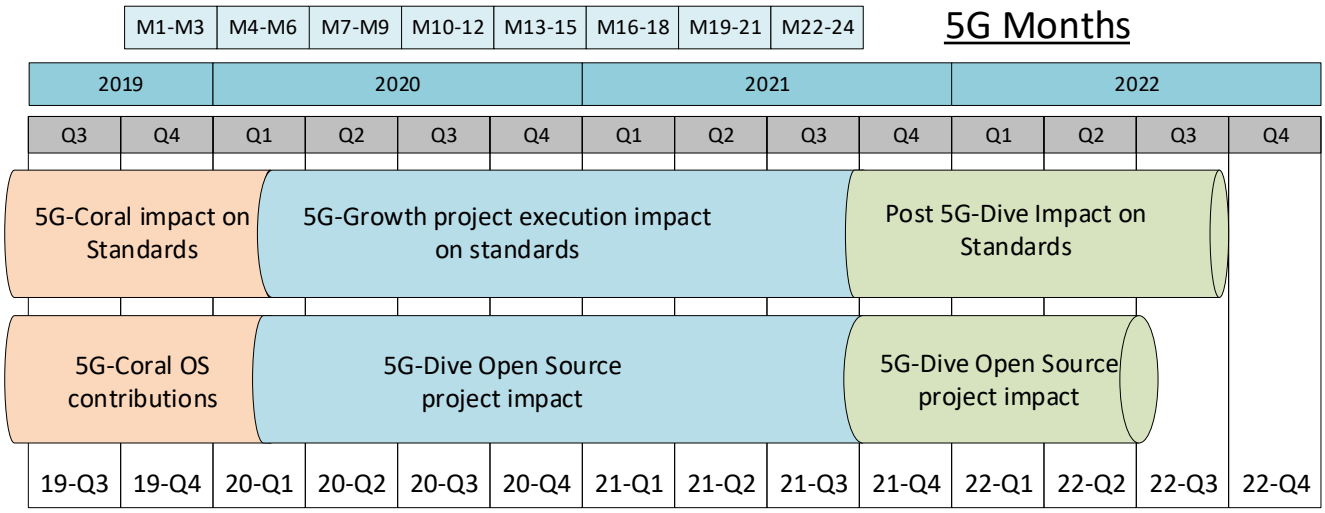

FIGURE 4: TIMELINE OF EXPECTED IMPACT TO SDOS AND OPEN SOURCE PROJECTS.

5.3. Standardization activities

This section captures SDOs and corresponding working groups and activities that are relevant to 5G-DIVE project scope. The 5G-DIVE SAC collects information from members who are participating and contributing to SDO meetings.

5.3.1. 3GPP

3GPP covers cellular telecommunications technologies, including radio access network (RAN), core network (CN) and service capabilities, which provide a complete system description for mobile telecommunications. The 3GPP specifications provide hooks for non-radio access to the core network and interworking with non-3GPP networks. 3GPP specifications and studies are contribution-driven, by member companies, in Working Groups and at the Technical Specification Group level. The three Technical Specification Groups (TSG) in 3GPP are: Radio Access Networks (RAN); Services & Systems Aspects (SA); and Core Network & Terminals (CT) [1]. 3GPP is the primary SDO in 5G-DIVE project targeting at specifications of radio access networks (RAN) and core networks (CN) of cellular communication systems. The specifications of Rel-16 is to be completed (final freeze) on the Q4 of 2020 and the Release 17 has just started. RAN plenary in approved the work plan for release 17 which is scheduled to start on May 2020 and continue until March of 2022. Several study items (SI) and working items (WI) relating to 5G-DIVE have been identified by 3GPP in SA and RAN working groups in release 17, addressing aspects such as Industrial IoT & URLLC, Enhancements on Data collection Architecture (eNA), RAN Data collection enhancements (RAN3 SON/MDT), Network Data Analytics, 5G-Lan type service, Edge Computing on 5GC, Next Generation real-time communication services.

Written contributions are submitted to 3GPP meetings by 3GPP member organizations. The meeting calendar [8] describes the schedule of the meetings. 3GPP Release cycle is typically 15 months. There are plenary sessions that approve the content of the release before the release cycle starts.

The 5G-DIVE DEEP architecture is expected to have impact on 3GPP data collection study and work items. 3GPP has been working, and is continuing the work, on data driven network optimizations since early LTE and NR releases. This work, as well as other study items that are relevant to 5G-DIVE are disseminated to the work packages.

5.3.2. IETF & IRTF

The Internet Engineering Task Force (IETF) is a large open international community of network designers, operators, vendors, and researchers concerned with the evolution of the Internet architecture and the smooth operation of the Internet. The technical work of the IETF is done in Working Groups (WG), which are organized by topic into several Areas. Much of the work is handled via mailing lists. The IETF holds meetings three times per year.

The IETF working groups are grouped into areas, and managed by Area Directors (ADs) who are members of the Internet Engineering Steering Group (IESG). Providing architectural oversight is the Internet Architecture Board, (IAB).

The Internet Research Task Force (IRTF) focuses on longer term research issues related to the Internet while the parallel organization, the Internet Engineering Task Force (IETF), focuses on the shorter term issues of engineering and standards making.

The potential innovations on IETF and IRTF associated with the 5G-DIVE are expected to be related to new orchestration approaches. Enhancements to service provisioning are in scope of the efforts in IETF about service function chaining, network management and reliable wireless.

The main working and research groups of IETF/IRTF related to 5G-DIVE are: SFC WG, ANIMA WG, DMM WG, RAW WG, DHC WG, NMRG, and COIN RG.

Contributions are made in the form of Internet-Drafts, which are submitted (typically associated to a specific WG) for anybody to read and comment. Drafts matching a given WG milestone can be asked for adoption by a WG, so the document next becomes a "product of the IETF", and typically ends up being published as an RFC. The submission window only closes for a couple of weeks before each of the 3 physical meetings that take place per year.

There are no releases in IETF and each document has their own lifetime. Each WG has milestones which are typically not scheduled for more than 1.5 years, but in practical terms, most of the documents have cycles spanning for 3-4 years from first submission (as individual document) until publication as Request For Comments (RFC). RFC is a formal document from the IETF that is the result of committee drafting and subsequent review by interested parties.

The following paragraphs describe WGs listed above and topics that will be impacted by the work executed in the 5G-DIVE project.

The **Service Function Chaining (SFC) WG** works on Informational applicability documents that show how the technology, meta-data, and associated control-plane mechanisms can be used in specific use-cases. The SFC WG may work on Informational documents that provide operational considerations. The SFC WG is relevant for 5G-DIVE because some of the fog control and mobility extensions being addressed in 5G-DIVE can be of applicability (and therefore be standardized) in SFC. Multiple contributions to the SFC WG has been made on this topic.

The **ANIMA WG** specifies Generic use cases of Autonomic Network and new GRASP extensions/options for them, including bulk transfer, DNS-SD interworking, autonomic resource management, autonomic SLA assurance, autonomic multi-tenant management, autonomic network measurement. In 5G-DIVE we are exploring some dynamic fog monitoring approaches that can be bootstrapped using GRASP extensions. A contribution has been already made to the ANIMA WG in this regard.

The **Distributed Mobility Management (DMM) WG** was originally focused to work on mobility extensions to enable distributed anchoring, as well as on maintenance of mobility protocols. It is currently analyzing whether to extend its current scope, and some of the research topics addressed by 5G-DIVE might fit in. As an example of contribution already submitted from 5G-DIVE, the Mobile IPv6 protocol might be extended to support function migration in SFC.

The **Reliable and Available Wireless (RAW) WG** has been recently chartered to work on extensions to allow using heterogeneous wireless technologies while providing some reliability and availability (similar to deterministic conditions, but of course considering the nature of wireless). Initially, this WG is looking into the use cases and the potential technologies that could be used in a solution. Some of the use cases, such as edge robotics are in scope of 5G-DIVE.

The **Dynamic Host Configuration (DHC) WG** is responsible of the maintenance and extensions of DHCP. Some mechanisms explored in 5G-DIVE might make use of DHCP, and that's why this WG is

considered relevant for the project. A contribution from the project has been already adopted as WG document.

The **Network Management Research Group (NMRG)** provides a forum for researchers to explore new technologies for the management of the Internet. In particular, the NMRG will work on solutions for problems that are not yet considered well understood enough for engineering work within the IETF. Currently AI and Intent are key topics on this WG. These are topics where 5G-DIVE might contribute, at least as a dissemination channel of our research in a venue where most of the participants come from key industries of the sector.

The **COIN proposed research group (COINRG)** will explore existing research and foster investigation of "Compute In the Network" and resultant impacts to the data plane. The goal is to investigate how to harness and to benefit from this emerging disruption to the Internet architecture to improve network and application performance as well as user experience. COIN will encourage scrutiny of research solutions that comprehend the re-imagining of the network to be a place where routing, compute, and storage blend.

COIN will address both controlled environments such as Data Center Networks (DCN) and the ongoing shift from data center (DC) toward edge computing and will debate whether this shift can be viewed as a cloud continuum. COIN specifically will focus on the evolution necessary for networking to move beyond packet interception as the basis of network computation.

Orchestration of end-to-end resources between the DC network and the edge is another key topic to address in COIN. In particular, the RG will examine orchestration with increasingly heterogeneous distributed components and draw inspiration from current approaches (e.g., Kubernetes, Swarm) that are likely to need updating, extending, and/or simplifying in multi-domain network environments. All the previous topics are definitely relevant to 5G-DIVE.

5.3.3. ETSI

ETSI is the European Telecommunication Institute, a recognized European Standards Organization dealing with telecommunications, broadcasting and other electronic communication networks and services. Most of the standardization work at ETSI is carried out in committees. Different tasks require different types of committees. Main types are:

1. Technical Committee (TC) - addressing a number of standardization activities in a specific technology area.
2. ETSI Project (EP) – similar to a Technical Committee but established for a fixed period of time.
3. ETSI Partnership Project – established when there is a need to co-operate with other organizations to achieve a standardization goal. 3GPP is one of them.
4. Industry Specification Group (ISG) – operating alongside the traditional standards-making mechanisms and focusing on a very specific activity.

The committees typically meet between two and six times a year, either on ETSI premises or on other locations. ETSI members will decide what work to be done by each committee, establishing and maintaining a work program which is made up of individual items of work.

For 5G-DIVE project, there are opportunities to demonstrate and validate proposed standards, and to contribute project results to them. Four ETSI ISGs (all focused on *network transformation*) are directly related to 5G-DIVE:

a) NFV, on network function virtualization.

b) MEC, on edge computing.

c) ENI (Experiential Networked Intelligence), on AI-enabled network management.

d) ZSM, on network service automation.

Contributions to the individual groups are prepared as documents, including the requested changes to the current version of the draft work-item results. The contributions are discussed in online or F2F meetings and the contributions comply with ETSI IPR rules.

Each ISG is appointed for a limited period, requiring explicit renewal:

a) NFV is in its fourth two-year cycle

    1. Starting its Release 4 (cloud nativeness), after releases 1 (feasibility), 2 (interoperability), and 3 (operationalization).

    2. An additional cycle is expected.

b) MEC is in its third two-year cycle

    1. Essential concepts an architecture consolidated. Evolution towards cloud nativeness.

    2. Not clear if a further cycle will be required.

c) ENI is in its second two-year cycle

    1. Essential concepts and architecture produced. Now focused on data and action interoperability.

    2. A further cycle is feasible.

d) The second ZSM two-year cycle just approved

    1. Essential concepts and architecture being finished. Convergence with the other ISGs above.

    2. A further cycle is almost assured.

In addition to ETSI NFV as the main pillar for network virtualization technologies, 5G-DIVE solution includes aspects relating to Multi-Access Edge Computing (MEC) and Experiential Networked Intelligence (ENI). ETSI MEC ISG is heading towards its Release 3 and ENI is defining the framework for Artificial Intelligence to complement MEC and NFV. ETSI has also recently started a new standardization group called Permissioned Distributed Ledgers (PDL) to address the adoption of

blockchain technologies in the telecommunication industry, initially focusing on business use cases, architectures, interfaces and data models.

5.3.4. IEEE

IEEE covers a number of standards. IEEE 802 covers only LAN/MAN standards, for instance, IEEE 802.11 (Wifi) or IEEE 802.3 (Ethernet). As organization it is structured in working groups (such as .11) that have task groups (such as .11ax). Each standard passes a set of ballots: Task, WG, Sponsor ballot.

It is believed that there are two possible activities relevant to 5G-DIVE, namely 1) IEEE 802.1 in deterministic networking and its profile for industrial networks, and 2) IEEE 802.11 as a radio network. IEEE contributions are individual contributions discussed in the standardization meetings and voted. IEEE standards typically have a development period of 4 years. For IEEE 802.11be which is the next big thing, it is expected for 2023. IEEE 802.1 is a faster group, releasing smaller standards in a shorter period. With respect to the 5G-DIVE, companies are disseminating results of 5G-DIVE into 802.1 and 802.11 groups.

5.3.5. ITU-T

ITU is the ONU specialized agency for ICT. The Study Groups (SG) of ITU's Telecommunication Standardization Sector (ITU-T) assemble experts from around the world to develop international standards known as Recommendations.

ITU-T is especially influential in the standardization of the transport network architecture and the specification of the underlying network nodes, systems and technologies. Thus, it is relevant to all 5G-DIVE use cases needing eMBB and URLLC, to update the standard when the current technology cannot deal with the required performance. Focus Group Technologies for Network 2030 (FG NET-2030) and G.ctn5g, within Study Groups 13 and 1, respectively. Contributions can be submitted only by ITU-T members. They are discussed in periodic meetings (approx. every 3-6 months). Their approval is consensus based.

SG13: Future networks, with focus on IMT-2020, cloud computing and trusted network infrastructure

Functional requirements and architectures for networks supporting content delivery in IPTV, identity management, sensor networks/RFIDs, and open services and platforms for service integration and delivery. Continuing work focuses on cloud computing, ubiquitous networking, distributed service networking, ad-hoc networks, network virtualization, software-defined networking, the Internet of Things, and energy saving networks – all underscoring future networks, mobile and NGN.

Focus Group Technologies for Network 2030 (**FG NET-2030**) was established SG13 in July 2018. Focus is on networks performing extremely fast response in critical situations and high-precision communication demands of emerging market verticals.

SG15: Networks, Technologies and Infrastructures for Transport, Access and Home

Standards for the optical transport network, access network, home network and power utility network infrastructures, systems, equipment, optical fibers and cables and the related installation, maintenance,

management, test, instrumentation and measurement techniques, and control plane technologies to enable the evolution toward intelligent transport networks, including the support of smart-grid applications. Special consideration is being given to the changing telecommunication environment towards packet networks as part of the evolving next-generation (NGN) and future (FN) networks, Characteristics of transport networks to support IMT-2020/5G

ITU-T G.ctn5G: including networks supporting the evolving needs of mobile communications (IMT-2020).

ITU-T works over study periods which last four years. The current study period is 2017-2020. The full work programs of SG13 and SG15 for the current study period can be found at references [5] and [6].

5G-DIVE is poised to take early inputs on the ITU-R evaluation and recommendation of the 5G global specifications (due in Q1'2020), which will help the project tune its choice of 5G technologies to the performance insights and recommendations from ITRU-R WP5D.

In addition, there are already focus-group activities in ITU-T, such as ITU-T FG ML5G (Machine Learning for 5G and Beyond) and ITU-T FG NET2030 (Networks 2030) who are exploring the next steps beyond 2020 for 5G and its evolution until 2030. The FG ML5G intends to specify the architectural framework for ML in future networks. To this end, the recommendation Y.3172 introduces key components, including the ML pipeline, the ML management and orchestration as well as guidelines to integrate such blocks into future networks and in a range of technology-specific underlying networks. These groups are quite relevant to 5G-DIVE in order to share our findings and remaining challenges, as well as pave the way for the long-term evolution of 5G and its wide suite of technologies including 3GPP and non-3GPP technologies.

5.3.6. ORAN Alliance

O-RAN Alliance [3] is an operator-driven organization established in 2018 (merger of CRAN Alliance and xRAN Forum), where mobile operators are the members and HW/SW vendors are contributors. The focus of O-RAN is on the RAN part of the mobile network, aiming to evolve RANs to be more open and intelligent through defining an O-RAN reference architecture promoting RAN virtualization and big data enabled RAN intelligence, specifying open and interoperable interfaces, and providing reference designs with opensource SW and HW.

Figure 5 shows the O-RAN reference architecture [4]. A1 and E2 interfaces are O-RAN specific interfaces to support of the hierarchical RAN Intelligent Controller (RIC), which is composed by two decoupled layers, i.e. Non-Real-Time (Non-RT) RIC and Near-Real-Time (Near-RT) RIC. Non-RT RIC provides >1s control while Near-Real-Time works on the time scale of 10ms-1s. Open fronthaul interface is another O-RAN specific interface specifying an O-RAN LLS (lower layer split) fronthaul interface between O-RU and O-DU to make them multi-vendor interoperable. Other interfaces like F1, E1 etc. are 3GPP specified interfaces. O-RAN will profile them for openness and multi-vendor interoperability. RAN virtualization and cloudification is another fundamental principle of O-RAN. Relevant opensource SW frameworks like OPNFV, ONAP, Akraino, K8S, OpenStack, QEMU will be leveraged and verified. More details regarding O-RAN reference architecture can be found in [4].

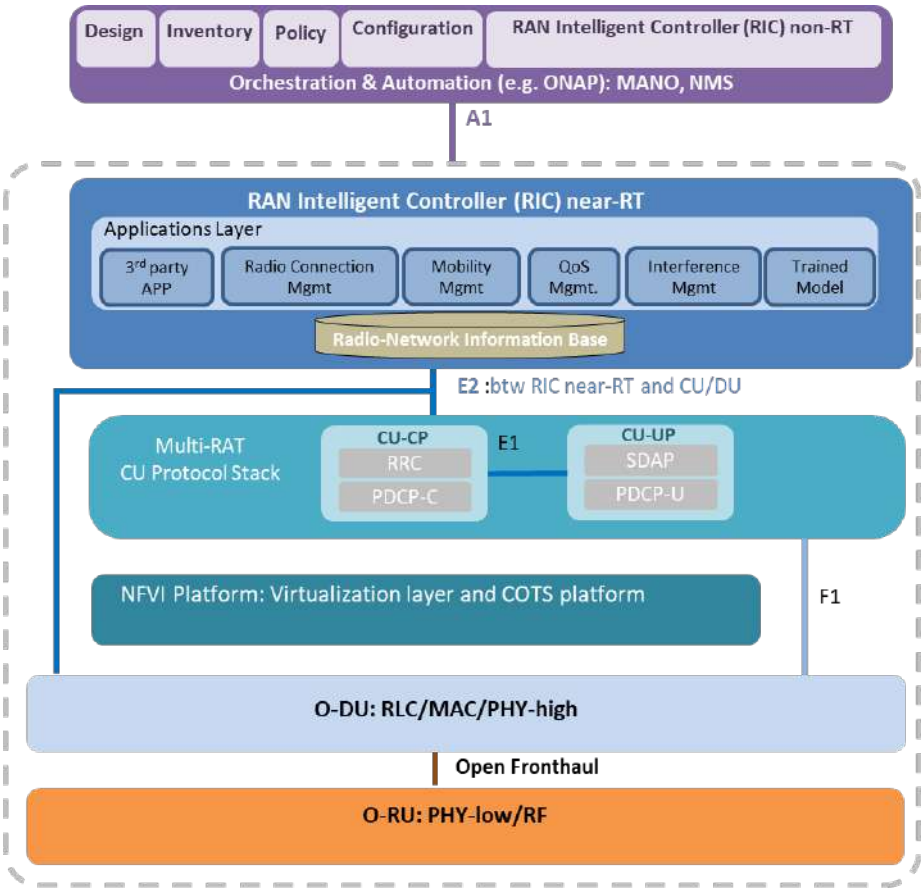

FIGURE 5: O-RAN REFERENCE ARCHITECTURE.

Currently, there are 9 work groups: WG1 - Use Cases and Overall Architecture, WG2 - Non-RT RIC and A1 Interface, WG3 - Near-RT RIC and E2 Interface, WG4 - Open Fronthaul Interfaces, WG5 - Open F1/W1/E1/X2/Xn Interface, WG6 - Cloudification and Orchestration, WG7 - White-box Hardware, WG8 - Stack Reference Design, and WG9 - Open X-haul Transport.

5G-DIVE project shares the same principles on virtualization and intelligence (data-driven and AI), as embraced by O-RAN. Although 5G-DIVE focuses more on the intelligent vertical applications at the Edge leveraging 5G connectivity, rather than on 5G RAN itself, the O-RAN architecture and works in some work groups serve as good references to 5G-DIVE, especially the work regarding the hierarchical RIC design in WG2 and WG3, and the work regarding cloudification and orchestration in WG6. In addition, one use case in 5G-DIVE called massive MTC regarding cloudification and orchestration of massive MTC RAN functions is quite related to O-RAN, though the current focus of O-RAN is not on massive MTC.

5.3.7. GSMA's Operator Platform concept

Very recently (January 2020) the GSMA has released a White Paper [7] describing the concept of Operator Platform. Basically, the objective is to aggregate edge capabilities from different operators, in a federated manner.

The architecture consists of a common exposure and capability framework, including federation interfaces towards other operators. A number of APIs can be assumed:

- Northbound APIs, for service management and fulfillment.
- East-West APIs, for exchange information with other operators when extending operator footprint.
- Southbound APIs, for connecting to the specific operator infrastructure.
- User-Network Interface (UNI) API, to communicate the final users to the operator platform.

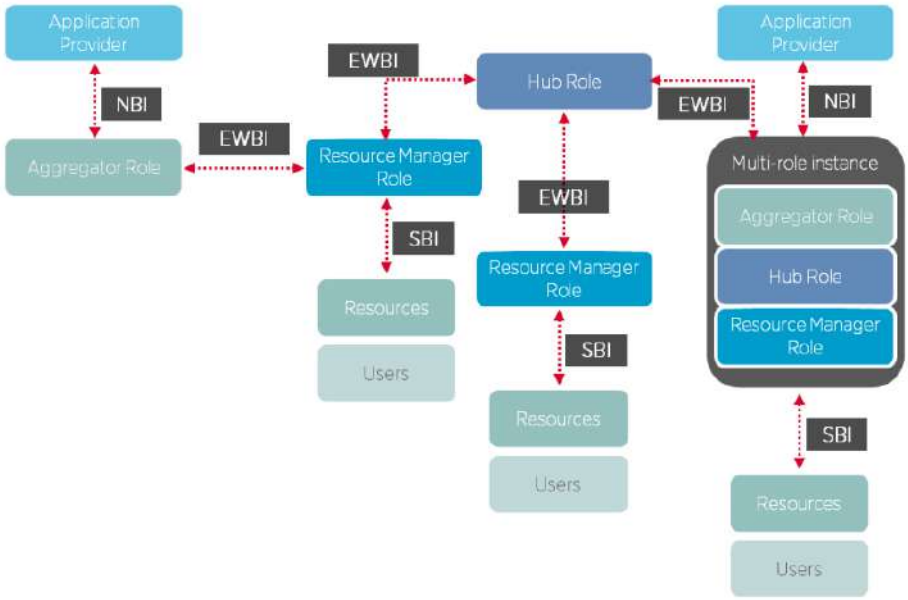

FIGURE 6: FEDERATION OF OPERATOR PLATFORM ACTORS

Regarding the federation roles possible in the Operator Platform, the following are identified, as described in Figure 6:

- Application provider, which is the owner of the application to be developed on top of the Operator Platform
- Aggregator, who maintains the relationship with the application provider, aggregating capabilities from different operators.
- Operator, who retains the ownership of the network and service capabilities.
- Hub, as entity for abstracting of the connections of multiple operators and aggregators
- End user, being the final consumer of the application deployed on top of the Operator Platform.

This approach to federate edge infrastructures from different operators seems relevant to 5G-DIVE since will allow to integrate environments from different owners as well as enabling mechanisms for interact and operate together. It is envisioned that 5G-DIVE architectural assets could leverage on the Operator Platform for broadening the reach of the providers. Since this initiative is quite new, it is yet soon to investigate such potential interactions. It is expected to explore it during the project lifetime.

5.4. Standardization Activity Roadmap

To create the project standardization activity roadmap, the Standards Advisory Committee has followed the two steps below:

1) Map the project technology development areas onto the standardization activities.

2) Align the 5G-DIVE SAC with 5GPPP pre-standardization activities and disseminate the activities from relevant 5GPPP projects to 5G-DIVE.

The above two steps are presented in the following sub-sections. First subsection is classifying the standardization activities to technical innovations of 5G-DIVE project and the second section is visualizing the timeline of main standards entities towards 2022. The third section is describing the collaboration with 5GPPP pre-standards working group.

5.4.1. Classification and mapping of standardization activities

Based on the standardization activities identified above, a classification of the standardization activities per technology development area (or topic) in the project is first attempted. This is shown in Table 10.

The table describes initial key innovations of this projects and potential mappings to standardization groups. One purpose of this mapping is to provide a loose coupling between SDOs and key innovations of this project. The SAC does not expect that there will be standard contributions to each of the key innovations of the project as some of the key innovations are out of the scope of most of the standards. However, this table provides a view of which of the SDOs or Open Source projects are working on topics that 5G-DIVE considers as key innovations. The Table 10 together with Table 11 describe which working groups in the SDOs are relevant to WPs of the 5G-DIVE.

TABLE 10: MAPPING OF TECHNOLOGY AREA TO SDOS.

#	Key Technology development area of the project	Standardization groups
1	Customized configuration and deployment of 5G NR and 5G Core for the I.40 and ADS use cases	3GPP, ORAN
2	5G new radio (NR) based access to unlicensed spectrum.	3GPP
3	Integrated access and backhaul for 5G new radio (NR).	3GPP
4	Mission critical services over 5G.	3GPP, IETF
5	5G positioning services.	3GPP
6	Design of Services, Functions and Applications for I4.0 and ADS use cases	IEEE, 3GPP, IETF
7	Design the Data Analytics Service within the EFS	IEEE, 3GPP
8	Technologies to support ultra-low latency edge and fog computing systems	IEEE, 3GPP, IETF
9	Orchestration of high mobility volatile resources	ENI, IETF
10	Cloud native design of massive MTC RAN functions and resource orchestration	O-RAN

TABLE 11: SDO WORKING GROUPS RELEVANT TO 5G-DIVE.

SDO	Working Groups	Working Topics
ETSI ENI	NFV, MEC, ENI, ZSM	• Data ingestion and Data Normalization • Knowledge Management and Processing • Situation-based Policy Generation • De-normalization and Output Generation
3GPP	SA2, RAN2, RAN3	Enhancements to Network Analytics Phase 2 SON – MDT
ITU-T	ML5G	• MLFO • ML Sandbox • ML Pipeline (Collector) • ML Pipeline (Pre-processor) • ML Pipeline (Model) • ML Pipeline (Policy) • ML Pipeline (Distributor) • ML Marketplace
ORAN	WG2, WG3, WG6	• WG2: RAN Intelligent Controller (RIC) non-Real Time (Non-RT) • WG3: RAN Intelligent Controller (RIC) near-Real Time (Near-RT): • WG6: Cloudification and Orchestration
IETF	SFC WG, ANIMA WG, DMM WG, RAW WG, NMRG, COIN RG	• Service Function Chaining control • Function migration and orchestration in fog environments • Pseudo-deterministic behaviour in wireless networks • Dynamic discovery and advertisement of resources in edge/fog networks
IEEE	IEEE 802.1, IEEE 802.11	IEEE 802.1 in deterministic networking and its profile for industrial networks, and IEEE 802.11 as a radio network.

5.4.2. 5G-DIVE Standardization timeline

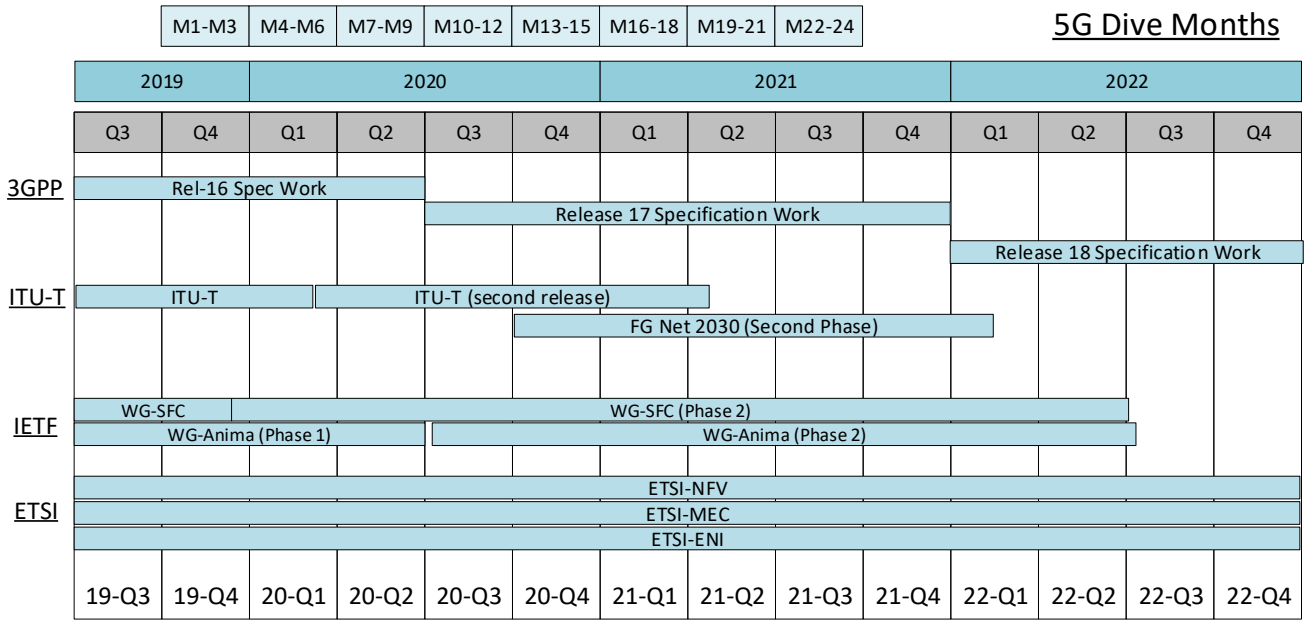

FIGURE 7: TIMELINE OF THE MAIN SDOS OF 5G-DIVE.

5.5. Open Source activities

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

5.5.1. 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

5.5.2. ONAP

Open Network Automation Platform (ONAP) is an open-source project for the development of a general network automation platform. It is formed from the convergence of two previous open source projects: ECOMP and Open-O and it is hosted by the Linux Foundation Networking Initiative

ONAP is the reference architecture and implementation for several network automation modules and it is supported by a significant number of operators and vendors. One of the major benefits of ONAP is that it has a large developer community. Most relevant modules on ONAP are orchestration and control integration, data collection. Contributions are made as source code or other type of documents or data. Each contributor is required to provide an acknowledged contribution agreement (Apache 2.0 License).

ONAP project releases a new version of the software every six months. Each major release is named after a city, in alphabetical order: (Amsterdam, Beijing …) Current version is ONAP Dublin. 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

5.5.3. Eclipse Edge Native WG

On December 10, 2019, the Eclipse Foundation announced the launch of the Edge Native Working Group, a vendor-neutral and code-first industry collaboration that will drive the evolution and broad adoption of open source software for edge computing. With edge computing code from the foundation already deployed in production environments, the Edge Native Working Group is focused on the near-term creation of an end-to-end software stack that will support deployments of today's most transformative technologies, including the Internet of Things (IoT), Artificial Intelligence (AI), autonomous vehicles, and more. Founding members of the Edge Native Working Group include ADLINK, Bosch, Edgeworx, Eurotech, Huawei, Intel, Kynetics, and Siemens. [2]

The working group's purview will encompass the two flagship projects currently at the Eclipse Foundation including Eclipse ioFog [9] and Eclipse fog05 [10]. In addition to the code that the Eclipse Foundation has already released, the Edge Native Working Group will focus on the development of various layers of software at the network edge that will enable others to build customized applications for their own specific implementations. This includes applications for retail, carrier environments, 5G, IoT, and Industry 4.0 or smart manufacturing deployments. Regardless of the applications needed, the Edge Native Working Group will help to solve the challenges endemic to edge computing; a heterogenous hardware landscape, low bandwidth, latency, limited power, and security.

Another project proposal that has been recently approved to be part of the Eclipse Edge Native Working Group is the Eclipse zenoh [11] project. 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.

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. The Eclipse fog05 is a main part of the 5G-DIVE's Edge and Fog System (EFS) and the orchestration and control system (OCS) components. It provides a decentralized infrastructure that unifies computing, networking and storage fabrics end-to-end, while addressing the challenges imposed by resource heterogeneity. The Eclipse zenoh is a main part 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.

5.6. Standard Contributions

Table 12 collects standard contributions associated with 5G-DIVE project.

TABLE 12: 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	UC3M
7	Mar'20	IETF	DHC	SLAP quadrant selection options for DHCPv6	CJ. Bernardos; A. Mourad	draft-ietf-dhc-slap-quadrant-05.txt	ID-Exists	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 Cases in Fog RAN	CJ. Bernardos, A. Rahman, A. Mourad	draft-bernardos-sfc-fog-ran-07	ID-Exists	UC3M, IDCC
10	Mar'20	IETF	SFC	Distributed SFC control operation	CJ. Bernardos, A. Mourad	draft-bernardos-sfc-distributed-control-operation-00	Experimental	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	Experimental	UC3M, IDCC
12	Mar'20	IETF	DMM	SFC function mobility with Mobile IPv6	CJ. Bernardos, A. Mourad	draft-bernardos-dmm-sfc-mobility-00	Experimental	UC3M, IDCC

6. Exploitation activities

This section is a preliminary plan for exploitation of project results that will be elaborated in Deliverable 4.2. 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. Partner-specific exploitation plans are presented here as starting points.

6.1. Work plan

The work plan for Year 1 includes activities relating to all aspects of the exploitation strategy as follows:

- Identify the commercial opportunities in the prototype systems and their components implemented for the field trials;
- Identify innovations as they emerge from the technology development undertaken by the technical work packages (WP1/WP2/WP3) and assess their suitability for patenting;
- Map these innovations onto identified products and services, existing as well as new, of industrial stakeholders with the per-partner exploitation plans as a starting point; and,
- Promote the exploitation of these innovations by the various stakeholders, including through the arrangement of an exploitation workshop towards the end of the project.

In view of the high importance given by the project to the exploitation activities, the project has appointed an Innovation Manager (Dr. Chenguang Lu from Ericsson) to lead the work and ensure successful exploitation of the innovations from the project.

6.2. Partner-specific exploitation plans

A platform such as 5G-DIVE is broad enough to involve all the classical stakeholders of the ICT domain. Vertical industries are important in this project, in which vertical players will integrate their products in the trial testbed, experiment and perform field trials to validate their product portfolio with 5G technologies. It can influence operators and vendors to supply the necessary equipment and services to meet their requirements if there is a gap identified. Operators are involved in all facets of the project, mainly working in concepts such as multi-domain orchestration and slicing, including innovative technologies such as, closed-loop automation and SLA modelling. Moreover, vendors and service providers interest in this project relies in the possibility of learning new requirements from verticals to further develop their current product portfolio. All vendors and service providers are interested in both 5G-DIVE main architecture components, EFS/OCS evolution and DEEP, allowing them to integrate and validate current products and services for vertical applications, in order to feed their own business and development units. SME's are also stakeholders of the project, which foresee exploitation of 5G-DIVE results in their own innovative internal products and services, including some open-source projects, such as Zenoh and fog05. Finally, the academic stakeholder pursues to gain the knowledge on the new technologies to educate new students in the area, improve their knowledge, and transfer the knowledge to the industry or operators and ultimately create new spin-offs. The following paragraphs present the exploitation plans of the 5G-DIVE partners as a starting point for identifying innovations and commercial opportunities.

6.2.1. ADLINK

ADLINK's role in 5G-DIVE is two-fold, on the one hand, it takes the role of vertical industry in the manufacturing sector, aiming at evaluating the possibilities of 5G connectivity on its manufacturing plants. On the other hand, it is also a large vendor with interests in the Fog area. In the short to medium term, ADLINK is mostly interested in the Digital Twin application as a way of reducing downtime on its production plants. On the long term, the application of AI to Fog devices is interesting to ADLINK as a new world of products may result from this initiative, following the path of AI applied to mobile handsets.

ADLINK's exploitation plan in 5G-DIVE is aim at advancing the state-of-the-art in Fog and Edge platforms as well as establishing and Open Source ecosystem for edge-related technologies. ADLINK believe that for IIoT to happen we need open, inter-operable and vendor-neutral technology stacks that were designed ground up to address the needs characteristic of IIoT. The availability of this open technology ecosystem is essential to the adoption and growth of edge computing and IIoT in general. ADLINK as a vendor of Edge Technologies will leverage these open platforms in our hardware as well as in vertical solutions. Specifically, our activities in the contexts of 5G-DIVE are resulting in the following contributions:

- Development of the Eclipse Zenoh: a data-centric protocol that unifies data in motion, data in-use, data at rest and computations. It carefully blends traditional pub/sub with geo-distributed storages, queries and computations. It provides data-sharing between any kind of device including those constrained with respect to the node resources, such as computational resources and power, as well as the network.
- Continue the development of Eclipse fogØ5, an open source project that aims at providing a decentralized infrastructure for provisioning and managing compute, storage, and communication and I/O resources available anywhere across the network. Eclipse fog05 addresses highly heterogeneous systems even those with extremely resource-constrained nodes.

6.2.2. InterDigital

InterDigital is pursuing actively potential exploitation of the wireless and edge technology under development in 5G-DIVE through i) technology adoption in standards primarily 3GPP, IETF and ETSI MEC ISG, and ii) test-bed platform for Industry 4.0 verticals. Specifically, InterDigital has already developed a proof-of-concept platform that combines edge and 5G for I4.0 use case, supported with intelligence for object recognition and further augmentation of sensing (LiDAR) data. This platform was intended for showcase at MWC'20 (now cancelled). Videos of the platform capabilities have alternatively been taken. The platform continues to be progressed jointly with AAU linked third party, and plans are being drawn to showcase at future events later this year.

In addition, InterDigital, as SAC leader, is actively following and contributing to 3GPP, IETF and ETSI MEC, noticeably in features relevant to 5G-DIVE such as 3GPP eNA (Enhanced Network Analytics), eNPN (Enhanced Non-Public Networks), eNS (Enhanced Network Slicing), and IETF SFC (Service

Function Chaining) and IETF DMM (Distributed Mobility Management), and Release-3 of ETSI MEC including moving host.

The I4.0 test bed platform and the above standardization activities are the pillars of InterDigital's exploitation plan in 5G-DIVE.

6.2.3. EAB

Ericsson is the market leader in 3G, 4G and 5G mobile technologies. In 5G-DIVE so far up to month 6, the first 5G lab setup for 5G-DIVE project with Ericsson 5G equipment and commercial 5G UEs have been established at Ericsson premise. The current focus in Year 1 is to perform extensive lab tests, measuring 5G network performance (e.g. throughput and latency) with different system configurations in 5G RAN and Core, as well as the UEs. These measurements would give insights into how well 5G can fulfil the requirements of vertical use cases, e.g. Industry 4.0 use cases specified in 5G-DIVE deliverable of D1.1 [1]. These results will be first presented and shared within Ericsson for discussions on the possibilities for further improvements and seeking the opportunities to contribute to improve Ericsson products and solutions for vertical use cases. Analyzing the measurement results properly may also help Ericsson in its standardization work, e.g. in 3GPP. The results and findings will be also shared with 5G-DIVE partners to assist the PoC designs with right assumptions about 5G performances. This would lead to a more optimized design for the final 5G-DIVE trials.

Another ongoing work in 5G-DIVE is the development of the technologies and the PoC testbed for massive MTC use case in Industry 4.0. The main idea is to apply the new paradigm of Cloud-native design to re-design the virtualized IoT communication stacks and design an orchestrator for efficient resource scaling and service automation, to address the scalability challenges in the future when trillions of devices will be connected to the IoT networks. For Year 1, the focus is on design and implementation work to develop the first working PoC prototype. We plan to use the first results for internal technology transfer activities starting early discussions with relevant R&D organizations and standardization teams. It is also planned to seek opportunities to publish the results in conferences and journals.

6.2.4. TID

TID will apply the experience gained in the execution of the 5G-DIVE project to contribute to the definition of 5G services and complementary tools for and intelligent management of those services when considering scarce resources on edge and fog infrastructures, even potentially from third parties. It is expected to derive from 5G-DIVE a better and direct understanding of vertical requirements, especially the ones represented in the project with the Industry 4.0 and the drones, and how they can be addressed considering the constrained edge environments.

5G-DIVE is expected to provide Telefonica with the technology base and experience for the design and development of specific 5G products and services for the commercial market. Furthermore, we foresee a direct enhancement of the 5TONIC experimentation and demonstration capabilities (lab fostered by Telefonica), consolidating its position as a global reference for the evolution of 5G globally, and, in particular, for Telefonica Group. All the experience in 5G-DIVE will be disseminated internally to

Telefonica operations and business units, opening a bidirectional channel with the project in this respect, and providing feedback in both directions.

6.2.5. FET

In 5G-DIVE project, FET has to fulfill the previous agreement to provide available radio spectrum (2600MHz) for this 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.

6.2.6. TELCA

As an advanced network service virtualization SME, Telcaria will benefit from the technology advances generated from the 5G-DIVE project. Telcaria will acquire the know-how for applying 5G-DIVE technologic achievements to rapid prototyping, design, validation, and direct deployment of AI and business automation technologies. The main areas in which Telcaria foresees exploitation potential of 5G-DIVE is in the experience gained from the development of the Intelligence engine support stratum, so in a near future, Telcaria will be capable of adapting and integrating these technologies inside enterprise network solutions, across all their domains. Likewise, from a management point of view, the experience and results obtained from the development of the Business automation support stratum will improve Telcaria expertise in the operation and lifecycle management of edge and cloud solutions. Overall enhancing Telcaria AI, orchestration and automation knowledge which will directly impact on the development and commercialization of a unified SD-WAN platform.

6.2.7. ASKEY

ASKEY aims at exploiting in the short term the project results by providing the UAV platform to verify the benefits of using 5G connectivity for the drone control. In the long term, ASKEY is interested on seeking how to apply its 5G connectivity technology for more drone applications in all verticals, especially drone usages in public safety, logistics, building inspections, etc.

In the project, ASKEY will do offering and testing its 5G CPE and gNB with the integration of its partner's drone product portfolio in demonstrating a drone fleet used in a public safety scenario with MEC and AI technologies. With demonstrations, it aims to show Askey is able to position itself as being a total solution even a service provider. Among other exploitation paths in the project, ASKEY is not only interested in validating the 5G CPE and gNB connectivity for the all drone use cases in 5G environment, but also in researching more topics such as how to integrate V2V (Drone-to-Drone) technology into drone fleet usage, how to integrate AI technology onto the drone, etc.

6.2.8. Academic partners – UC3M, RISE, NCTU, ITRI and III

In general, the exploitation plans for the academic partners include technology transfer to large and small (SME) industrial partners, showcasing as part of testbeds, creating spin-off companies, open-source software, patents and engaging in standardization.

7. Conclusions

A comprehensive communication, dissemination and exploitation plan (CoDEP) for the 5G-DIVE project has been defined, including standardisation activities with a roadmap. This deliverable is a plan for fulfilling the project's overall Objective 4 to disseminate and contribute project results into international research and innovation venues to pave the way for their successful exploitation.

Communication and public activities have been planned using many channels, for example, a project portal web site, social network accounts and press releases. Furthermore, video interviews, magazine articles, leaflets and posters are used to promote the project vision and initial results.

The dissemination and collaboration activities focus on professional communities, scientific as well as industrial. The activities range from scientific publication to demonstration and interaction with other EU projects.

The plan for standardisation activities covers seven standardisation organisations (SDOs), and for each, identifies specific working groups, technical committees, study groups, etc, relevant for the project, and where project members have the possibility to provide input, directly or indirectly. A roadmap is defined mapping project development to standardisation activities and relating the progress of the project with the timeline of some major SDOs.

The plan for dissemination through open source software (OSS) includes three OSS projects, of which project members have a leading role in one.

The plans for communication, dissemination and exploitation defined in this deliverable will be updated and refined for Deliverable 4.2. D4.2 will otherwise focus on first year achievements and progress towards the dissemination goals set in this plan.

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