H2020 5Growth Project
Grant No. 856709

D5.1: Initial Communication, Dissemination, and Exploitation Plan (CoDEP) draft including Standardization roadmap

Abstract

This deliverable presents the communication, dissemination, and exploitation plan (CoDEP) of 5Growth. The list of activities under each part of the plan is provided as well as the targeted metrics. Standardization deserves substantial attention in this document, in which the initial standardization roadmap is introduced, including the identification of relevant standard development organizations and relevant open source projects. It also reflects the involvement of verticals in standardization and in the CoDEP as a whole. Early achievements in some of the activities are also listed.

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Disclaimer

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List of Acronyms

Acronym	Description
3GPP	Third Generation Partnership Project
5G NR	5G New Radio
5G PPP	5G Public Private Partnership
AI	Artificial Intelligence
ANIMA	Autonomic Networking Integrated Model and Approach
API	Application Programming Interface
CoDEP	Communication, dissemination, and exploitation plan
DMM	Distributed Mobility Management
E2E	End-to-end
eMBB	Enhanced Mobile Broadband
ETSI	European Telecommunications Standards Institute
ICT	Information and Communication Technology
IDSA	International Data Spaces Association
IEEE	Institute of Electronics and Electrical Engineering
IETF	Internet Engineering Task Force
IMT	International Mobile Telecommunications
IoT	Internet of Things
IP	Internet Protocol
IPR	Intellectual Property Rights
IRTF	Internet Research Task Force
ITU-T	International Telecommunications Union – Telecommunications standardization sector
MEC	Multi-Access Edge Computing
NMRG	Network Management Research Group
NDA	Non-disclosure Agreement
NFV	Network Functions Virtualization
ONAP	Open Network Automation Platform
ONOS	Open Network Operating System
OPNFV	Open Platform for NFV
O-RAN	Operator Defined Next Generation RAN
OSM	Open Source MANO
SDN	Software Defined Networks
SDO	Standard Development Organization
SD-WAN	Software-Defined networking in a Wide Area Network
SME	Small and medium-sized enterprise
TSG	Technical Specification Groups
V2X	Vehicle-to-everything
WG	Working Group

Executive Summary

The main contributions of this document are:

- Presentation of the communication, dissemination, and exploitation plan (CoDEP).
- Presentation of the early achievements according to this plan.

The 5Growth CoDEP includes communication, dissemination, and exploitation activities. *Communication* includes all the activities related with the promotion of the project and its results beyond the projects own community. This includes explaining its research in a way that is understood by the non-specialist, e.g. the media and the public. *Dissemination* includes activities related with raising awareness of its results in a technical community working on the same research field. In general, this will be done through publications, and participation and organization of technical events. Finally, *exploitation* (in accordance with the European IPR Helpdesk) covers activities aiming at using the results in further research activities other than those covered by the project, such as developing, creating and marketing products or processes, creating and providing a service, or standardization activities. Particular emphasis is given to standardization in this deliverable; the initial roadmap defined is also presented.

The CoDEP plan (see Figure 1 for a complete scheme) started at the proposal stage with the NDA signature and the identification of the various components of the project that could have an impact not only from a research point of view, but also from an exploitation point of view. Once the grant was awarded, the grant preparation phase, through the consortium agreement, served to define governance rules, including innovation management, IPR ownership rules, and establishment of access rights, among others.

After that, and from project start, it is structured in various phases. During the *Raise Awareness* phase, at the initial stages of the project, the focus is on communication (e.g., setting up the web portal and social media accounts and high-level project presentations) to make the project known not just to the technical community but to a larger audience outside the project topics including the public. Dissemination and standardization activities also start in this phase with preliminary technical ideas. In the *Presentation of Results* phase, dissemination and exploitation activities increase their intensity, since the architecture and integration efforts will have produced meaningful results. Initial demonstrations of specific concepts of the architecture are also expected during this phase. However, it is in the *Integrated Technical Demonstration* phase where demonstration activities involving multiple blocks of the architecture working in an integrated way are expected.

Finally, in the *Long-lasting Impact* phase the projects to generate an impact to other research or exploitation actions taken once the project is finished. This includes, shaping the topics and framework of future research projects, exploiting 5Growth concepts in a market-oriented way by incorporating them in products and services, and leaving the 5Growth footprint in standards that include project contributions.

The plan not only defines the various activities undertaken, but it also defines target metrics for them.

In accordance with the plan, some early results have already been produced. Some highlights follow:

- Communication
    - Design of promotion material, website, and creation of news, social media accounts, along with initial actions to raise awareness about the project through these means. This already resulted in 50000 visits to the website and an increasing impact through social media.
    - Communication talks and video to present the scope of the project.
    - Some events organized targeting general public (e.g., high school students).
- Dissemination
    - Nine accepted publications (including one guest editorship), some of them joint with other projects.
    - Participation in various work groups to join efforts with other 5GPPP projects.
    - Seven dissemination talks to explain 5Growth and its concepts to a technical audience.
- Exploitation, including standardization
    - Creation of the standardization advisory committee.
    - Identification of relevant SDOs for networking (e.g., 3GPP, IETF, ETSI) and for vertical-oriented topics (e.g., IDSA for eIndustry, EC 62278:2002 for transportation) and monitoring of groups of interest for potential contribution.
    - Identification of relevant open source projects for networking (e.g., Openstack, OSM) and vertical-oriented (e.g., e.DO).
    - Definition of the initial standardization roadmap according to the timelines of the SDOs and the project.
    - Participation in 5GPPP pre-standardization working group to coordinate efforts with other 5GPPP projects.

1. Introduction

The Communication, Dissemination, and Exploitation Plan (CoDEP) of 5Growth includes the three following groups of activities as follows [1][2]:

- Communication: It includes all the activities related with the promotion of the project and its results beyond the project's own community. This includes communication of its research in a way that it is understood by non-specialist, e.g., the media and the public.
- Dissemination: It includes activities related with raising awareness of its results in a technical community working on the same research field. In general, this will be done through peer-reviewed publications in academic conferences and journals, and participation and organization of technical events.
- Exploitation: In accordance with the European IPR Helpdesk, it covers activities aiming at using the results in further research activities other than those covered by the project 1) in developing, creating and marketing products or processes, 2) in creating and providing a service, or 3) in standardization activities.

The CoDEP was conceived at the proposal stage and includes all phases of the project (i.e., proposal, grant preparation, project lifetime, and after the project ends), where the focus is on activities tailored to each period. A summary of the plan is presented in Figure 1.

The goal of the proposal stage was to lay down the foundations for all activities following in the project execution phases both in technical and legal terms. Technical challenges were identified at the proposal phase and corresponding research topics with potential to generate exploitation impact were selected for the project execution phases. The proposal stage also served to set the legal and organizational framework, including the signing of the NDA, the identification of responsibilities (e.g., innovation manager), or the per-partner IPR management. All items included are listed in the upper part of the figure next to the label *Proposal stage*.

Once the grant was awarded, the grant preparation phase involved the legal departments of the consortium members to more clearly specify the legal framework. Therefore, the consortium agreement served to define governance rules, including innovation management, IPR ownership rules, and establishment of access rights, among others. The complete list is provided in the figure next to label *Grant preparation stage*.

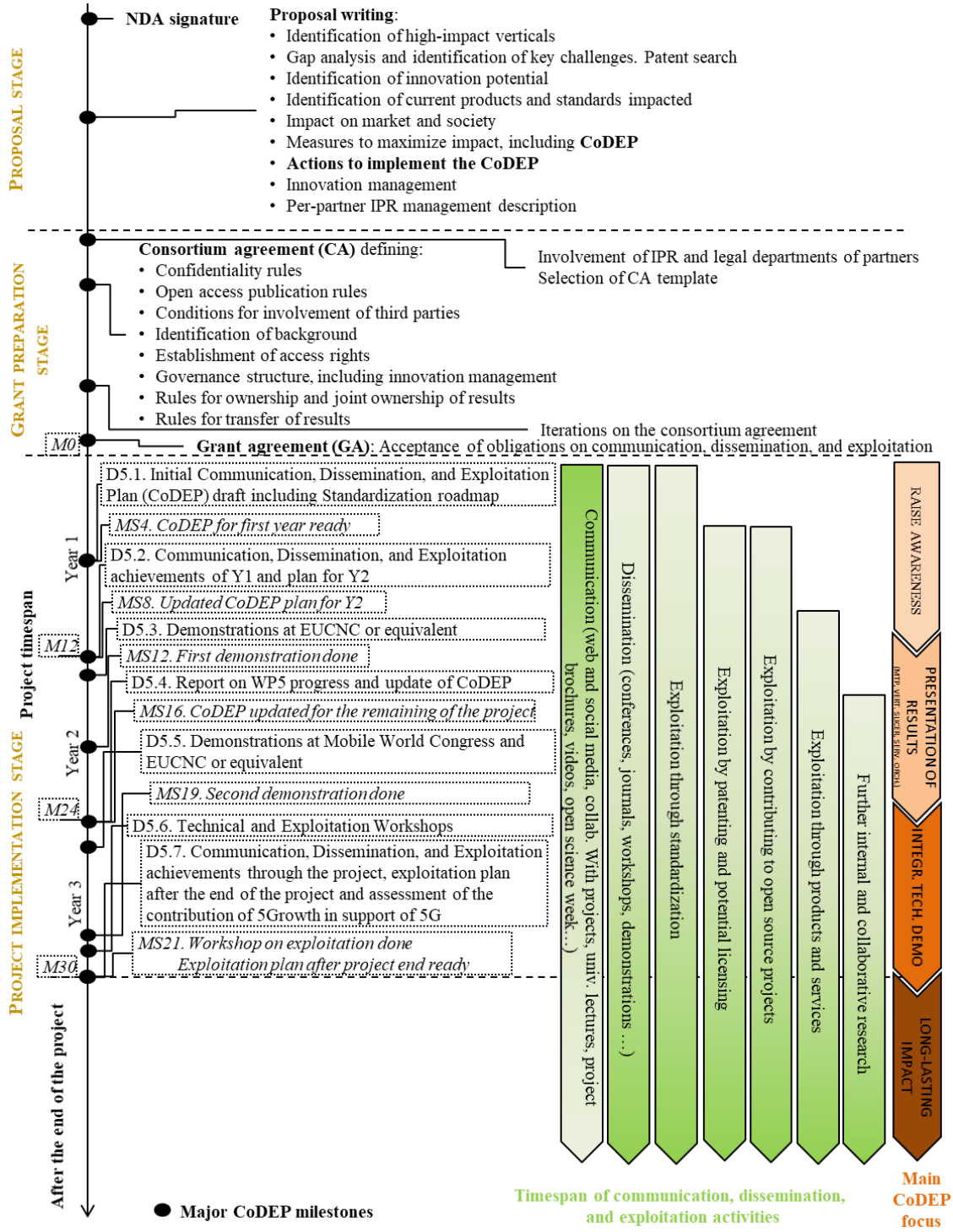


FIGURE 1: 5GROWTH COMMUNICATION, DISSEMINATION, AND EXPLOITATION PLAN

The CoDEP activities will gain momentum during the project execution phase. Figure 1 presents the various project milestones and deliverables directly related with the implementation of the CoDEP as well as the various activities and phases during project execution. All activities will we carried out in parallel, but the emphasis of each of them will be different depending on the phase of the project. During the *Raise Awareness* phase, at the initial stages of the project, the focus is on communication (e.g., setting up the web and social media and high-level project presentations) to make the project known not just to the R&D community but to a larger audience outside the project including the public. Dissemination and standardization activities also start in this phase with preliminary technical contributions. More specifically, all the activities below are initiated in this phase:

- Web portal and social media accounts.
- Project brochure.
- Project poster.
- High-level project presentation and participation at events to explain project scope.
- Videos.
- Participation in events for a general audience (e.g., open science week).
- University lectures.

The above activities are allocated more efforts at the beginning of the project due to the preparation of the initial communication resources and framework needed throughout the project, but they continue until the end of the project and after the project ends.

In the *Presentation of Results* phase, dissemination and exploitation activities increase their intensity. Initial demonstrations are expected during this phase (e.g., at events such as Mobile World Congress or EUCNC). More specifically, these activities include:

- Dissemination
    - Publication of research results in technical journals and conferences.
    - Enrolment of PhD and Master students on the topics of the project.
    - Participation in public exhibitions and demonstrations.
    - Organization of special events (e.g., technical workshops).
    - Collaboration with other projects.
- Exploitation
    - Identification of products and services that could be influenced by 5Growth.
    - Patents and licensing.
    - Contribution to relevant open source software projects.

- Contribution to standardization bodies according to the standardization roadmap initially presented in this deliverable and continually refined by the standardization advisory committee throughout the project lifetime.

Furthermore, it is in the *Integrated Technical Demonstration* phase where demonstration activities take more relevance and experimental results are obtained to validate the main architectural concepts of the project in an integrated way.

Finally, the project aims at having an impact after the project ends through other research projects, standardization contributions that include 5Growth concepts, or by influencing products and services of partner organizations. These activities conform the *Long-lasting Impact* phase.

In addition to the preparation of the communication material, the initial phase of the project posed substantial effort in defining the standardization roadmap that will be implemented during the project. This includes the initiation of the activities of the standardization advisory committee, the identification of relevant SDOs and open source projects (both networking and vertical-oriented), and the matching of project timelines with those of SDOs. Furthermore, this initial roadmap will be periodically updated to adapt to standardization interests and context variation.

In the same way, the whole CoDEP will be periodically updated throughout the project if, for instance, new activities need to be defined or new collaboration and dissemination opportunities appear. The following sections describe in detail the work plan for each of the CoDEP activities. After that, the early achievements in some of the activities of the CoDEP are also listed.

2. Communication plan

5Growth will create, from the early stages of the project, a basic set of necessary presentation materials targeted for various audience types: a **communication package** that will be used as the core communication measure to promote the project as summarized in the following section.

2.1. Work plan

The following table includes the targeted audience, the related activities, the timing, and the metrics of the communication activities, including quantified goals.

TABLE 1: 5GROWTH COMMUNICATION PLAN

Audience	Activity	Timing	Metric
All, General public, Research	**Project website.** 5Growth will share its concepts, results and achievements through its dedicated project website. The website will be the primary tool of communication and promotion of the project.	M1 and cont. update	Number of unique visits, Most visited pages, Most downloaded papers,
All, General public	**Press releases, posters, leaflets.** 5Growth will prepare and distribute project poster, press releases and leaflets to raise public awareness.	M3 and event-driven	1 leaflet and 1 poster available at Month 3. Published press releases (target: two per year)
General public	**Public Communication.** 5Growth project, including its impact on the transformation of vertical industry, will regularly be promoted through participation and organization of events for society at large and distribution through social media. We will also make use of EC communication tools and magazines.	M1 and event-driven	Num. of events organized / attended (target: at least one org. per year) LinkedIn and Twitter metrics
General public, Interest groups	**Video.** 5Growth will work on the creation of public videos to advertise the proposed network scenarios and their capabilities.	Event-driven	Videos of all demo activities available in the web
Students	**Lecture materials** related with 5Growth will be introduced in academic courses taught by partners	Pot. every 6 months	Num. of courses related with project topics

3. Dissemination plan

The purpose of the dissemination plan is to guarantee that all concepts and technologies developed in the 5Growth project are disseminated adequately to relevant entities, including standards development organizations. Dissemination and Collaboration (primarily within the 5G-PPP) activities are expected to be conducted in Year 1 to help promote the project concept and initial results to the large European and more International R&D community and raise opportunities for synergy with other projects and activities. This chapter presents first the plan set in Year 1 and reports next the related achievements for dissemination and collaboration activities respectively. The dissemination activities are carried out continuously when there is the appropriate combination of availability of project results and opportunity. In this respect, project milestones are a key source of dissemination. As far as dissemination is concerned, the following activities are expected:

Publications in selected journals and magazines, such as IEEE/ACM journals, transactions and magazines (e.g., IEEE JSAC, IEEE TNSM, IEEE Communications Magazine, IEEE Network) and reputed international conferences (e.g., IEEE ICC, IEEE Globecom, IEEE IM, ACM Conext). **Collaborations** with other EU and international research projects through 5G-PPP working groups, networld2020, and other H2020 projects in support of the 5G-PPP commitments and towards the realization of the 5G vision **Presentations** and participation on behalf of the project in research-oriented workshops, industry-oriented workshops (e.g., ETSI workshops on standardization), technology platforms, and any other similar forum, including participation on academic and industrial panels organized in these events. Participation in public **exhibitions and demonstrations** for academia (e.g., demonstrations in conferences) and industry (e.g., Mobile World Congress, EUCNC, SDN and NFV World Congress or equivalent) to disseminate research work to create awareness of 5Growth technology and applications. This also includes participation in large-scale vertical-oriented events (e.g., Innotrans, European Utility Week, Int'l Machine Tool exhibition). **Organization of events**, such as workshops collocated with well-established conferences (e.g., IEEE ICC, IEEE Globecom) to showcase 5Growth results.

3.1. Dissemination work plan for year 1

The dissemination activities will be steered towards generating impact through peer-reviewed publications, presentations, talks, demonstrations, panels, workshops, and events. The goals set in Year 1 include:

- Submission of at least 10 scientific articles for publication at reputed conferences and journals on year 1.
- Submission of at least 10 contributions to SDOs, such as 3GPP, IETF, ETSI, IEEE, ITU over the lifetime of the project.
- Submission of at least 2 joint documents scientific / articles / publications for publication at reputed conferences and journals together with EU and international research projects, e.g., through 5G-PPP working groups, or working groups of other platforms, such as networld2020).

- Demonstration of project related prototypes or solutions at least 1 flagship event (e.g., MWC / EUCNC) on year 1.
- Demonstration of project related prototypes or solutions at least 1 vertical-oriented event (e.g., InnoTrans, European Utility Week, CIRED, Int'l Machine Tool exhibition) on year 1.
- Organization of at least 1 research- or industry-oriented workshop on year 1.
- Participation of at least 1 research- or industry-oriented workshop on year 1.
- Participation in at least 1 open source project over the lifetime of the project.
- Filing at least 5 patent applications over the lifetime of the project.
- Addition of core skills for technology development within the project into academic curriculums, along with the proposal of PhD and MSc theses on specific topics on 5Growth research agenda.

The following table summarizes the dissemination plan.

TABLE 2: 5GROWTH DISSEMINATION PLAN

Audience	Activity	Timing	Metric
Academic and industrial research	5Growth aims at **publishing its work in selected, high impact-factor journals** and magazines on **communications/networking** (e.g., IEEE Communication Magazine, IEEE JSAC), and reputed international conferences (e.g., ICC, PIMRC, Globecom, CoNext, EUCNC) as well as smaller-scale but highly targeted, including **vertical**-oriented ones (e.g., FIWARE Summit, International Conference on Electricity Distribution – CIRED)). An appropriate balance between academic and industrial awareness will be sought.	Continuous	At least 10 publications per year in top-tier scientific journals and conferences.
Other research projects	**Collaboration with other EU and international research projects** (e.g., through 5G-PPP working groups, or working groups of other platforms, such as networld2020) will also be key towards a coordinated action inside the 5G-PPP and with other H2020 projects related with the vertical industry involved in the project	5G-PPP WGs & ad hoc bi-lateral collaboration	Num. of meetings attended (target: at least two per year). Num. of joint documents generated (target: at least two per year).
Mostly academia, but also industry	**Organization, presentations and participation in the organization of events** (e.g., panels, targeted workshops, workshops co-located with relevant conferences, special sessions) and participation in these same kind of sessions as keynote speaker, panelist, etc., thanks to important vendors, technology providers and operators, high-tech SMEs, and reputed academic organizations within the consortium.	Particip. in one per yr. One workshop organized	Organization of one 30-people workshop co-located with a major conference (e.g., EUCNC, IEEE WCNC, ICC, INFOCOM) with 70% satisfaction in the workshop quality poll for attendees. Participation in workshops: we measure the number of events (target: at least one per year), we will measure the metrics (web access, cites) of work presented to measure its impact.

Industry	**Exploitation workshop.** Chaired by the innovation manager and specifically devoted to maximizing the exploitation outcomes of the project in terms of standardization, patenting/licensing, and products and services. Experts on innovation from the various companies representing all industrial sectors already in the project (verticals, operators, vendors, and SMEs and external experts acting as advisors on maximizing the exploitation outcome of the project.	One workshop org. before M28	One 30-people exploitation workshop before the end of the project with 70% satisfaction in the poll for attendees.
Mostly industry, & also academia	**Technology demonstration**. The project team believes that the realization of proofs-of-concept is the key to maximize innovation potential. 5Growth will participate in demonstrations of key project components in exhibition booths in fairs, such as those of EUCNC, or industrial events, such as Mobile World Congress (MWC), where some of partners have regularly exhibited.	Approx. every 6 months	Technology demonstration in at least two events per year. Two demonstration deliverables are planned during the project. More demonstrations in several events are targeted.
Vertical industry	**Vertical-oriented demonstration.** 5Growth will participate in vertical-oriented events (e.g., InnoTrans, European Utility Week, CIRED, Int'l Machine Tool exhibition). It will present how the 5Growth platform offers a simple interface that allows verticals to focus on their specific business parameters when requesting a service and forget about the underlying deployment process.	Approx. every year	Vertical demonstrations in at least three events. Two demonstration deliverables are planned during the project, which will include vertical-oriented demonstrations.
Industry	Though being part of exploitation activities, the **participation in standardization** efforts of 5Growth also offers an **indirect way to disseminate the results** of the project to the industrial community. Nevertheless, there are other **non-traditional ways of standardizing (e.g., OPNFV, OpenStack)**, such as contributing, and **publishing open source software** (part of 5Growth exploitation plan), which may become a de facto standard.	Continuous meetings	Participation in at least one open source project.

3.2. Synergies with other projects

In this section, we have identified a set of ongoing projects (by the time the project starts) which results may impact 5Growth. For all the projects identified, there is an involved 5Growth partner, hence we can use the already established relation to maintain a cooperation between projects. Only a selection of projects is listed below. Many other projects that are not listed may as well impact the 5Growth design.

Project name	Short Description	Technical relationships	Contact
On-going EU FP/H2020 projects			
5G-TRANSFORMER	Development and evaluation of a mobile transport and computing platform together with its management framework. This enables serving the needs of verticals by deploying the underlying building blocks that automate service deployment in an automated and transparent way to the vertical.	5Growth evolves the 5G-TRANSFORMER architecture and makes it work over the ICT-17 test sites.	UC3M, NEC, TID, CTTC, NOKIA (several partners)
5G-Coral	Integrated MEC and Fog computing architecture to solve the diverse needs of 5G services.	Edge transport and computing is a key segment of 5Growth.	TIM, UC3M, TELCA
5G-CARMEN	5G-CARMEN will realize a 5G 1000Km-highway corridor stretching from Bologna-Munich-Prague to validate the Cooperative, Connected, and Automated Mobility use cases. It covers 5G NR, C-V2X interfaces, MEC, end-to-end network slicing, highly accurate positioning and timing, and predictive quality of service.	5G-CARMEN will exploit cross-border federation mechanisms that evolve from 5G-TRANSFORMER. In this way, 5Growth and 5G-CARMEN will exploit synergies towards such evolution.	TIM, NEC
5G EVE	End-to-End ICT-17 connectivity platform. It integrates sites across Europe under a common architectural framework with open APIs to make it accessible to ICT-19 projects.	Supporting infrastructure to be used for 5Growth deployment, verification and validation.	TIM, ERC, UC3M, TID, NOKIA (other partners)
5G-VINNI	End-to-End ICT-17 connectivity platform. It integrates sites across Europe under a common architectural framework with open APIs to make it accessible to ICT-19 projects.	Supporting infrastructure to be used for 5Growth deployment, verification and validation	UC3M, TID, NOKIA
BOOST4.0	BOOST 4.0 goal is to develop a large-scale experimentation and demonstration of data-driven "connected smart" Factories 4.0, to retain European manufacturing competitiveness. It will address this goal, by demonstrating in a measurable and replicable way, an open standardized and transformative shared data-driven Factory 4.0 model through 10 lighthouse factories.	Big Data Analysis Technologies.	TID, INNOVALIA
PRODUCTIVE4.0	The main goal is to achieve significant improvement in digitalizing the European industry by means of electronics and ICT – up to TRL8. What makes the project unique is the holistic system approach (across various industrial sectors) of consistently focusing on the three main pillars: digital production, supply chain	Fog Layer to improve the development of a Proactive Quality Control Services. Additionally, it will implement new mechanisms to reduce the processing time of the huge quantity of data acquired.	INNOVALIA

	networks and product lifecycle management.		
SLICENET	SLICENET aims to contribute to remove the limitations of current network infrastructures by achieving fully softwarisation-friendly 5G infrastructures, and radically address the associated challenges in managing, controlling and orchestrating the new services running in such infrastructures for users (especially vertical sectors), thereby maximizing the potential of 5G infrastructures and their services based on advanced software networking and cognitive network management.	SLICENET will enhance the openness of configuration and services management by verticals, automated service life-cycle management, model-based monitoring management, closed loop management of individual resources in the RAN, MEC, transport or core domains, AI-based prediction of user mobility.	ALB, EFACEC_E
National Projects, Celtic program and Internal projects			
Multi-Gigabit Innovations in Access	It studies (fixed) next-generation access networking, including 1) If the upstream and downstream capacity of an access line can be dynamically shared; and 2) Network virtualization allowing VNO, VPN, mobile front, etc., to share the same access infrastructure. It will investigate local controllers governing an automated response to handle unpredictable traffic intents and network slicing for fixed access networks.	Incoming intents need to be automatically processed for the on-demand deployment of network slices over the platform architecture. Insights in the different network technology domains and their closed control loops are important for end-to-end slice orchestration.	NBL
5G MOBILIZER	It will allow the integrated conception and validation of 5G products and exploring B2B and B2C models. Products for the access network as well as network management and control and security of application to IoT (energy distribution, railway signaling networks) or broadband multimedia (video streaming and distribution).	5G access and core (incl. virtualization). New connectivity for human-to-machine and machine-to-machine verticals. Synergies in topics and use cases deployed in Aveiro. Mutual benefit from the architectural design from each other.	ALB, IT, EFACEC_S, EFACEC_E
5G-MISE pre-commercial trial in Bari-Matera	Pre-commercial trials in 3.6-3.8 GHz. Evaluated verticals include ten application areas and more than seventy use cases: video distribution and contribution for media-virtual reality, security and logistics for smart port, monitoring and transport for smart city, process digitization and production chain, assisted driving and logistic for mobility-road safety.	SSSA is participating to the Bari-Matera cluster with activities on transport network slicing and latency-aware applications.	SSSA
DigiXsafe (P2020)	DigiXsafe develops a new level crossing control system using safety critical COTS and modular standardized software.	Similar field of application to use cases of EFACEC_S pilot with copper/fiber	EFACEC_S

		comm. Analysis of the impact of 5G systems.	
New Dimensions (P2020)	New Dimensions develops a New Integrated Platform for Transportation systems supporting cybersecurity, advanced communications and technical Supervision	Implications of 5G networks on platforms for the integrated management of transportation systems.	EFACEC_S

Furthermore, project partners participate to multiple 5GPPP working groups, namely:

- Pre-Standardization
- Vision and Societal Challenges
- 5G Architecture
- Trials
- SME 5GPPP
- Software Networks
- Security
- Test, Measurements and KPI Validation

Their scope is described at: https://5g-ppp.eu/5g-ppp-work-groups/. This participation includes presenting and representing the project in all periodic meetings that are organized and participation in joint actions (e.g., co-organization of events, joint documents/papers, joint demonstrations).

Additionally, the project also participates in the 5GPPP boards towards a tight coordination with the rest of 5GPPP projects: the project coordinator in the steering board and the technical manager in the technology board.

4. Exploitation plan

4.1. Products and Services

The exploitation plan has been organized for each partner category (verticals, vendors and service providers, network operators, small and medium enterprises, academia and research centers) in three main phases, namely short, medium and long term, as reported in the sections 4.1.1, 4.1.2, 4.1.3, 4.1.4, and 4.1.5.

Moreover, such exploitation plan will have a concrete impact on products and services in case of SMEs, vendors and verticals. The following sections explain the target activities for each timeframe for each type of partner and also present a table with a specific discussion on exploitation for each partner. Finally, a detailed table with related products and services is presented in section 4.1.6.

4.1.1. Verticals

The 5Growth project is vertical-centric, providing 5G sites and testbeds where verticals can deploy their pilots, experiment and validate though trials. Three time-frames were defined:

- Short term - Verticals will exploit 5Growth results as telemetry and monitoring applications; the creation of internal skills in side their companies, to integrate their systems into ICT-17 platforms.
- Medium term - Verticals will exploit developing augmented worker applications and strengthening their portfolio of solutions.
- Long term - Verticals with the technology and products developed will expand to new more competitive and demanding markets.

Partner	Brief Exploitation Plan
COMAU	COMAU aims to test within the project timeline their telemetry and monitoring applications, with a target impact for deployment in 2020, with augmented worker applications for 2021 and with 5G digital twin applications for 2022.
EFACEC_E	EFACEC is a global player in the market of the electrical energy sector, with a large product portfolio and consolidated experience in system turn-key projects. Within its international activity. The 5Growth project results will allow: • The creation of internal skills in the company and among the consortium partners, concerning the integration of new ICTs in Electrical Power and Energy Systems (EPES), namely focused on the deployment of dedicated communication infrastructures to support advanced monitoring, automation and control solutions for Smart Grids; • Strengthen our portfolio of solutions for Smart Grids by adding innovative communications features to the products' configuration options. The envisioned value-added innovations will help to strengthen the position in Smart Grid markets where EFACEC is already present and to expand to new markets, more competitive and demanding.

EFACEC S	The participation in the project will allow EFACEC to develop new signaling systems products, it will open new commercial windows over the market of next generation of signaling systems that are under the standardization and digitalization efforts resulted from of the EULYNX consortium project and Shift to Rail Join Undertaking towers 2020.
INNOVALIA	Innovalia's exploitation plans for 5Growth results will be the use of the 5G wireless communication capabilities defined in this project for the continuous support and collaboration services it provides to different national and international SMEs. This will improve its position as a technological center for manufacturing SMEs.

4.1.2. Vendors and service providers

Vendors participating in 5Growth are set to lead the future market of 5G facilities by developing novel hardware, software platforms and services. Three time-frames were defined:

- Short term - Opportunity to get their R&D efforts into focus and evolve their current product portfolio with vertical requirements as input.
- Medium term - Use findings to understand verticals requirements and needs related to the various vertical markets present on the project, and to identify gaps in 5G End-to-End connectivity platforms in order to develop innovative, flexible solutions that could suit most of the categories of verticals in the consortium.
- Long term – Exploitation of results by further feeding their product and business units.

Partner	Brief Exploitation Plan
NEC	NEC plans to use the results and findings from 5Growth to evolve the current fronthaul/backhaul product portfolio towards the fronthaul/backhaul integration paradigm, and to develop an added-value management and orchestration platform that brings the flexibility of SDN/NFV to NEC line of products, impacting the Mobile Radio Access Networks and Mobile Wireless Networking business units. The project results will be used to demonstrate the benefits of the designed orchestration platform both to NEC development groups and potential customers, e.g., European network operators. NEC expects to derive a converged view about gaps and choke-points in today's technology for mobile carrier networks, the collaborative definition of requirements and findings about new concepts for 5G that shall support NEC's strategy and approach in directing its standardization roadmap in global Standards Development Organizations, such as the Internet Engineering Task Force (IETF) and the 3rd Generation Partnership Project (3GPP), in different areas to build a solid standards and technology base for the 5G communication system. With the motivation to serve a variety of verticals as well as mobile and stationary device types with different communication characteristics, requirements, duty cycles, traffic patterns, constraints and functional capabilities, NEC believes that the 5G Control- and Data-Plane can optimize the use of network resources on one hand, and ensure the end-to-end service quality experienced through end devices on the other hand by enabling smart connectivity and associated tailored provisioning, selection and configuration of basic and value-adding services.

ERC	5Growth brings the opportunity to learn requirements from verticals and telecommunication operators, perform new research and standardization, and opportunities for further development of monitoring, automation and benchmarking of technologies. Ericsson will be feeding these results of the project to our Product Development Units, especially for the OSS/BSS PDU and PDU Cloud and SDN.
TEI	In this landscape, TEI intends to exploit 5Growth results to further validate and evolve the 5G portfolio and the IoT solutions (IoT Accelerator) by leveraging on the experience gained in the field-trials that are in the scope of the project. In particular, validation of the 5G technology potential (including slicing) in the realistic environments foreseen by 5Growth will be an important asset for TEI to be advertised towards customers to demonstrate the potential for take-up in the selected vertical applications. Ericsson Customer Units will also be involved to convey project outcomes towards customers.
IDG	Through its participation in 5Growth, InterDigital targets the validation through trials of some of its 5G, Video and Sensors technology innovations. These trials conducted in integrated setups with 5G technologies from several partners, including noticeably partners involved in 5G EVE and 5G-VINNI projects, and for use cases and test environments defined by the vertical industry represented in 5Growth, are envisioned to bring valuable technological and business insights that will pave the way for tangible exploitation of InterDigital's innovations. The exploitation routes foreseen by InterDigital include but are not restricted to (i) patented innovations; (ii) standard essential contributions; and (iii) pre-commercial proof-of-concepts leading to commercial products.
NBL	Nokia plans to exploit its participation in 5Growth in multiple dimensions: • Nokia will use the results of the 5Growth project, with patented innovations and pre-commercial proof-of-concepts, to evolve the current end-to-end product portfolio on (i) mobile, fixed and converged broadband access (AirScale C-RAN, Airframe, Altiplano, Lightspan) (ii) orchestration solutions (e.g., CloudBand Network Director, Digital Operations Suite), towards automated service life-cycle management solutions facilitating network slicing in multi-vendor / multi-operator environments, fully supporting the requirements as set out by the verticals. • Nokia will share insights of 5Growth with telecom operators who already use the Nokia ecosystem for current end-to-end life-cycle management of 5G services, with regards to orchestration and programmable forwarding plane solutions. • Nokia might contribute certain project outputs to the relevant industry communities focused on network programmability, in the form of source code to the open source projects like P4. Further on, Nokia will further disseminate the project results through its involvement in global standards development organizations, such as IETF, ETSI, 3GPP etc.

4.1.3. Network operator

Network operators will evaluate how to best fulfil the requirements and offer service to various vertical industries over their network, as well as how to shape their relationship with them. Three time-frames were defined:

- Short term - Foresee a direct enhancement of their 5G experimentation and demonstration facilities, extending them to meet vertical requirements, ultimately consolidating their position as a global reference for the evolution of 5G.
- Medium term- Operators will gather the know-how for the planning and design of future 5G networks.
- Long term - Operators will apply the experience gained during the validation of 5Growth scenarios to contribute to the definition of 5G services for their industrial.

Partner	Brief Exploitation Plan
TIM	The wide set of experimental activities and trials planned within the project are expected to provide valuable and very useful hints for the planning and design of future 5G network. In particular, the trials should provide evidence about the actual capability of 5G to support several vertical applications running in parallel, each of them requiring multiple network slices to meet the specific requirements. In the medium and long term all these results will be exploited by TIM in the different phases that should lead to the deployment of its 5G network. But, already in a shorter time frame, the experience gained within the project will be immediately transferred internally to prepare the different company departments to deal with the future 5G business and exploited outside the company in the framework of the various initiatives ongoing/planned in Italy to pave the way towards 5G.
TID	As the innovation company of a multinational telecommunications operator, TID will seek for exploitation activities related to direct technology transfer to the relevant Business Units of Telefónica. 5Growth will provide a much wider, diverse and realistic environment for the exploration and demonstration of 5G technologies, with direct interaction with end users representing different vertical sectors, and the project results will be applied to (a) the improvement of the Telefónica technology evaluation and testing facilities focused on 5G infrastructures and innovative network services, and (b) the enhancement of Telefónica service validation practices, focused on a reduction of time-to-market and a closer loop with customers. TID will apply the experience gained in the validation of the 5Growth scenarios to contribute to the definition of 5G services for industrial customers of the Telefonica Group, and to provide Telefonica business units with a better and direct understanding of the requirements of these verticals, and how they can be addressed. Furthermore, we foresee a direct enhancement of the 5TONIC experimentation and demonstration capabilities, consolidating its position as a global reference for the evolution of 5G. The target of this exploitation activities will be business units of the Telefónica Group in Europe and worldwide, for which we plan to: • Showcase the 5Growth technologies and features, as well as the 5G advanced capabilities in general. • Demonstrate the vertical applications in industrial scenarios to support the technological and business validation of 5G connectivity services. • Demonstrate that the performance capabilities conforming to 5G PPP KPIs can be met in the context of these specific vertical use cases. • Provide the technology base and experience for the design and development of specific 5G products and services for the commercial market.

ALB	Altice Labs is the innovation branch of Altice Portugal and the Altice Group companies worldwide, as well as a provider of network systems and services. In this dual research and industrial role, Altice Labs intends to exploit 5Growth results to strengthen Altice Portugal technological leadership and prepare the transition to new service paradigms enabled by network virtualization, programmability and 5G. In particular, Altice Labs will evaluate the possibilities offered by 5G to enable service innovation and the delivery of a wide range of connectivity services to multiple industries and business environments. As a network technology provider, Altice Labs will leverage the results and expertise gained through 5Growth to prepare the evolution to next-generation of network systems, able to meet the challenges of 5G – two candidate areas are OSS systems and NG-PON2-based backhaul/fronthaul. Finally, Altice Labs plans to enhance the local 5G testbed infrastructure (currently under construction in the framework of H2020 ICT-17 5G-VINNI project) by integrating new components and features required by 5Growth use cases.

4.1.4. Small and medium enterprises

SMEs plan to evolve their products in their specific fields of interest. Three time-frames were defined:

- Short term - SMEs will exploit from the technology created from 5Growth in contributing to open source projects and training courses on SDN, NFV, MEC architectures and cloud platforms.
- Short/Medium term - SMEs could design novel concepts, inspired from 5Growth results to feed-back their product portfolio,
- which will foresee in the Long term an increase in their competitiveness for consultancy services.

Partner	Brief Exploitation Plan
MIRANTIS	Mirantis as a provider and integrator of the MCP-based cloud and orchestration platform for the 5Growth project, targets trialing of the relevant open source technologies for reference project use cases. Upon successful field trials of the project use cases and getting appropriate results, Mirantis might be able to generate set of best practices and benefits for the production cases implementation at the customer facilities. Additionally, as a valuable contributor to the numerous open source projects and initiatives, Mirantis might contribute certain project outputs to the relevant industry communities focused on the 5G, NFV and Edge technologies both in a form of the blueprints for implementation or as a tangible source code to the open source projects like OpenStack, OPNFV and others.
NXW	Nextworks will exploit the enhanced know-how built through the participation to the project activities in the NFV, SDN and MEC technical areas to increase the company competitiveness in consultancy services as 3rd party software developer for ICT solutions and in training courses on SDN, NFV, MEC architectures and cloud platforms. Moreover, the hands-on expertise on vertical-driven service orchestration and 5G infrastructures deployments will influence the evolution of the company's products for IoT platforms and smart building, towards virtualized and distributed services able

	to exploit 5G technologies to improve scalability and customization, towards novel smart city solutions. NXW is a small company with a very agile development process. This will help to bring selected, novel concepts, as inspired by the project outcomes, into products' innovations in a short-medium term.
TELCA	As an advanced network service virtualization and young SME, Telcaria will benefit from the technology advances generated from 5Growth project. Telcaria will acquire the know-how for applying 5Growth technologic achievements to rapid prototyping, design, validation, and direct deployment of 5G technologies. The main areas in which Telcaria foresees exploitation potential of 5Growth is in the experience gained from network slicing and the multi-domain network management of resources, so in a near future, Telcaria will be capable of adapting and integrating these technologies inside large enterprise networks, across all their domains. Likewise, from a management point of view, the experiences and results obtained from cross-domain orchestration among sites will be further integrated into the operation and lifecycle management these networks. Overall enhancing Telcaria SDN, NFV and Orchestration knowledge which will directly impact on the development and commercialization of a unified SD-WAN platform.

4.1.5. Academia and research centers

The Universities and R&D centers participating in the 5Growth consortium are interested in building on and further developing existing research strength in the networking research community. Two time-frames were defined:

- Short/Medium term - Academia will improve the knowledge in 5G, multi-domain orchestration and slicing, transferring it to the industry.
- Medium/Long term - the patent and license rewards will help to undertake future European and international research, which will contribute towards further collaborative research possibilities with the project partners and others.

Partner	Brief Exploitation Plan
UC3M	UC3M plans to exploit 5Growth to transfer the technology to large industrial partners and SMEs, with particular emphasis on companies located in the technical business park "Parque Científico Leganés Tecnológico". UC3M has currently a Master on SDN/NFV in collaboration with Ericsson, whose syllabus will be heavily impacted. In addition, UC3M forms part of the 5TONIC laboratory and plans to use the results of this project in order to find exploitation opportunities for spin-offs in collaboration with other 5TONIC partners.
CTTC	As a non-profit R&D institution, the exploitation plan of CTTC consists in transferring the knowledge gained from the 5Growth project. The scientific production resulting from these research activities will allow CTTC to strengthen its position inside the networking research community as well as to help in technology transfer activities related with NFV/SDN/MEC technologies. In addition, CTTC's plans are also focused on enhancing its Ph.D. training program using project results, in order to transfer the acquired knowledge to the industry, after the completion of the students' degree. In turn, this will allow

	offering the gained knowledge into future projects, hence enabling evolving the proposed solutions in a variety of contexts, with particular emphasis on verticals. Contribution to standardization bodies and participation in open source projects jointly with other partners is also expected.
IT	IT plans to closely link the results of this project with its mission of "creating and disseminating scientific knowledge in the field of communications", improving the competitiveness of Portuguese industry and Telecommunication operators. More concretely, the raised know-how will empower skilled people, with knowledge in software development for telecommunications, to improve this knowledge, and transfer it to the industry or operators. Similarly, it will allow its introduction in graduate studies and projects inside the University of Aveiro, aiming to create even more competitive and proficient future telecom professionals. Results will also lead to new research projects or consultancy actions with operators and IT companies in the same areas, aiming to attract Ph.D. students and Post-Doctorates, as well as to place influence in standardization bodies and the industry fora (not only directly participating in bodies such as IEEE, IRTF and OSM, but also through partnerships with other consortium members and contribute to other bodies indirectly).
NKUA	NKUA will include several of 5Growth concepts and enablers in relevant Bachelor and Master courses in the Department of Informatics and Telecommunications, in which Prof. Ioannis Stavrakakis, Ass.Prof. Nancy Alonistioti and Dr. Sokratis Barmpounakis are teaching. NKUA will make publications of high-quality project results in International peer reviewed Journals, Magazines and book chapters: Submission and publication of the technological concepts and results achieved by the work to be carried on, in selected internationally acknowledged Journals and Magazines as well as special issues related to 5G research areas. NKUA will also exploit 5Growth results by combining the outcomes of the development, integration of the computing and communication enablers, in which NKUA is actively involved or leading, with its on-going research developments. More specifically NKUA plans to extend its in-house cloud infrastructure deployment –based on OpenFlow and SDN controllers and make use of the respective developments and project outcomes in order to extend its current testbed and federate the experimentation towards exploiting IoT principles.
POLITO	POLITO will actively seek to exploit the expertise acquired in 5Growth by partnering with local SMEs with the support of the Torino Wireless ICT hub. Creation of new companies that can benefit from the 5Growth experience will be fostered through I3P, the Innovative Enterprise Incubator of POLITO.
SSSA	SSSA will exploit knowledge and IPR created in 5Growth with its current industrial partners, such as Ericsson, TIM, Rete Ferroviaria Italia (RFI), Trenitalia. Among others, SSSA will focus most of its efforts on specifically exploited solutions, such as algorithms for service and resource orchestration based on resource abstraction, monitoring data, and Artificial Intelligence (AI), monitoring supported self-healing mechanisms, and vertical-oriented and intent-based interfaces for service chaining and orchestration.

4.1.6. Exploitation plan of products and platforms for vendors, SMEs and verticals

In the following table a detailed description of the platform and products for vendor, SME and vertical according to the exploitation plan, is reported.

Short Name	Platform/ product	Description of impact on platform/product	5Growth component
ALB	Operations Support Systems portfolio	This portfolio is currently in the process of evolution to a new generation of OSS systems, which will benefit from lessons learned about orchestration and management of 5G infrastructure through the development and evaluation of the EFACEC use cases. http://www.alticelabs.com/en/operations_support_systems.html	Vertical Slicer/ Service Orchestrator
COMAU	Operations Support Systems in production lines	5Growth 5G Pilots will allow COMAU to evaluate the evolution of its Operation Support Systems in production lines towards 5G	5G Pilot
EFACEC_E	GSmart & view4grid	A current main concern to EFACEC is the competitiveness of its products and systems. The 5Growth project results will allow EFACEC to strengthen its portfolio of solutions for Smart Grids by adding innovative communications features to the products' configuration options. The major benefits will impact on EFACEC's portfolio for Smart Grids' applications integration and deployment, a set of solutions designed to implement flexible management and monitoring over an entire smart electrical infrastructure, including high level platforms with management software and web user interfaces, smart meters and sensors, data concentrators and distributed controllers, or any other type of IP capable device. https://www.efacec.pt/en/automation/	5G Pilot Vertical Slicer/ Service Orchestrator
EFACEC_S	DigiXSafe	The participation in the project will allow EFACEC_S to develop new signaling systems products, it will open new commercial windows over the market of next generation of signaling systems that are under the standardization and digitalization efforts resulted from of the EULYNX consortium project and Shift to Rail Join Undertaking towers 2020. https://www.efacec.pt/en/transportation/	5G Pilot
INNOVALIA	Metrology Software M3	The participation of INNOVALIA in the 5Growth Project will allow the extension of its portfolio of products and services offering not only the remote control of its Quality Control Equipments but also a decision support system based on the Augmented Reality to achieve the strategy of Zero Defect Manufacturing (ZDM) using the MEC to reduce the processing time of the captured data. The impact will be	5G Pilot

		directly located in the Metrology Software M3 offered by Innovalia Metrology. https://www.innovalia-metrology.com/metrology-products/metrology-software/	
ERC and TEI (Ericsson)	IOT Accelerator	Ericsson IoT Accelerator is a platform to develop market and manage secure IoT solutions. IoT Accelerator can benefit from the experience gained in 5Growth in relations to the IoT pilots and relevant use cases and possibly can incorporate functionalities that could emerge from the vertical partners in the consortium. https://www.ericsson.com/ourportfolio/iot-solutions/iot-accelerator?nav=offeringarea613	Vertical Slicer, Service Orchestrator, Resource Layer
	Cloud Packet Core	Especially driven by the expected verticals cooperation's and experimentation in the 5Growth project pilots, the Cloud Packet Core platform can be enhanced especially in relation to Massive IoT support (Introducing network slices for massive IoT with decoupled lifecycle from consumer eMBB service) and support of enterprise with dedicated instances for critical enterprise deployments, like manufacturing sites. https://www.ericsson.com/ourportfolio/cloud-core/cloud-packet-core	Service Orchestrator, Resource Layer 5G Pilot
	Ericsson NFVI	Ericsson NFVI solution consists of software and hardware products as well as support and system integration services forming a complete solution for telecom operators. 5Growth can bring important elements to the platform, both in the resource layer aspects, being hardware products part of the NFVI solution, and in orchestration and virtualization functionalities. https://www.ericsson.com/ourportfolio/digital-services-solution-areas/nfvi?nav=fgb_101_0363	Vertical Slicer, Service Orchestrator, Resource Layer
IDG	360-Degrees Adaptive Viewport Video Streaming over 5Growth	The platform showcases the concept of micro-services based design by distributing several computing tasks necessary to deliver a high-resolution 360 video streaming service to terminals with different resources and capabilities. This platform will be enhanced in 5Growth by incorporating 5Growth vertical slicer and resource layer, with the goal of demonstrating the impact of these two key components in terms of latency reduction and advanced scalability.	Vertical Slicer, Resource Layer
MIRANTIS	Mirantis Cloud Platform (MCP)	MCP is a comprehensive multi-cloud software stack built with an operations-centric approach. Being part of the 5Growth virtualization component at resource level, MCP Edge will be deployed at each testbed and used for field trials of the project vertical cases. https://www.mirantis.com/software/mcp/	Resource Layer, 5G Pilot
NEC	iPASOLINK VR Family	NEC iPASOLINK VR family (microwave backhaul): The iPASOLINK VR delivers enhanced wireless signal processing performance. The design of Resource Layer abstractions	Resource Layer

		and interfaces with data-plane equipment will directly impact potential evolutions of this product family. http://www.nec.com/en/global/prod/nw/pasolink/products/ipasolink_VR4.html	
	NEC iPASOLINK EX family	In a lightweight, compact 23cm squared enclosure, iPASOLINK EX Advanced realizes industry-leading 10Gbps single link capacity features. The design of Resource Layer abstractions and interfaces with data-plane equipment will directly impact potential evolutions of this product family. http://www.nec.com/en/event/mwc/leaflet/pdf_2017/i_pasolink_ex_advanced.pdf	Resource Layer
	NEC E-RAN (MEC platform)	NEC's In-Building Small Cell Solutions are easy to install and can be used for WiFi like fast deployment. 5Growth innovations on control loops for service orchestration and programmable traffic management schemes can potentially be integrated in the evolutions of this product. http://www.nec.com/en/global/solutions/nsp/sc2/sol/s02.html	Service Orchestrator
	NEC Active Antenna System	NEC Active Antenna System (28GHZ NR --- currently a prototype, expected to be ready by the beginning of the project). 5Growth innovations on network slicing can potentially have an impact over evolutions of this product. http://www.nec.com/en/event/mwc/leaflet/pdf_2017/tailored_5g_network.pdf	Resource Layer
	WizHaul (Transport resource management)	SDN/NFV-based centralized resource management orchestrator for mobile transport domains. 5Growth novel orchestration algorithms for monitoring and prediction, and automated closed-loop resource management will have a potential impact on the evolution of this product.	Service Orchestrator, Resource Layer
	OVNES (Network slice broker)	The 5G Network slice broker is piece of software integrated on a network controller or orchestrator. It acts as a mediator between tenants' slice requests and physical network resources availability. 5Growth novel orchestration solutions for SLA monitoring and management, and automated network slice management will have a potential impact on the evolution of this product.	Vertical Slicer, Service Orchestrator
	Net2Vec	Net2Vec is a flexible high-performance platform that allows the execution of deep learning algorithms in the communication network. The monitoring platform of 5Growth and its interfaces with high-speed data processing platforms can have an impact on the evolutions of this product.	Monitoring platform
NBL	Mobile, fixed and converged broadband access	The outcome of 5Growth is also expected to impact significantly NOKIA's software-defined access solutions on mobile and fixed access networks. It is foreseen the potential adoption of suggested 5Growth enhancements on programmable traffic management schemes, in NOKIA	5G Pilot, WP2 innovations

		access nodes. A domain specific language such as P4 will be adopted for this purpose and extended appropriately to allow programmability independently of the access technology employed, thus impacting NOKIA's entire mobile and fixed access product portfolio.	
	AirScale Cloud RAN	The AirScale Cloud RAN solution consists of the AirScale Cloud Base Station Server and the Nokia AirScale Radio Network Controller (RNC). The anticipated 5Growth innovation on programmable traffic management at the RAN is expected to complement the innovations for this product suite. https://networks.nokia.com/solutions/airscale-cloud-ran	Vertical Slicer, 5G Pilot
	Cloud and Edge Computing Nokia AirFrame DC	The Nokia AirFrame Data Center solution offers a flexible range of data center infrastructure portfolio. 5Growth research on tools for closed loop control, such as programmable traffic management schemes, can be potentially adopted to improve future offerings in the Nokia AirFrame Data Center. https://networks.nokia.com/solutions/airframe-data-center-solution	Vertical Slicer
	Digital Operations Suite	The DO Suite provides and agile and modular orchestration for managing service orchestration across virtualized and hybrid networks. It is expected that 5Growth enhancements to the Vertical Slicer and Service Orchestrator (e.g., algorithms for arbitration across coexisting services, service utilization demand forecasting for appropriate vertical service dimensioning, service decomposition etc.) can steer DO innovation. https://networks.nokia.com/portfolio/service-orchestration	Vertical Slicer, Service Orchestrator
	CloudBand Network Director	CloudBand Network Director is an NFV resource and network service orchestrator, built for OpenStack and VMware. It provides two main functions. As a network service orchestrator, the system onboards network services, automates their lifecycles, and provides monitoring and troubleshooting tools. As a resource orchestrator, it administers, monitors and optimizes NFV infrastructure resources across geographically distributed NFV infrastructure) nodes. 5Growth innovations pertaining to SLA-driven service management automation, resource allocation algorithms, automated optimization and self-* properties, etc., are expected to impact the (future) list of features of the CloudBand Network Director. https://networks.nokia.com/products/cloudband	Service Orchestrator Resource Layer

NXW	Symphony	Symphony is an integrated and open platform for smart buildings, including domotics, media services, A/V communications, video-surveillance, energy management, etc. The adoption of the resource virtualization combined with Vertical Slicer will allow to evolve Symphony towards an integrated set of virtualized and distributed services able to exploit 5G technologies to improve the scalability and simplify the automated deployment and customization of the system in wider environments, towards smart city solutions. http://www.nextworks.it/en/products/brands/symphony	Vertical Slicer
TELCA	Alviu	Alviu is a flexible and resilient control system that enables the integration of cloud and network services through a centralized and dynamic administration. On top of this, it reduces equipment expenses and offers a wider range of White Box Switches to enterprises. The innovations of 5Growth vertical slicer and service orchestration will impact directly in how Alviu slices and manages network infrastructure. https://www.telcaria.com/#serviceModal1	Service Orchestrator, Vertical Slicer

4.2. Patents and licensing

The 5Growth project addresses an area which provides significant opportunities for standard essential patents. All partners are committed to producing European IPR as important channel for exploiting project outcomes. Partners have declared a strong background of over 40 patents related to the 5Growth area. At least 5 patents are expected to be filed in the project deployment.

It has to be considered that, after submitting a patent application, it typically takes about one to three years to get a grant, sometimes significantly longer. It is also common to file additional divisional/continuing applications several years after the original filing. This means it can take several years before the final protection scope is known, and the time may vary significantly.

Manufacturers can also use patented systems or patented methods in products of their portfolio. In this case, the patent department inside the company typically activates a continuous monitoring of possible infringement typically targeting main competitors operated on the same market segment. Infringement detection and the relevant legal contention can also bring to additional revenues from the invention.

Finally, patents may lead to subsequent licensing, depending on the interests of the partners in exploiting their inventions for their products/solutions or by selling the license to 3rd parties leveraging on licensing revenues. The licensing options is also possible for patents filed by academic institutions in the consortium.

4.3. Standardization Plan

Maximizing the impact of the project innovations on present and future standardization and industry forums, has been set as a key objective to help create opportunities for commercial exploitation of the project outcomes. This section presents first the plan for the activities and achievements that will be undertaken on standardization. To maximize impactful contributions towards standardization bodies, the project involves vertical actors, with high standardization impact. In addition to the impact on vertical-oriented standards (e.g., EN50126 (IEC62278) for railway signaling), the verticals in the consortium will have a key role in the collection of relevant insights towards 5G standardization, driving the 5G performance evaluation and technology validation in the context of the 5Growth target use cases. These contributions are expected to successfully influence SDOs activities, for example in 3GPP Releases 17 and 18, ETSI MEC release 3, ETSI NFV, ETSI ENI, ITU-T FG ML5G or ITU-T FG NET2030, leveraging the bridging role of industrial partners with leading and active experts in the SDOs.

4.3.1. Standardization work plan for year 1

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.

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.

4.3.2. Relevant standardization activities

4.3.2.1. 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 provides hooks for non-radio access to the core network, and for 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), Core Network & Terminals (CT). [1]

3GPP is the main SDO in 5Growth 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 on the Q1 of 2019 and the Release 17 is just about to start. The release 17 is anticipated to be completed in Q2 of 2021 and release 18 is expected to follow the release 1

Several study items (SI) and working items (WI) relating to 5Growth have been identified by 3GPP in SA and RAN working groups in release 17, addressing aspects such as Industrial IoT & URLLC, RAN Data collection enhancements, 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 describes the schedule of the meetings. 3GPP Release cycle is approximately 15 months. There are plenary sessions that approves the content of the release before the release cycle starts.

4.3.2.2. 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, or ADs. The ADs 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 5Growth are expected to be related to new orchestration approaches and enhancements to service provisioning are related to the efforts in IETF about service function chaining, network management reliable wireless.

The main working groups of IETF related to 5Growth are: SFC WG, ANIMA WG, DMM WG, NMRG, RAW (proposed WG) and COIN WG

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, and if so the document starts becoming 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 not releases in IETF. And each document has their own lifetime. WG has their 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 RFC.

The following subsections describe SFC, WG ANIMA, WG DMM, WG. NMRG and WG COIN topics that may be impacted by the work executed in the 5Growth 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 will coordinate with BESS and PCE on the control-plane work related to SFC.

The **WG ANIMA** 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.

The Distributed Mobility Management, **DMM working group** may decide to extend the current milestones based on the new information and knowledge gained during working on other documents listed in the initial milestones. Possible new documents and milestones must still fit into the overall DMM charter scope as outlined above.

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.

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 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.

4.3.2.3. 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 5Growth 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 5Growth:

a) NFV, on network function virtualization.

b) MEC, on edge computing.

c) ENI, 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.

4.3.2.4. IEEE

IEEE covers the whole world of standards. IEEE 802 covers only LAN/MAN standards, like IEEE 802.11 (Wifi) or IEEE 802.3 (Ethernet). As organisation it is structured in working groups (.11) that have task groups (.11ax). Each standard passes a set of ballots: Task, WG, Sponsor ballot.

It is believed that there are two possible links, IEEE 802.1 in deterministic networking and its profile for industrial networks, and IEEE 802.11 as a radio network. IEEE contributions are individual contributions are 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 5Growth, companies are disseminating results of 5Growth to the standards groups listed above.

4.3.2.5. 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 5Growth 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 the following links:

https://www.itu.int/itu-t/workprog/wp_search.aspx?sg=13

https://www.itu.int/ITU-T/workprog/wp_search.aspx?sg=15

4.3.2.6. IDSA

IDS (International Data Spaces Association) is a p2p network of trusted data. Actors involved oblige themselves to play by the rules of IDS and are to be certified. IDS software connector & protocol provides usage control for data and different tailor-made level of trust. IDSA is the association supporting the development and diffusion of the IDS.

The INNOVALIA Pilot is planning to use IDS Ecosystem to ensure the control over the data transmitted. Contributions are submitted to IDSA WG Jive space by IDSA member organizations and discussed in WG meetings every 6 months. IDSA is releasing updates on the Reference Architecture once a year. Minor releases are frequent. The DIN SPEC will be published in In November 2019 will be published. The 5Growth will validate the IDSA work in the planned pilots and provides contributions to the releases of the standards.

4.3.2.7. ORAN

The O-RAN Alliance was founded by operators to evolve the radio access network. Future RANs will be built on a foundation of virtualized network elements, white-box hardware and standardized interfaces that fully embrace O-RAN's core principles of intelligence and openness. The O-RAN Alliance defines future RAN requirements and helps building a supply chain eco-system to realize its objectives.

One of the innovations in WP2 on next generation RAN is related to the activities and roadmap of O-RAN and we may provide potential contributions to this SDO, and this innovation may be required by most of UCs requiring RAN support.

The relevant working groups of ORAN for 5Growth project

a) WG2: The Non-real-time RAN Intelligent Controller and A1 Interface Workgroup
b) WG6: The Cloudification and Orchestration Workgroup

Contributions to ORAN are made by O-RAN Alliance members (both operators and vendors, NEC is one of the active members). The contributions are discussed in periodic meetings and the approval is consensus based. There are releases in O-RAN alliance for the different specifications, interfaces and software. ORAN milestones are not scheduled and there is not O-RAN Alliance wide roadmap.

4.3.2.8. EC 62278:2002- Railway applications - Specification and demonstration of reliability, availability, maintainability and safety (RAMS)

The railway standards comprising of EN 50126 – 1 & 2 (IEC 62278) have been developed by CENELEC (European Committee for Electro-technical Standardization). These standards apply to both heavy rail systems, light rail and urban mass transportation.

Technical railway standards are covering:

- Railway Applications - The Specification and Demonstration of Reliability, Availability, Maintainability and Safety (RAMS).
- Part 1: Generic RAMS Process,
- Part 2: Systems Approach to Safety.

The ***part 1 of EN 50126*** considers RAMS, understood as reliability, availability, maintainability and safety and their interaction; - considers the generic aspects of the RAMS life cycle. The guidance in this part can still be used in the application of specific standards; - defines: - a process, based on the system life cycle and tasks within it, for managing RAMS; - a systematic process, tailorable to the type and size of the system under consideration, for specifying requirements for RAMS and demonstrating that these requirements are achieved; - addresses railway specifics; - enables conflicts between RAMS elements to be controlled and managed effectively; - does not define: - RAMS targets, quantities, requirements or solutions for specific railway applications; - rules or processes pertaining to the certification of railway products against the requirements of this standard; - an approval process for the railway stakeholders. This part 1 of EN 50126 is applicable to railway application fields, namely Command, Control and Signalling, Rolling Stock and Fixed Installations, and specifically: - to the specification and demonstration of RAMS for all railway applications and at all levels of such an application, as appropriate, from complete railway systems to major systems and to individual and combined subsystems and components within these major systems, including those containing software; in particular: - to new systems; - to new systems integrated into existing systems already accepted, but only to the extent and insofar as the new system with the new functionality is being integrated. It is otherwise not applicable to any unmodified aspects of the existing system; -

as far as reasonably practicable, to modifications and extensions of existing systems already accepted, but only to the extent and insofar as existing systems are being modified. It is otherwise not applicable to any unmodified aspect of the existing system; - at all relevant phases of the life cycle of an application; - for use by railway duty holders and the railway suppliers. It is not required to apply this standard to existing systems which remain unmodified, including those systems already compliant with any former version of EN 50126. The process defined by this European Standard assumes that railway duty holders and railway suppliers have business-level policies addressing Quality, Performance and Safety. The approach defined in this standard is consistent with the application of quality management requirements contained within EN ISO 9001.

The ***part 2 of EN 50126*** - considers the safety-related generic aspects of the RAMS life-cycle; - defines methods and tools which are independent of the actual technology of the systems and subsystems; - provides: - the user of the standard with the understanding of the system approach to safety which is a key concept of EN 50126; - methods to derive the safety requirements and their safety integrity requirements for the system and to apportion them to the subsystems; - methods to derive the safety integrity levels (SIL) for the safety-related electronic functions. NOTE This standard does not allow the allocation of safety integrity levels to non-electronic functions. - provides guidance and methods for the following areas: - safety process; - safety demonstration and acceptance; - organization and independence of roles; - risk assessment; - specification of safety requirements; - apportionment of functional safety requirements; - design and implementation. - provides the user of this standard with the methods to assure safety with respect to the system under consideration and its interactions; - provides guidance about the definition of the system under consideration, including identification of the interfaces and the interactions of this system with its subsystems or other systems, in order to conduct the risk analysis; - does not define: - RAMS targets, quantities, requirements or solutions for specific railway applications; - rules or processes pertaining to the certification of railway products against the requirements of this standard; - an approval process by the safety authority. This part 2 of EN 50126 is applicable to railway applications fields, namely Command, Control and Signalling, Rolling Stock and Fixed Installations, and specifically: - to the specification and demonstration of safety for all railway applications and at all levels of such an application, as appropriate, from complete railway systems to major systems and to individual and combined sub-systems and components within these major systems, including those containing software, in particular: - to new systems; - to new systems integrated into existing systems already accepted, but only to the extent and insofar as the new system with the new functionality is being integrated. It is otherwise not applicable to any unmodified aspects of the existing system; - as far as reasonably practicable, to modifications and extensions of existing systems accepted prior to the creation of this standard, but only to the extent and insofar as existing systems are being modified. It is otherwise not applicable to any unmodified aspect of the existing system; - at all relevant phases of the life-cycle of an application; - for use by railway duty holders and the railway suppliers. It is not required to apply this standard to existing systems which remain unmodified, including those systems already compliant with any former version of EN 50126. The process defined by this European Standard assumes that railway duty holders and railway suppliers have business-level

policies addressing Quality, Performance and Safety. The approach defined in this standard is consistent with the application of quality management requirements contained within EN ISO 9001.

The level crossing railway system designed and used in 5Growth project, development and installation shall comply with the railways RAMS requirements. The most important working groups for these standards is CENELEC - CLC/TC 9X. The CENELEC Project 60237 is finished and the previous standards shall be withdrawal after 2020-07-03.

4.3.3. Standardization Activity Roadmap

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

1) Identify the standardization activities that are or may be relevant to the 5Growth project
2) Map the project technology development areas onto the standardization activities from 1) above, by accounting of the timeline towards 2022.
3) Align the 5Growth SAC with 5GPPP pre-standardization activities and disseminate the activities from relevant 5GPPP projects to 5Growth.

The above two steps are presented in the following sub-sections. First subsection is classifying the standardization activities to technical innovations of 5Growth 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.

4.3.3.1. 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 3.

TABLE 3: MAPPING OF TECHNOLOGY AREA TO SDOS

#	Key Technology development area of the project	Standardization groups
1	Use cases, gaps, requirements, architectures	ETSI NFV, ETSI ZSM, 3GPP, ONAP, ITU-T SG13, COINRG, NMRG, CENELEC - CLC/TC 9X
2	Automated service definition, generation, creation and onboarding process	ETSI NFV, ETSI ZSM, OSM, ONAP, SFC WG
3	Enhance the support to enable verticals to manage services and configuration of applications.	ETSI ZSM, 3GPP, OSM, ONAP
4	AI-based solutions for arbitration, service demand and traffic prediction	ETSI ENI, ETSI ZSM, ONAP, NMRG
5	Definition of novel security and trust models for services that run over multi-domain slices	ETSI ZSM, OSM, ANIMA WG
6	AI-based E2E network slicing solution	ETSI ENI, ETSI ZSM, ITU-T SG13, ITU-T SG15,,NMRG

7	Novel multi-domain federation strategies	ETSI MEC, ETSI ZSM, OSM, ONAP, NMRG
8	AI-based prediction of user mobility to anticipate redeployment of computing and storage resources and for the pre-emptive scaling in/out/up/down of virtual functions	ETSI ENI, ETSI ZSM, ONAP, SFC WG, DMM WG
9	Model-based monitoring management	ETSI NFV, ETSI ZSM, OSM, ONAP
10	Closed-loop automation and SLA Control for automated vertical service lifecycle management	ETSI ZSM, OSM, ONAP
11	Telemetry orchestration mechanisms	ETSI NFV, ITU-T SG15, OSM, ONAP
12	Closed loop management of individual resources in the RAN, MEC, transport or core domains	ETSI ENI, ITU-T SG13, 3GPP, OSM, ONAP
13	AI-based prediction of user mobility to anticipate the migration of virtual functions and enable advanced resource-layer orchestration	ETSI ENI, ETSI MEC, ETI ZSM, ONAP, SFC WG, DMM WG
14	Automated traffic management at network edge	ETSI MEC, ETSI ZSM, OSM, ONAP, RAW
15	Definition of novel security and trust models for services that run over multi-domain slices in a multi-tenant environment.	ETSI NFV, ETSI ZSM, ITU-T SG13, ITU-T SG15, OSM,
16	Closed-loop automation and SLA Control for automated vertical service lifecycle management.	ETSI ENI, ETSI ZSM, OSM, ONAP
17	Closed loop management of individual resources in the RAN, MEC, transport or core domains.	ETSI ENI, ETSI MEC, ETI ZSM, OSM, ONAP
18	Prediction mechanism (based on AI/ML, Bayesian analysis, etc.) of user mobility and resource demands to anticipate the migration of virtual functions and enable advanced resource-layer orchestration.	ETSI ENI, ONAP, SFC WG, DMM WG
19	Automated E2E network slicing solution, exploiting AI/ML, optimization frameworks and system control, to jointly optimize RAN, Transport, Core and cloud/MEC resources, across multi-technology and multi-vendor sites.	ONAP, ETSI ENI
20	Automated solutions for arbitration of concurrent slices, service demand and traffic prediction exploiting AI/ML, Bayesian analysis and others.	ONAP, NMRG, ANIMA WG

TABLE 4: STANDARDIZATION WORKING GROUP MAPPING TO 5GROWTH USE CASES

SDO	Working Groups	Study Item
3GPP	RAN2, RAN3, SA2	Industrial IoT & URLLC, RAN Data collection enhancements, 5G-Lan type service, Edge Computing on 5GC, Next Generation real-time communication services
IETF & IRTF	SFC WG, ANIMA WG, DMM WG, NMRG, RAW, COINRG	N/A
ITU-T	SG13, SG15	All use cases listed on the left require eMBB and/or URLLC. ITU-T scope resides in any solution, architectural (SG13) or regarding switching and transmission technologies (SG15), which may be requested to the transport network (both fronthaul and backhaul links) to meet the use case performance.
ETSI	ETSI NFV, ETSI ZSM, ETSI ENI, ETSI MEC	All use cases can be demonstrated as concrete proofs-of-concept within the PoC framework of the individual groups. ETSI PoCs are required to show a particular feature or new requirement to the standard framework being defined by the group.
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.
IDSA	N/A	WG-Architecture, WG-Requirements
CENELEC	CLC/TC 9X	The level crossing (supported by 5G communications) railway system design, development and installation shall comply with the railways RAMS requirements (EFACEC_S Use Cases/Portugal Pilot Site)

4.3.3.2. 5Growth Standardization and Open Source timeline

The following figure presents a timeline of 5Growth SAC SDOs and open source projects over the lifetime of the 5Growth project.

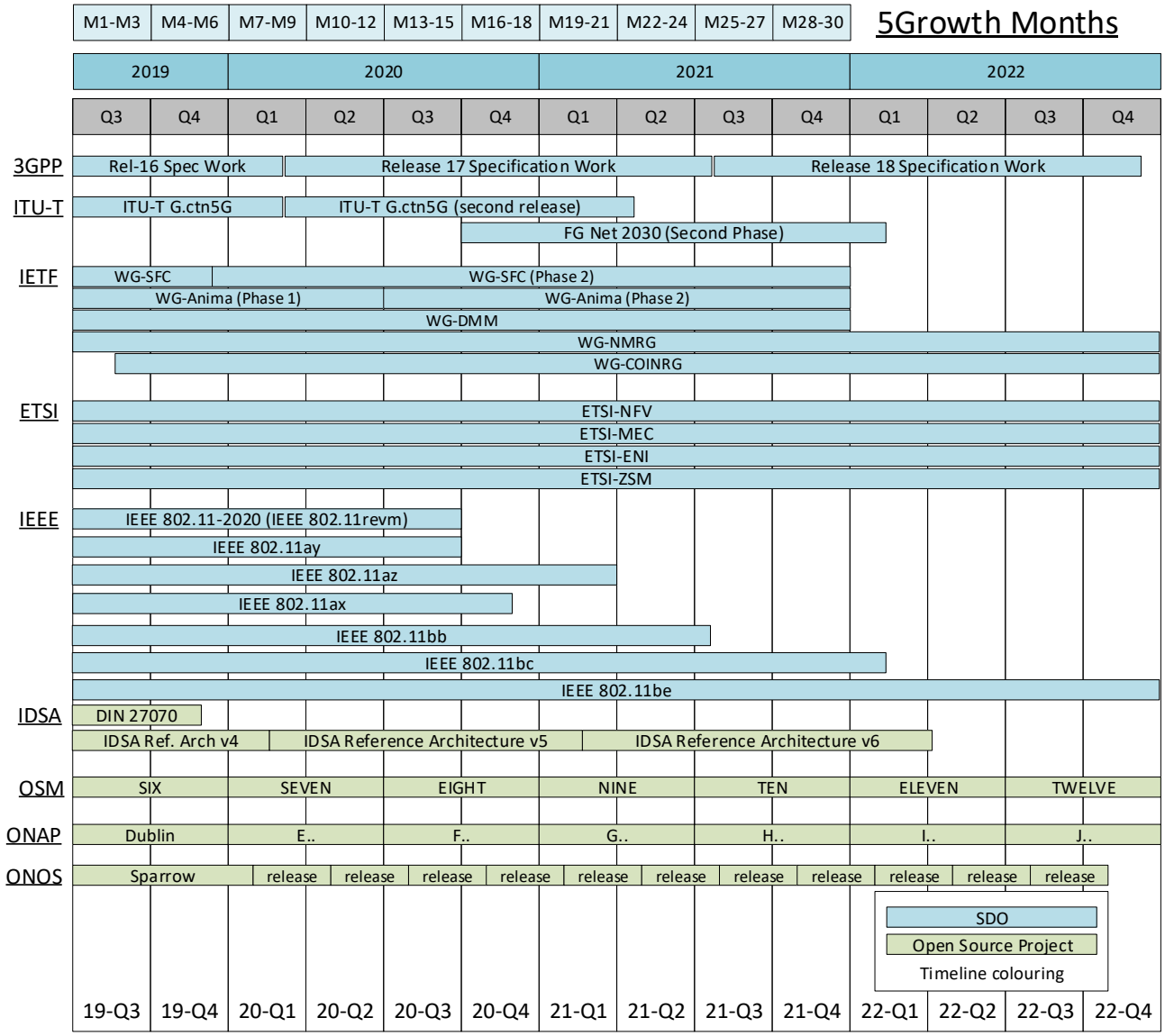


FIGURE 2: STANDARDIZATION AND OPEN SOURCE ACTIVITY ROADMAP TOWARDS 2022

4.4. Open Source

4.4.1. Relevant Open Source activities

This section presents the open source activities used or contributed in 5Growth project.

4.4.1.1. OpenStack

OpenStack is a cloud operating system that controls large pools of compute, storage, and networking resources throughout a datacentre, all managed and provisioned through APIs with common authentication mechanisms. One of the native components of OpenStack also provides OpenStack administrators control while empowering their users to provision resources through a web interface.

The OpenStack community is truly open: the code is developed under open source licence, the design is transparent, and the community is available for everyone. One of the strengths of OpenStack community is that it gathers people with similar philosophies and design aspirations about cloud architecture and open-source software.

OpenStack is governed by a non-profit foundation and its board of directors, a technical committee, and a user committee. The board of directors is made up of eight members from each of the eight platinum sponsors, eight members from the 24 defined maximum allowed Gold sponsors, and eight members elected by the Foundation individual members.

5Growth uses OpenStack as a cloud operating system for running Virtual Machines (VMs). Potentially some changes may be done into OpenStack components to tune the system (patches, drivers etc.) and satisfy project needs. The scope of the 5Growth project falls mostly in to the network and compute related components like Nova, Neutron, Octavia, Designate etc.

OpenStack is committed to an open design and development process. The community operates around a six-month, time-based release cycle with frequent development milestones. During each release cycle, the community gathers for the Forum to gather requirements from users, then developers meet at the Project Teams Gathering (PTG) to begin development work and cross-project collaboration. The following is an example of the OpenStack release cycle:

- **September 10-14, 2018:** Project Teams Gathering in Denver, USA
- **November 13-15, 2018:** The Forum (Stein release) at OpenStack Summit Berlin
- **April 10, 2019:** Stein Release
- Latest Release: Learn about OpenStack Train, Explore all the OpenStack projects

TABLE 5: OPENSTACK RELEASE SCHEDULE

Series	Status	Initial Release Date	Next Phase	EOL Date
Ussuri	Development	2020-05-13 *estimated* (schedule)	Maintained *estimated 2020-05-13*	
Train	Maintained	2019-10-16	Extended Maintenance *estimated 2019-10-16*	
Stein	Maintained	2019-04-10	Extended Maintenance *estimated 2020-10-10*	

The OpenStack Roadmap is a community effort to help people evaluating OpenStack, users, and community members understand the features coming in the next release.

- Watch the community-generated Roadmap for Rocky presentation, May 2018
- Read the community-generated Roadmap for Rocky
- View recent Project Update videos from the OpenStack Summits
- The roadmap is formed from the blueprints: https://blueprints.launchpad.net/openstack

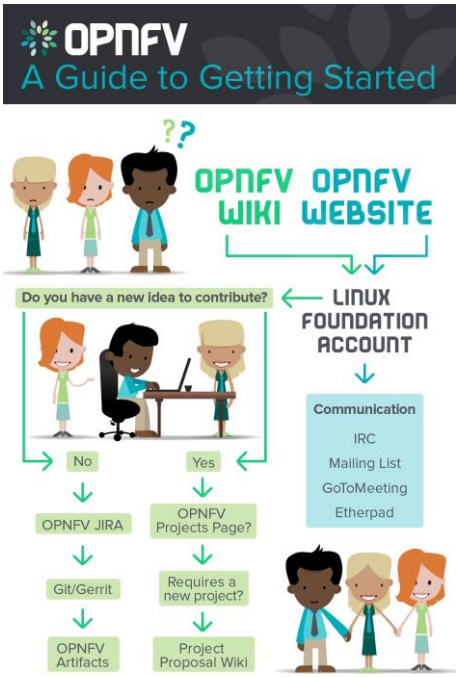
4.4.1.2. OPNFV

Open Platform for NFV (OPNFV) facilitates the development and evolution of NFV components across various open source ecosystems. Through system level integration, deployment and testing, OPNFV creates a reference NFV platform to accelerate the transformation of enterprise and service provider networks. Participation is open to anyone, whether you are an employee of a member company or just passionate about network transformation.

Virtual network functions range from mobile deployments (5G/LTE), where mobile gateways (e.g. SGW, PGW, etc.) and related functions (e.g. MME, HLR, PCRF, etc.) are deployed as VNFs, to deployments with “virtual” customer premise equipment (CPE), tunneling gateways (e.g. VPN gateways), firewalls or application level gateways and filters (e.g. web and email traffic filters) to test and diagnostic equipment (e.g. SLA monitoring).

TABLE 6: OPNFV RESOURCES

RESOURCE	LINK
Main web site for	https://www.opnfv.org
Wiki for the OPNFV	https://wiki.opnfv.org
How are contributions made to the forum?	https://www.opnfv.org/community/get-involved
Visualization of the releases	https://wiki.opnfv.org/display/SWREL/Releases
Roadmap until the end of the 2022	https://wiki.opnfv.org/display/SWREL/Iruya+Release+Key+Updates



OPNFV provides consumable releases every six months, these are made available around March and September respectively. A release of OPNFV provides an install-able datacenter reference platform, providing a variety of compositions and associated functions applicable for carrier network virtualization.

4.4.1.3. Akraino Edge Stack

Akraino Edge Stack is an open source software stack that improves the state of edge cloud infrastructure for carrier, provider, and IoT networks.

Akraino Edge Stack community is focused on Edge APIs, Middleware, Software Development Kits (SDKs) and will allow for cross-platform interoperability with 3rd party clouds. The Edge Stack will also enable the development of Edge applications and create an application w/ Virtual Network Function (VNF) ecosystem.

Akraino can potentially be used to host some 5Growth infrastructure components or for running vertical applications.

TABLE 7: AKRAINO EDGE STACK RESOURCES

RESOURCE	LINK
Website	https://www/lfedge.org/projects/akraino
Wiki	https://wiki.akraino.org
Documentation	https://wiki.akraino.org/display/AK/documentation
Mail Lists:	https://lists.akraino.org/g/main

Blueprints	https://wiki.akraino.org/pages/viewpage.action?pageid=1147243
Calendar	https://wiki.akraino.org/display/AK/Akraino+TSC+Group+Calendar
Release calendar	https://wiki.akraino.org/display/AK/Release+Calendar

Releases to the Akraino project are targeted at 6 months spacing. Release 1 target was May 30th 2019. Next release will be Nov 30th 2019. There is no clearly defined roadmap for Akraino edge stack, as the community is contribution driven.

4.4.1.4. 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

4.4.1.5. 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 are 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

4.4.1.6. ONOS

ONOS (Open Network Operating System) is an open source, extensible, modular and distributed SDN control platform able to manage network components and run software applications to provide communication services and simplify the management and configuration of entire networks.

As reported in its web page (https://onosproject.org/mission/), ONOS mission is "To produce the Open Source Network Operating System that will enable service providers to build real Software Defined Networks".

ONOS governance structure, depicted in Figure 3, is based on a board of directors and four steering teams: the technical steering team, the use case steering team, the release management team, and the community steering team. The *technical steering team* is responsible for all the ONOS technical decisions including, for example, the content and structure of the code and the prioritization of the technical features. The ONOS chief architect is the leader of the technical steering team. The *use case steering team* is responsible for prioritizing the use cases that will be developed and for the specification of their customer requirements, as input to the ONOS technical team. The *release management team* coordinates the release management process, defining the priority of the features in the different releases. The *community steering team* is in charge of feeding and growing the community.

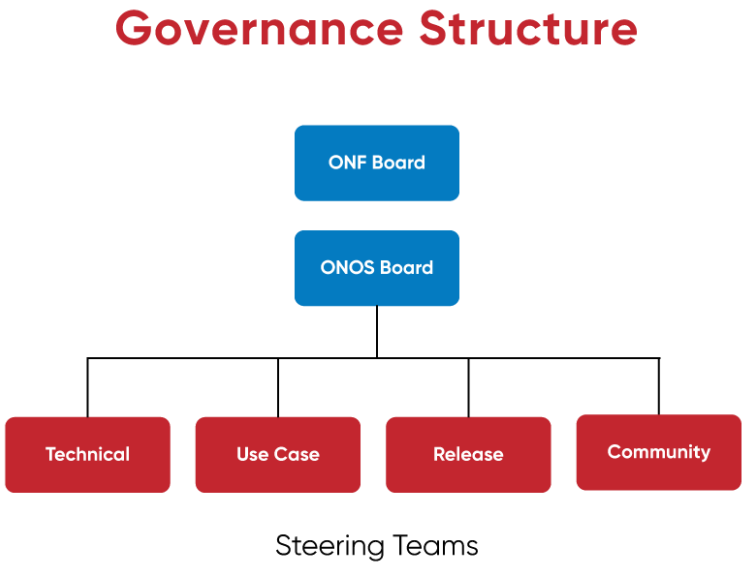


FIGURE 3: ONOS GOVERNANCE STRUCTURE

ONOS can be adopted as SDN controller in the context of the Resource Layer implementation.

ONOS contribution to the source code must be released under the Apache 2.0 license. Moreover, all submitters are required to agree to the ONOS Contributor License Agreement (CLA)[1], which is based on the Apache Software Foundation CLA.

ONOS releases are based on cycles of three months and they are delivered at the end of February, May, August and November. The maintenance is guaranteed for the last two releases. The last available release is "Sparrow", released in August 2019.

4.4.1.7. E.DO

FIGURE 4: E.DO ROBOT

E.DO is a manipulator created by COMAU S.p.A., shown in Figure 4. The robot is composed by six joints, the first three for the arm and the lasts for the wrist. Externally, e.DO can be enhanced with user-developed accessories and configurations. Internally, e.DO is ROS-native, open-source control logic gives users complete freedom to create and execute their own programs and applications.

The possibility to add some applications on the sixth axis as a gripper gives to e.DO the prospect to do everything from executing simple pick and place movements to handling automated activities. The maximum payload is 1kg and it can apply a torque of 4N/m.

To support open source community around the e.DO platform, Comau has created following web resources for the e.do platform:

a) Forum: https://edo.cloud/forums
b) Android app: https://edo.cloud/apps
c) Source code and binaries: https://edo.cloud/github
d) Documents and Datasheets: https://edo.cloud/documents

Figure 5 shows, at high level, the system architecture of the platform and how different components communicate between each other. The e.DO controller is based on a Raspberry PI 3 which controls both the motion components (power management, motors and brakes) and the different interfaces

[1] https://onosproject.org/wp-content/uploads/2016/07/ONLab_individual_CLA.pdf

to controllers. The Raspberry PI 3 has the ROS Kinetic Kame inside. The operating system is Open Source OS Raspbian Jessie. The Raspberry PI 3 also communicates through Robot Operating System (ROS) Serial with the USB and has the possibility to communicate with external devices with the USBs, WiFi and Ethernet. Regarding the integration with 5Growth project, the same COMAU second use case about monitoring and telemetry could be applied on the e.DO robot as well as some remote control via 5G.

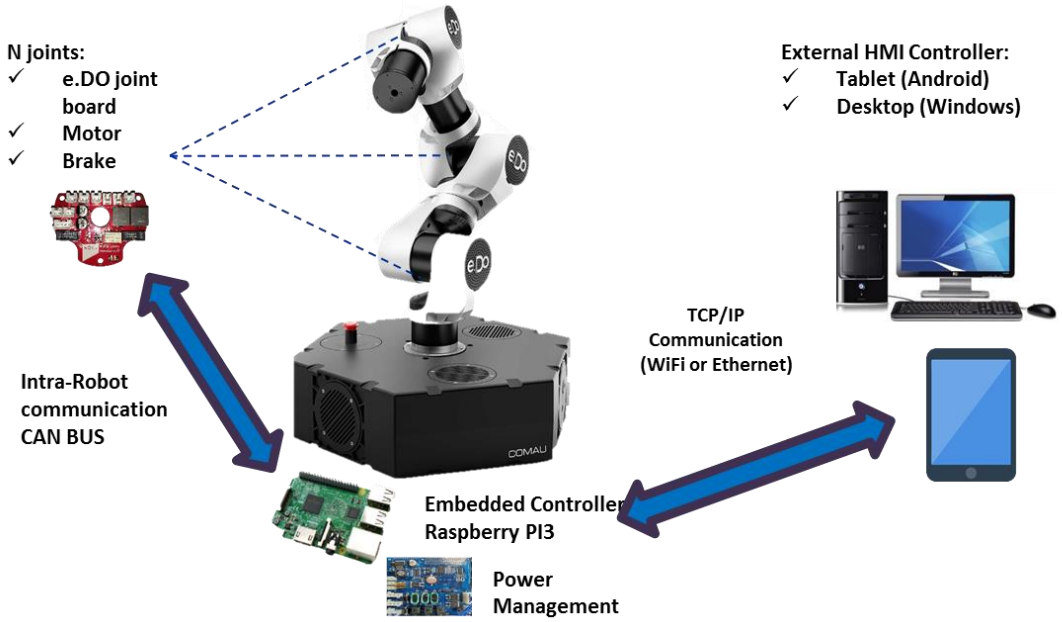


FIGURE 5: SOFTWARE ARCHITECTURE

The Open Source components of e.DO are ROS compliant and the modules included in the e.DO GitHub repository include:

TABLE 8: E.DO OPEN SOURCE COMPONENT DESCRIPTION

Component name	Component description	Github repository
eDO_boards_firmware	eDO Boards Firmware	https://github.com/Comau/eDO_boards_firmware
eDO_core	eDO Ros core Package	https://github.com/Comau/eDO_core
eDO_core_msgs	User Interface Project	https://github.com/Comau/eDO_core_msgs
eDO_ui_sdk	Edo MoveIt Package	https://github.com/Comau/eDO_ui_sdk
eDO_moveit	Edo Robot URDF file for ROS	https://github.com/Comau/eDO_moveit
eDO_description	Edo Robot URDF file for ROS	https://github.com/Comau/eDO_moveit

5. Early achievements

5.1. Communication activities

In this section we report the early achievements of the project related to the communication activities. The following sections will deal with some specific aspects of communication activities since the project kick-off on June 1, 2019 in Madrid. The first official project press release was released on July 27 2019, in Madrid, Spain. Additionally, partners also released their own internal (company-wide) and external press releases (see Annex A. News and Press releases). More details can also be found in the project website (http://5growth.eu/).

The following figures (Figure 6 and Figure 7) present the poster and leaflet of the 5Growth project.

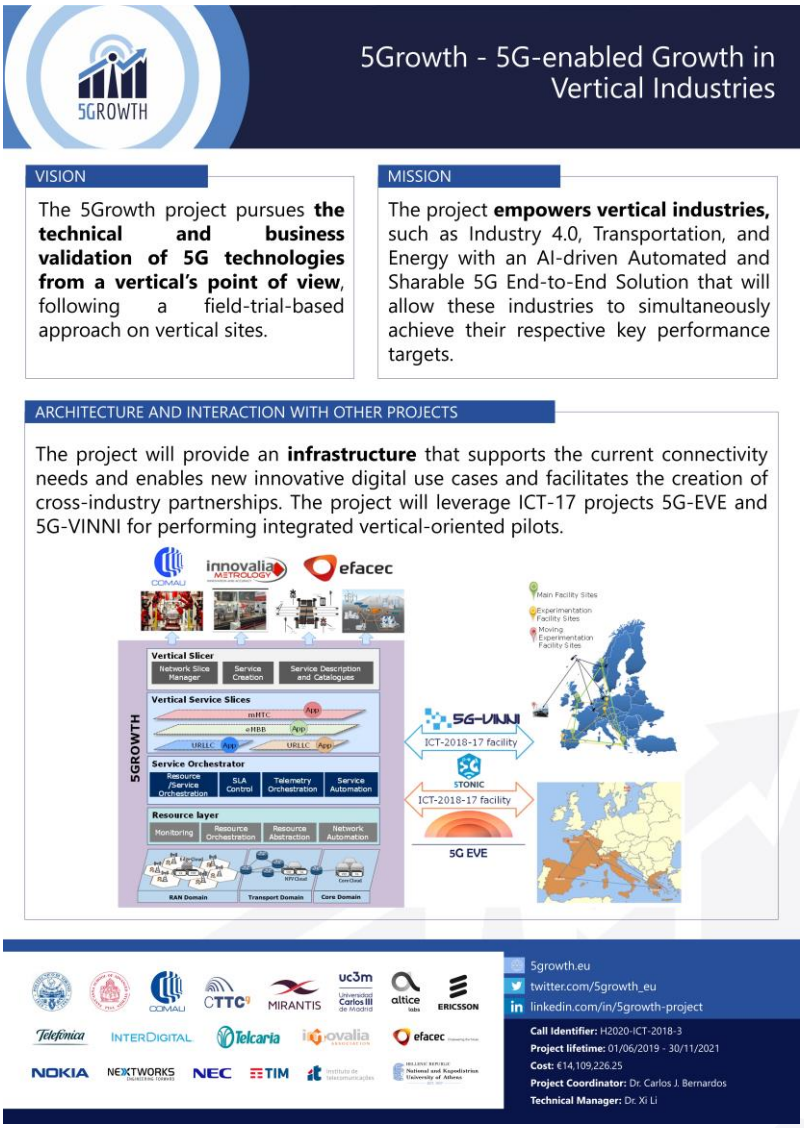


FIGURE 6: 5GROWTH POSTER

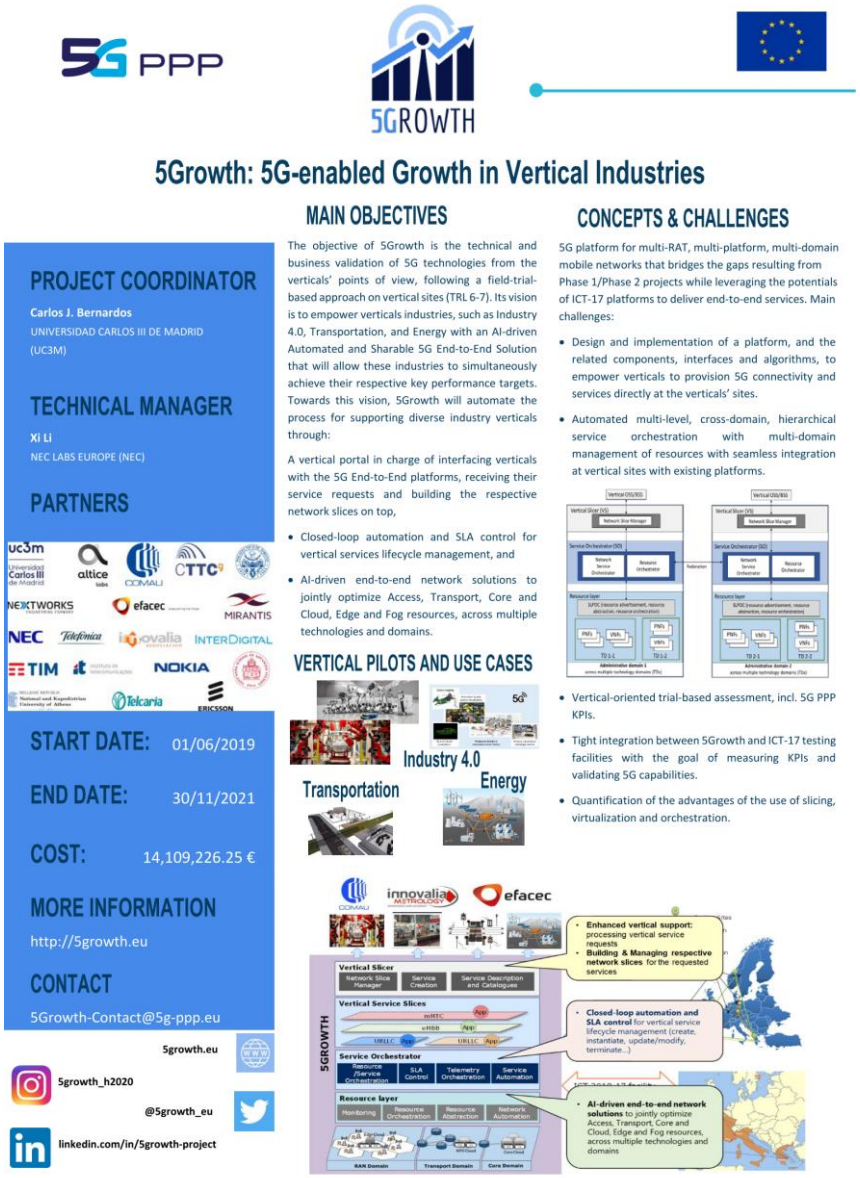


FIGURE 7: 5GROWTH LEAFLET

5.1.1. Web, social media, and project communication material

The project website has been established at the beginning of the project and it is reachable at following URL: http://5growth.eu/. The landing page is reported in Figure 8.

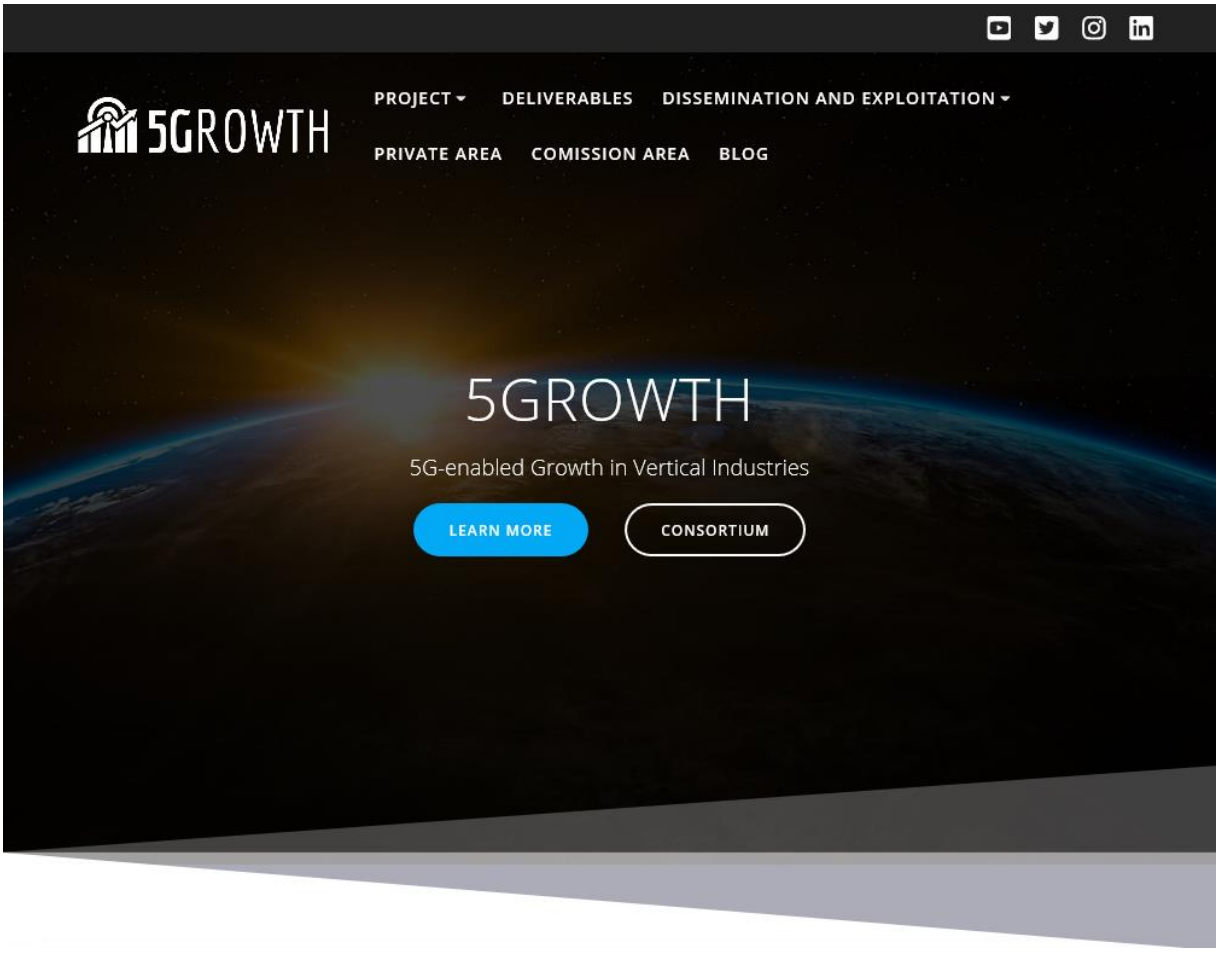


FIGURE 8: 5GROWTH WEBSITE LANDING PAGE

Some initial statistics have been gathered for the website. They are reported in the Figure 9. It can be observed that, since the beginning of the project (i.e., "last 365 days" statistics) about fifty thousand visits have been achieved.

Summary

Online Users: 4

	Visitors	Visits
Today:	87	215
Yesterday:	62	234
Last 7 Days:	514	2,162
Last 30 Days:	1,914	9,009
Last 365 Days:	8,790	50,337
Total:	8,790	50,337

FIGURE 9: OVERALL WEBPAGE HITS

In details, as shown in Figure 10, the most popular subpages are the ones related to the consortium events and to project deliverables.

Top Pages

ID	Title	Link	Visits
1	Home Page	/	6,279
2	5GROWTH in Torino, Italy	/2019/09/17/5growth-in-torino-italy/	886
3	Plenary Meeting in Pisa	/2019/09/03/plenary-meeting-in-pisa/	418
4	Deliverables	/deliverables/	343
5	Home Page	/index.php	301
6	Europe prepares four 5G pilots in industrial applications	/2019/10/16/europe-prepares-four-5g-pilots-in-industrial-applications/	243
7	Consortium	/project/consortium/	184
8	Project	/project	177
9	Project	/project/	161
10	Consortium	/project/consortium	149

FIGURE 10: DETAILS OF VISITED WEBSITE PAGES

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

- LinkedIn: www.linkedin.com/in/5growth-project
- Twitter: https://twitter.com/5growth_eu?lang=es

Figure 11 reports that 5Growth LinkedIn profile gathered many viewers since the beginning of the project and already has 84 connections. This figure just shows a sample period of the evolution of views.

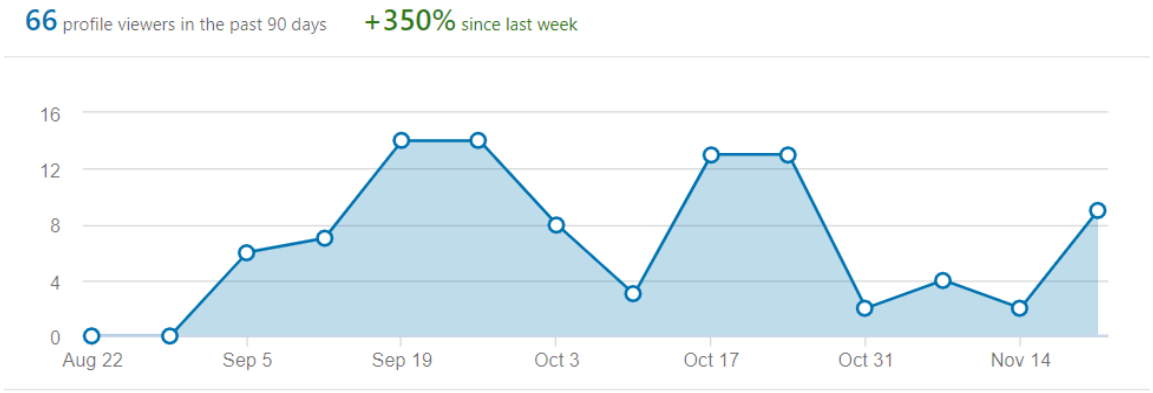


FIGURE 11: 5GROWTH LINKEDIN PROFILE VIEWERS

FIGURE 12: TWITTER ACCOUNT DETAILS

Figure 12 reports the details of the Twitter account that shows an already large number of Tweet impressions and almost two hundred followers.

Finally, activities are also present in Instagram as reported in Figure 13. The Instagram account of the 5Growth project is https://www.instagram.com/5growth_h2020/

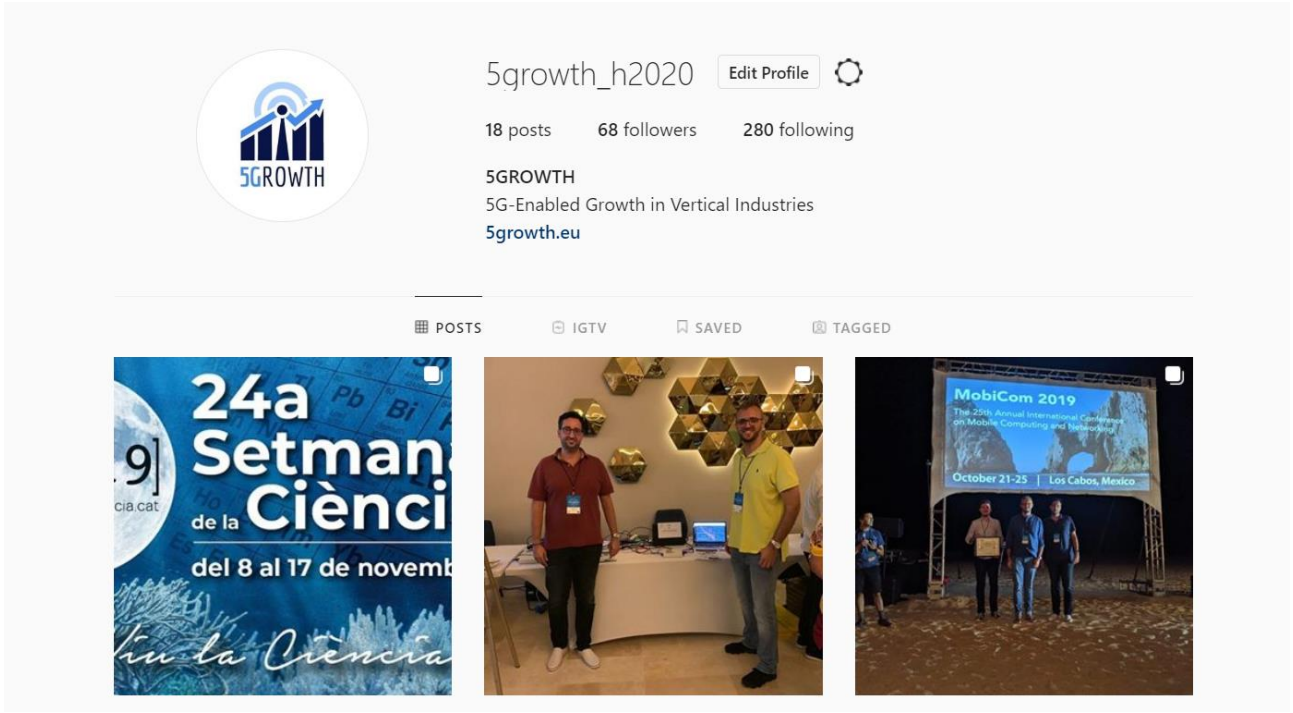


FIGURE 13: EXAMPLE OF INSTAGRAM ACTIVITIES

Finally, the 5Growth project has an active YouTube channel through which talks, demos, and communications videos are published.

FIGURE 14: VIDEO FROM THE 5GROWTH YOUTUBE CHANNEL

5.1.2. Communication Talks and other actions

Four communication talks (Table 9) have been given since the project started as part of the Raise Awareness Phase of the CoDEP. In this sense, the scope of the talks is general, and the focus is on explaining the high-level goals, main building blocks, and verticals involved, including the general technological framework of the project to general public.

TABLE 9: COMMUNICATION TALKS

#	Title	Event
1	The 5Growth project	Internet Festival, Oct. 10-13, Pisa, Italy https://www.internetfestival.it/en/home
2	5G Networks: Why? What? How?	24th Science week, Nov 8-17, Castelldefels, Spain http://www.cttc.cat/24th-science-week/
3	The 5Growth project	Aveiro TechDays. Dissemination of 5Growth project by Aveiro Harbour, Aveiro, Portugal. October 2019. http://ww2.portodeaveiro.pt/sartigo/index.php?x=7090
4	5G challenge (virtualization and edge computing)	Demonstration to general public during Bright researchers night 2019. Sep. 27-28, 2019, Pisa, Italy. http://www.bright-toscana.it/bright/

Additionally, internal communication actions have also been undertaken inside the partner organizations, through internal news and talks.

Furthermore, a communication article about the project was also published:

- "Projeto 5Growth valida comunicações avançadas de 5G," in Power:on magazine (Efacec's internal magazine) (in Portuguese)

Finally, academic partners of the consortium prepared several courses on SDN/NFV-related topics that are taught to graduate and undergraduate students, which benefit from the 5Growth work. A preliminary list of the courses is presented in Table 10.

TABLE 10: LECTURES AND COURSES

#	Title	Host organization
1	Master in NFV and SDN for 5G networks	UC3M Telematics Department Link
2	Advanced Communication Networks	NKUA Dept. of Informatics and Telecommunications Link
3	Intelligence at the Edge of 5G for enabling 5G services	TIM Academy on 5G and Edge Computing Link
4	Cloud Computing (Master Course)	Politecnico di Torino Link
5	Software networking (Master Course)	Politecnico di Torino Link

5.2. Dissemination activities

In this section we report the dissemination activities of the project. 5Growth has carried out multiple dissemination activities, even if the project is still at its early stage, this included presentations in multiple conferences, seminars and forums.

5.2.1. Publications and technical dissemination

The following table presents 5Growth peer-reviewed articles in scientific journals and studies/demos/posters in scientific conferences.

TABLE 11: PUBLICATIONS IN SCIENTIFIC CONFERENCES

Type	Title	Publication/Conference
journal	Beyond 5G Evolution (Guest editorial)	MDPI Electronics
journal	Service Shifting: a Paradigm for Service Resilience in 5G	IEEE Communications Magazine
journal	Reducing Service Deployment Cost Through VNF Sharing	IEEE/ACM Transactions on Networking
conference	vrAIn: A Deep Learning Approach Tailoring Computing and Radio Resources in Virtualized RANs	ACM Mobicom'19
conference	Demo: vrAIn Proof-of-Concept — A Deep Learning Approach for Virtualized RAN Resource Control	ACM Mobicom'19
conference	SliMANO: An Expandable Framework for the Management and Orchestration of End-to-end Network Slices	IEEE CloudNet'19

conference	PI2forP4: AnActive Queue Management Scheme for Programmable Data Planes	ACM Conext'19

Table 12 presents 5Growth consortium talks at scientific conferences, seminars and forums, with the goal to raise awareness on the 5Growth project.

TABLE 12: 5GROWTH TALKS IN SCIENTIFIC CONFERENCES AND TECHNOLOGY FORUMS

Date	Venue	Description
2019-05-22	IEEE ICC 2019	Panelist at IEEE ICC 2019 Workshop: 5G-Trials – From 5G Experiments to Business Validation called Challenges in 5G Trials
2019-05-27	Dagstuhl Seminar 19222 "Control of Networked Cyber-Physical Systems"	Impulsive presentation of 5Growth ("5G Service Automation")
2019-06-20	IEEE EUCNC 2019	Presentation of 5Growth in ICT-19 Session at EUCNC'19
2019-07-23	IEEE EUCNC 2019	Presentation of 5Growth in EMPOWER-PAWR workshop: EUCNC.
2019-07-03	FUSECO FORUM	Presentation of 5Growth (results and WIP) at FUSECO Forum (https://www.fokus.fraunhofer.de/ngni/events/fuseco_forum_2019)
2019-09-03	ICT-19 session by 5G-EVE	5G-EVE organized a session devoted to discussing collaboration with ICT-19 projects (i.e., 5Growth)
2019-10-08	5GPPP TB Workshop	5G-enabled Growth in Vertical Industries

5.2.2. Synergies with other projects

The following table reports collaborative activities with other EU and international research projects (e.g., through 5G-PPP working groups, or working groups of other platforms) towards a coordinated action inside the 5G-PPP.

TABLE 13: COLLABORATIVE ACTIVITIES WITH EU AND INTERNATIONAL RESEARCH PROJECTS

Date	Item	Explanation
2019-06-09	Joint Paper with project 5GTransformer @ IEEE Communications Magazine	Service Shifting: a Paradigm for Service Resilience in 5G
2019-09-09	Joint Paper with projects: 5G-TRANSFORMER, 5G-MoNArch, 5G-TOURS @ ACM Mobicom'19	vrAIn: A Deep Learning Approach Tailoring Computing and Radio Resources in Virtualized RANs
2019-09-09	Joint Demo with projects: 5G-TRANSFORMER, 5G-MoNArch, 5G-TOURS @ ACM Mobicom'19	vrAIn Proof-of-Concept — A Deep Learning Approach for Virtualized RAN Resource Control
2019-10-08	5G-PPP Technology Board meeting	Report 5Growth interaction with ICT-17 platforms

2019-10-24	5G-PPP Software Network WG virtual meeting	Discussion about our future plan/actions of the WG for 2019-2020

Furthermore, partners regularly attend 5GPPP WG meetings (section 3.2).

5.2.3. Bachelor, Master, PhD Theses and Internships

The following table reports bachelor, master and PhD theses as well as internships on matters related to 5Growth.

TABLE 14: 5GROWTH-RELATED BACHELOR, MASTER AND PHD THESES, AND INTERNSHIPS

Type (PhD/Master/Int.)	State (Ongoing /Finished)	Title
Internship	Finished	P4 Programmable Traffic Management
PhD	Ongoing	AI/ML-enabled Sofware Defined Smart Networks on Distributed and Next generation Architectures
PhD	Ongoing	Smart Networks and IoT
PhD	Ongoing	Artifical Inteligence Driven Next Generation Networking
Master	Ongoing	A new SDN application providing Quality of Service (QoS) for network slicing
PhD	Ongoing	Offloading of 5G functions in accelerated edge data centres
Master	Ongoing	Machine learning techniques for anomaly detection in vertical industries
Master	Ongoing	Machine learning techniques for anomaly detection and resource management in 5G networks
PhD	Ongoing	Automated resource management in 5G networks

5.2.4. Standardization Dissemination

In addition to the creation of its initial standardization roadmap, the 5Growth partners will undertake activities to disseminate the project concept and initial results at various standardization forums and other relevant standard-related forums. In this respect, the 5Growth project is collaborating with other EU projects in a 5GPPP a pre-standardization working group by participating the calls, meetings and providing input to the deliverables. The SAC will keep track of the progress of the 5GPPP pre-standards WG and disseminates the relevant deliverables of the pre-standards WG to 5Growth project.

The 5Growth SAC will disseminate the standards contributions to the 5GPPP pre-standards standards tracker online too. The tool is to be used as collaboration platform to track EU leadership, disseminate standards progress with relevant contributions per EU project.

Recently, the 5GPPP pre-standardization working group established a vertical working plan. The goal of this working plan is to increase 3GPP awareness across verticals and to get verticals to contribute on 3GPP standardization. The Table 15 provides a list of 2019 deliverables of 5GPPP pre-standards group to 5Growth project.

TABLE 15: 5G-PPP DELIVERABLES FOR VERTICAL DISSEMINATION IN 5GROWTH

5GPPP Deliverable	Link to the deliverable
The Action Plan from the 2nd 5G Vertical User Workshop is published here with the downloadable presentations:	https://www.global5g.org/sites/default/files/Action%20Plan%20from%202nd%20vertical%20user%20workshop.pdf.

5.3. Exploitation activities

According to the exploitation plan of the 5Growth described in section 0, each partner category, (verticals' 'vendors and service providers', 'network operators', 'small and medium enterprises', and 'academia and research centers') started their activities towards their short-term exploitation objective. More evident results will be reached at the end of the first year.

Verticals: most of the effort has been spent to define the integration of their system into ICT17 platform. For each pilot, different scenarios apply, and different levels of integration have been considered. This first period allowed to acquire the required internal skill inside the company.

Network operators: on the basis of work done for each pilot, network operators focus on understanding the specific vertical requirements in order to extend their 5G experimentation and demonstration facilities.

SMEs: the analysis of potential contributions to open source projects and training courses on SDN, NFV, and MEC architectures and cloud platforms has started.

Universities and R&D centers: definition and analysis of scope of their work (on topics such as multi-domain orchestration and slicing) in a 5G context towards potential exploitation has started.

5.3.1. Products and services

Exploitation on products and services is categorized following the building blocks of 5Growth platforms, namely Vertical Service (VS), Service Orchestrator (SO) and Resource Layer (RL), and the 5G pilot as reported in the table in the section 4.1.6. At this very early stage of the project, no results on the product and platform are reported. More concrete outputs are expected at the end of the project.

5.3.2. Standardization

The 5Growth standards exploitation is targeting to exploit the results of the projects in pre-commercial proof-of-concepts and commercial products, innovations and new features adopted into standards, and new services generated on top of open source baseline implementations.

The standards exploitation activities are added to this section as the project proceeds. In the current phase of the project there are no exploitation activities related to standardization.

6. References

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

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

7. Annex A. News and Press releases

Project news are available at: http://5growth.eu/blog/. Other relevant activities are publicized through the various social media accounts of the project (see Section 5.1). A list of some of the news on 5Growth that have appeared, either published by partners or as news in other websites are (as of November 2019):

- http://ir.interdigital.com/file/Index?KeyFile=398573395
- https://www.5tonic.org/news/5tonic-selected-5growth-project-validate-advanced-5g-trials-across-multiple-vertical-industries
- http://5growth.eu/2019/09/03/plenary-meeting-in-pisa/
- https://www.santannapisa.it/en/news/5g-infrastructure-and-telecommunication-systems-santanna-school-partners-eu-project-test
- http://5growth.eu/2019/09/17/5growth-in-torino-italy/
- https://www.uc3m.es/ss/Satellite/UC3MInstitucional/es/Detalle/Comunicacion_C/1371277997033/1371215537949/Europa_prepara_cuatro_pruebas_reales_del_5G_en_aplicaciones_industriales
- https://5growth.eu/svn/5growth/execution/WP5/T5.1_Communication_activities/Press%20Releases%20and%20news/191017_UC3M_PressRelease_EuropePrepares4Real5GtestIndustrial_Spanish.docx
- http://5growth.eu/2019/10/16/europe-prepares-four-5g-pilots-in-industrial-applications/
- https://www.innovaspain.com/5growth-pone-a-prueba-la-tecnologia-5g-en-la-industrial-espanola/
- http://5growth.eu/2019/11/18/510/