› DESIRE6G ‹

D6.3: Communication and Dissemination Plan (CODP) Report 1

HEU 6G SNS JU Project

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Abstract

This deliverable presents the updated report on the communication and dissemination plan (CODP) for DESIRE6G. In section 2, we present the list of activities done, and progress made related to the metrics established in the initial CODP, divided them into communication, dissemination, and standardization activities. In section 3, we revise and update the plans for the second half of the project, as we move on from the Raising awareness phase to *Presentation of Results* and further into the *Integrated Technical Demonstration* phase.

The document also includes an update of the standardization and open sources activities carried out in the framework of DESIRE6G progressing on the transfer of project outcomes to the industry and software development communities.

Keywords

Communication, dissemination, standardization, open source.

Disclaimer

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List of Acronyms

RP	Reporting Period
3GPP	Third Generation Partnership Project
5G PPP	5G Public Private Partnership
AI	Artificial Intelligence
D6G	DESIRE6G
ETSI	European Telecommunications Standards Institute
ICT	Information and Communication Technology
IEEE	Institute of Electronics and Electrical Engineering
IETF	Internet Engineering Task Force
IRTF	Internet Research Task Force
ITU-T	International Telecommunications Union – Telecommunications standardization sector
NMRG	Network Management Research Group
NFV	Network Functions Virtualization
ONAP	Open Network Automation Platform
ONOS	Open Network Operating System
OPNFV	Open Platform for NFV
O-RAN	Open Radio Access Network
OSM	Open Source MANO
SDN	Software Defined Networks
SDO	Standard Development Organization
TSG	Technical Specification Groups
WG	Working Group

Executive Summary

The main contributions of this document are:

- Presentation of progress made since the project start, and with regards to D6.1 (June 2023) [1].
- Updated version of the communication, dissemination, and standardization and open source plan.

Communication includes all the activities related with the promotion of the project and its results beyond the project's own community. This includes explaining DESIRE6G (D6G) 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 the project's results towards the technical community working in the same research field. In general, this will be done through scientific publications, and participation and organization of technical and scientific events. Although standardization belongs to exploitation, this deliverable also covers standardization, as it is not as sensitive to partners as exploitation, and it is important to report publicly on plans and early achievements.

The communication and dissemination plan (see Figure 1 for a complete scheme) started at the proposal stage with the non-disclosure agreement (NDA) signature and the identification of the various components of the project that could have an impact from a research point of view. Once the grant was awarded, the grant preparation phase, through the consortium agreement, served to define governance rules, including innovation management, and establishment of access rights, among others. After that, and from project start, the plan 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 project generates 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 DESIRE6G concepts in a market-oriented way by incorporating them in products and services, and leaving the DESIRE6G footprint in standards that include project contributions. The plan not only defines the various activities undertaken, but it also defines target metrics for each of them.

Key contributions

Summary of the main contributions, take aways of the activities and metrics reported::

Communication

- Utilization of branded promotion material, physically and digitally to raise awareness and create an identifiable project identity.
- Creation of content and regular update of project website, and on social media (LinkedIn and X), which has resulted in more than 22,891 visits to the website and a total combined of 641 followers.
- Communication talks and press releases for lay and expert stakeholder groups: students, authorities, and the SNS JU community.
- 12 videos create and available on our YouTube platform directed at differences audiences.

Dissemination

- 25 published or accepted scientific publications, some of them joint with other projects.
- 30 dissemination talks/ presentations to explain DESIRE6G and its concepts to a technical audience.
- 5 demos, 2 of which have been presented at flagship events (OFC2024)

Standardization and Open Source

- Initial set of contributions: 8 to SDOs (3 approved) and 5 to open source communities (4 accepted).
- Continuous monitoring of relevant SDOs (e.g., 3GPP, IETF, ETSI) and open source projects for networking (e.g., OSM).
- Review of the initial standardization roadmap according to the timelines of the SDOs and the project.

1. Introduction

The communication and dissemination plan of DESIRE6G includes the three following groups of activities:

- *Communication*: It includes all the activities related with the promotion of the project and its results beyond the project's own community. This includes 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.
- *Standardization and Open Source*: it covers monitoring and impact in standardization activities, and contributions to open source.

The communication and dissemination plan 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., communication 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.

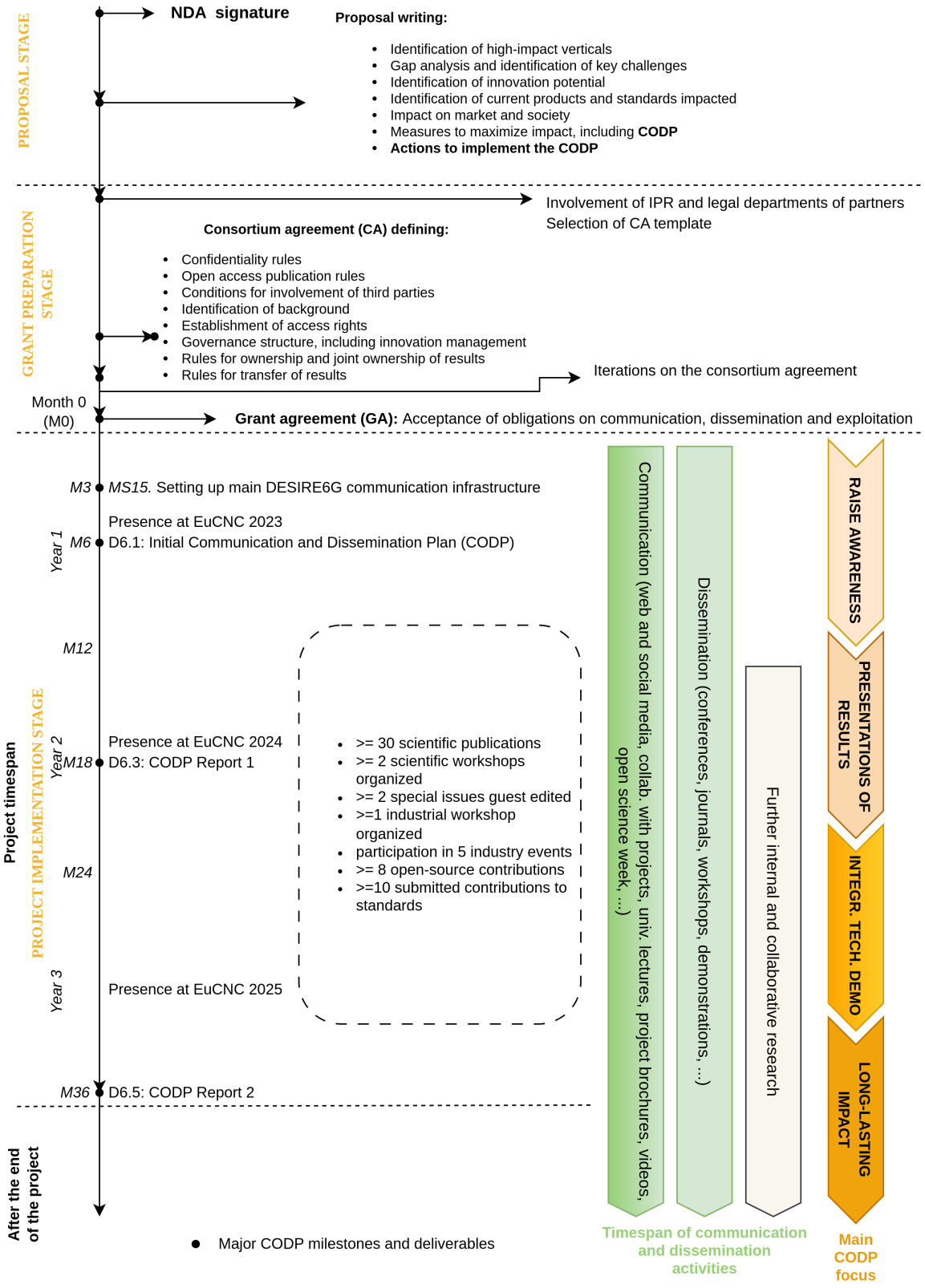

FIGURE 1: DESIRE6G COMMUNICATION AND DISSEMINATION PLAN

Once the grant was awarded, the grant preparation phase involved the legal departments of the consortium members to specify the legal framework more clearly. 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*.

The communication and dissemination plan activities will gain momentum during the *project implementation* stage. Figure 1 presents the various project milestones and deliverables directly related with the implementation of the plan 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 in graduate, master and doctoral courses.

The above activities require more effort 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. Some of these resources (e.g., brochure, poster and high-level presentation) are meant to be available for use in events where DESIRE6G targets general dissemination of the project mission.

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 relevant projects.
- Standardization and Open Source
    - Contribution to relevant open source software projects.
    - Contribution to standardization bodies according to the standardization plan initially presented in this deliverable and continually refined 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 DESIRE6G 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 plan that will be implemented during the project. This includes the identification of relevant SDOs and open source projects, and the matching of project timelines with those of SDOs. Furthermore, this initial plan will be periodically updated to adapt to standardization interests and context variation.

In the same way, the whole communication and dissemination plan 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 activities. After that, the early achievements in some of the activities of the plan are also listed.

2. Achievements of first reporting period (January 2023 - June 2024)

2.1. Communication activities

In this section we report the achievements in terms of communication since the project kick off on February 2nd of 2023 in Madrid until June 30th of 2024.

2.1.1. Branding

The logo, colours and fonts (Figure 2 and Figure 3) chosen at the beginning of the project have been carried out to every online and physical material to create a brand identity and remain recognizable. All deliverables, milestone reports, and presentations, even for internal use, also follow the official templates.

FIGURE 2: DESIRE6G'S MAIN LOGO AND HORIZONTAL LOGO

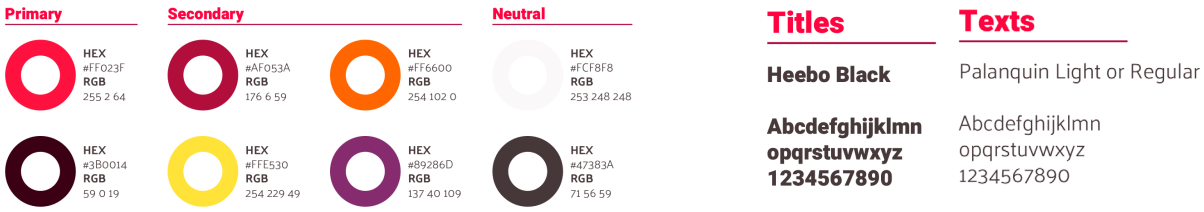

FIGURE 3: OFFICIAL COLOUR PALETTE AND FONTS FOR ALL DESIRE6G MATERIALS

2.1.2. Web, social media, and project communication material

Poster

The first project poster (Figure 4) was presented at ETSI Research Conference (6th to 8th February 2023 in France) during the official presentation of the first phase of SNS JU projects. At that time, the design identity had not been finalized.

Later on, partners have used the D6G colours and logo in their conference poster sessions around the world, as seen in Figure 5, in March 2024 in San Diego, California (USA).

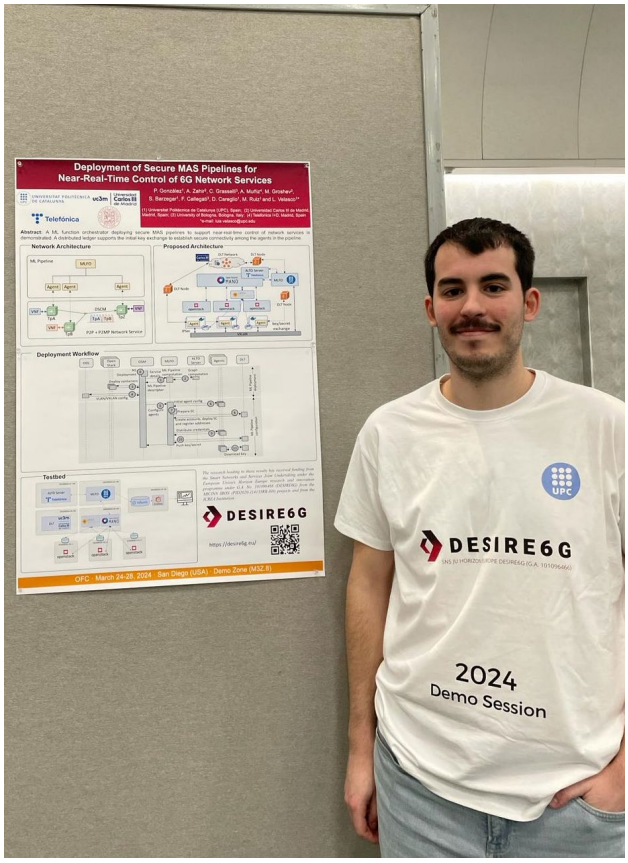

FIGURE 4: FIRST POSTER (FEBRUARY 2023)

FIGURE 5: POSTER AT OFC2024 BY POL GONZALEZ (UPC)

Leaflet

The project leaflet (Figure 6) was created to generate awareness about the project, and to communicate the project's objectives and key innovations in an easy way. Plenty of printed copies were distributed among D6G partners, who have displayed it at all kinds of events: conferences, workshops, panels, fairs,

SNS events, etc. Additionally, a QR code was added to the back of the brochure (not visible in the figure) to generate traffic to the project's website.

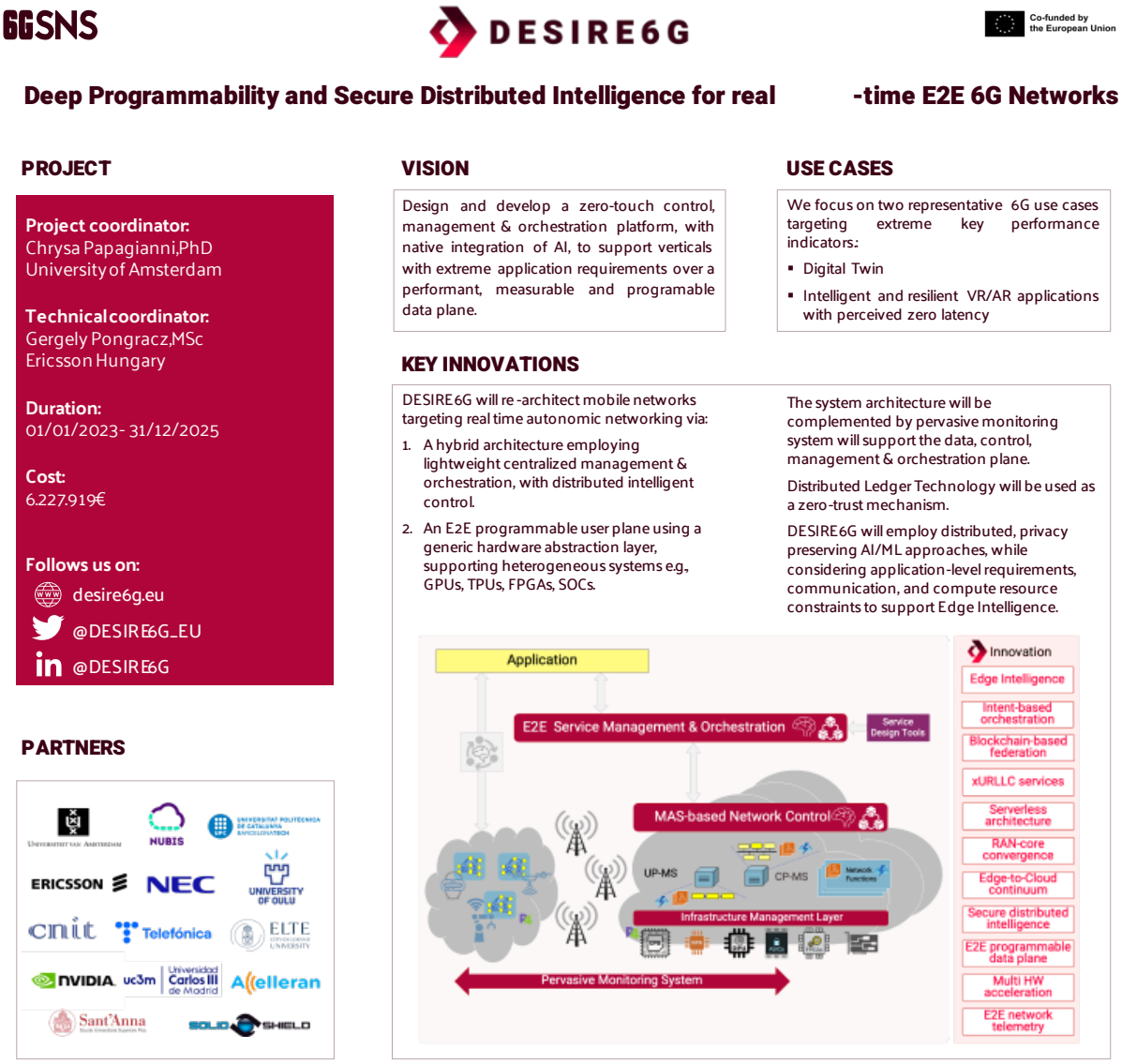

FIGURE 6: PROJECT LEAFLET (MAY 2023)

Website

The project website https://desire6g.eu/ was created at the beginning of the project and launched to the public on March 30th. Figure 7 shows the landing page.

The website is the most complete source of information about DESIRE6G. It is updated almost every week, with the latest publications, presentations, communication materials and events. Additionally, a

news item is added monthly reporting on highlights, such as workshop participation, face-to-face meetings, or demo presentations.

The Introduction video created for both an expert and general audience has been added to the front page to attract viewers.

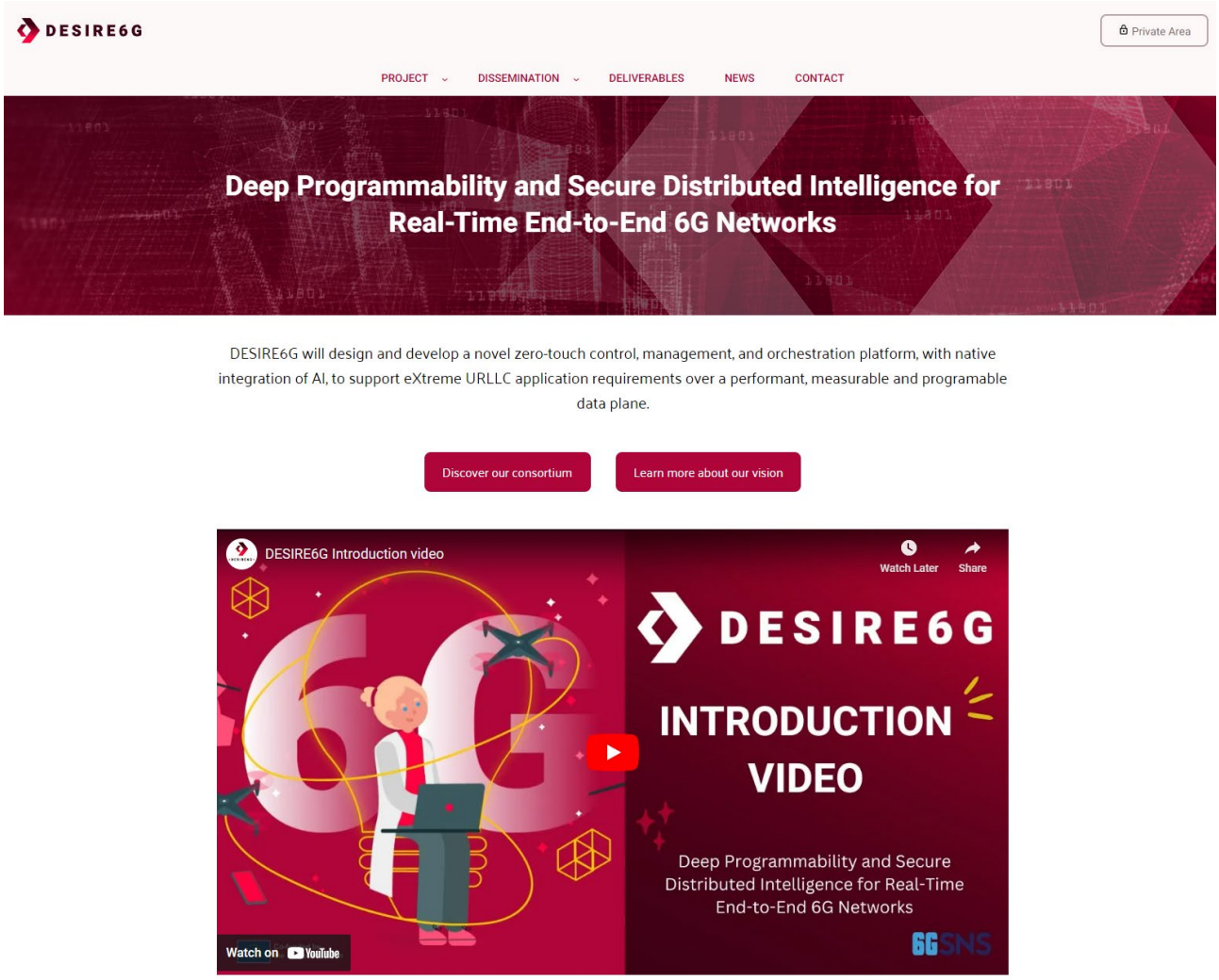

FIGURE 7: DESIRE6G WEBSITE LANDING PAGE

The initial statistics from the project website were collected in June 2023 to monitor engagement throughout the project's lifetime. Now (data retrieved as of June 19 2024), we can appreciate the increase in traffic generated to the website in 12 months.

TABLE 1. WEBSITE TOTAL VISITS AND VISITORS

	Total values June 2023	Total values June 2024
Total visits	1601	22,891
Total visitors	788	9,770

The distribution of visits and visitors shows that there is an increased activity coinciding with posts about events, which are shared on our social media accounts and where many people and institutions are tagged.

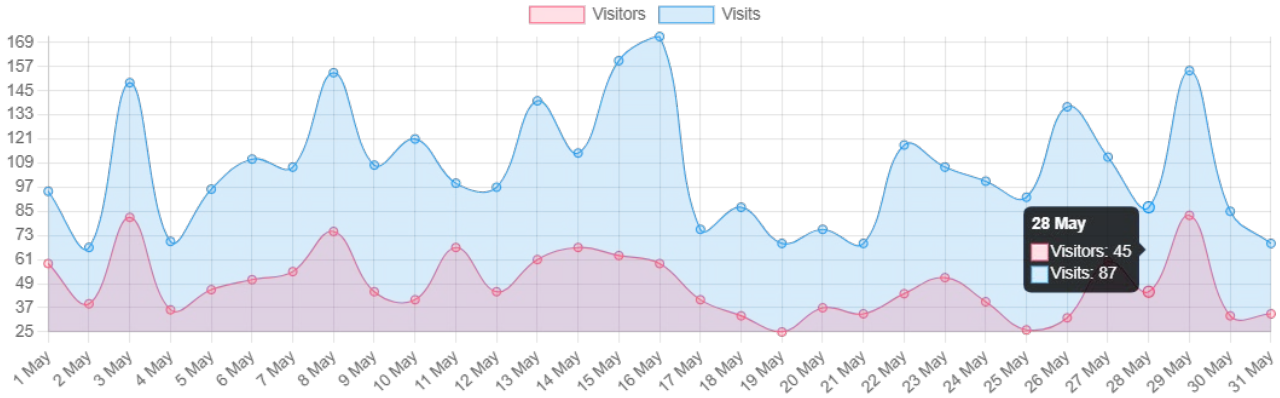

FIGURE 8: CHART OF DESIRE6G.EU VISITS AND VISITORS LAST MONTH (1-31 MAY 2024).

TABLE 2. MOST VISITED PAGES AND TOTAL VIEWS ON DESIRE6G.EU AS OF JUNE 19, 2024

#	Page title	Total visits June 2023	Total visits last year
1	Home Page	955	7,718
2	News	-	2,310
3	Contact	29	1,878
4	Deliverables	53	644
5	Consortium	77	595
6	Publications	57	588
7	Vision	44	511
8	Workshop 6G-PDN	34	499
9	Presentations	-	471

10	Project	88	459

Social Media

DESIRE6G has been active on social media via LinkedIn (https://www.linkedin.com/company/desire6g-project) and X (formerly Twitter) (https://twitter.com/DESIRE6G_EU). Social media accounts are used mostly to inform and interact about upcoming events, new publications, but also engaging with the research community around topics like 6G, network security and efficiency, programmability and machine learning. Additionally, a conscious effort is done to share contents and activities relatable to a broader audience, such as 6G community, science communication, education, collaborative research and women in STEM.

Below are shown the aggregated statistics from DESIRE6G's social media accounts. From Table 3 and Table 5 we can extract that LinkedIn has been a more successful platform than X (formerly Twitter) for DESIRE6G's outreach efforts (494 vs 146 followers). One explanation is that DESIRE6G members are much more active on LinkedIn, which they use as a professional social network, sharing updates of their work with their colleagues and peers. Conversely, very few D6G members have an account on X, which results in much less interaction.

Notably, there has been a substantial growth during the last year since the publication of D6.1., followers on LinkedIn have grown by 3.2x (Table 3). (Data from June 20, 2024).

LinkedIn Analytics

TABLE 3. @DESIRE6G_EU LINKEDIN ANALYTICS. FEBRUARY 2023 TO JUNE 2024

	June 2023	June 2024	Last 30 days 24 May to 22 June
Followers	153	500	35
Visitors	January to June 2023	June 2023 to 2024	
Page views	354	1,436	184
Unique visitors	174	500	67
Custom button clicks	30	20	0
Content	January to June 2023	June 2023 to 2024	
Reactions	364	1,235	303
Comments	7	20	2

Reposts	31	52	3

TABLE 4. LINKEDIN FOLLOWERS DEMOGRAPHICS BY LOCATION IN JUNE 2024

Metropolitan city Area	Numbers of followers	Percentage of total
Madrid Area, Spain	52	10.5%
Greater Istanbul, Türkiye	15	3%
Barcelona, Spain	14	2.8%
The Randstad, Netherlands,	13	2.6%
Budapest, Hungary	13	2.6%
Greater Delhi Area, India	11	2.2%
Pisa, Italy	10	2%
Greater Paris, France	8	1.6%
Bengaluru, India	7	1.4%
London, United Kingdom	6	1.2%
Athens, Greece	6	1.2%
Warsaw, Poland	6	1.2%

Interestingly, compared to June 2023, there are now some Indian followers, which showcases our efforts to reach a very broad geographic audience online. One strategy used is to tag as many people, companies, and events in our posts to appear in as many pages as possible. DESIRE6G is consistently among the TOP5 of SNS JU projects with more new followers per month, as shown in Figure 9.

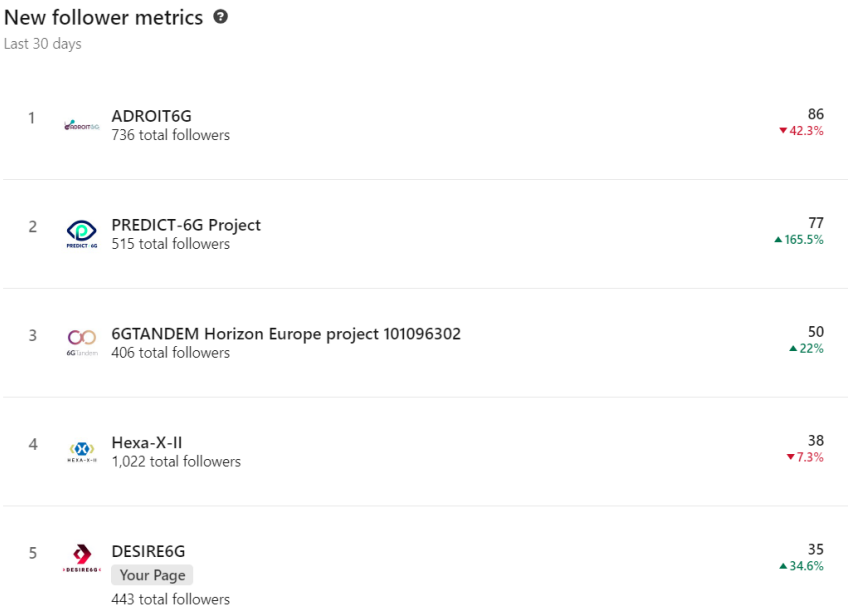

FIGURE 9: RANKING 6G SNS JU PROJECTS, JUNE 2024

X (former Twitter) statistics

Although much slower, following and engagement on X have grown steadily over the last year. Unfortunately, X does not offer analytics information anymore for free accounts, so it is not possible to compare activity with the first 6 months of the project.

TABLE 5. @DESIRE6G X ANALYTICS. FEBRUARY 2023 TO JUNE 2024

	Total values June 2023	Total values June 2024
Followers	42	158
Following	52	176
Tweets	72	226

Interaction in social media

The participation from the consortium members from their own social media accounts has been crucial to achieve the online presence of DESIRE6G. Through following, sharing, liking, and reposting from their own personal accounts, DESIRE6G's posts gained significant popularity. Moreover, interaction with other SNS JU projects and official accounts of organizations (such as SNS JU, 6G Flagship, PREDICT-6G, and DETERMINISTIC6G) generated additional traffic.

YouTube channel

A YouTube channel was also created at the beginning of the project. Figure 10 shows the main page.

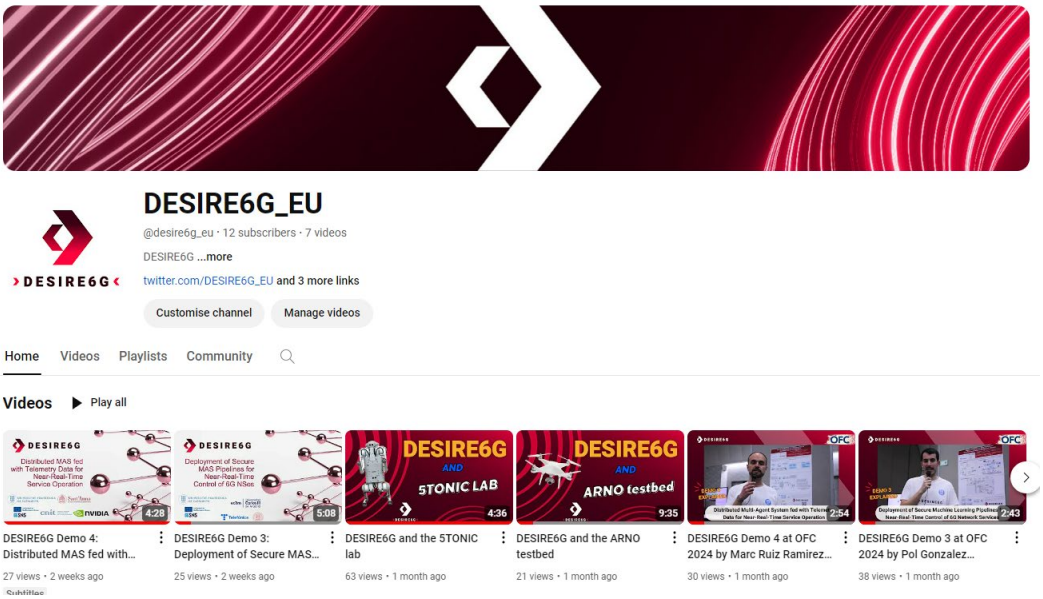

FIGURE 10: MAIN PAGE YOUTUBE CHANNEL

The first video (DESIRE6G Introduction video, shown in Figure 7) was uploaded to the channel (www.youtube.com/@desire6g_eu) on April 2nd 2024. This video was created together with a professional animation company, which supported us in creating the script, drafted together with WP leaders. This video (available here), gives some context about the project, the need for 6G research, and the key objectives, all understandable for the general public. In addition, the content goes in depth in the technical innovations to be developed in the project, aimed at an expert audience. At the end, the video explains the role of SNS JU and the ecosystem of SNS projects, working to achieve European 6G network by 2030.

Since then, we have uploaded 11 more videos (shown in Figure 11): three are partner introductions by TSS, EBY and UC3M (a series that we have just started, focused on introducing partners' views and interest on the project), two are about the testbeds (5TONIC and ARNO, by UC3M, CNIT and SSSA), and five are about the WP5 demos (CNIT, UPC, SSSA, UC3M, TID, NVIDIA and ACC). Figure 12 shows the analytics of views and subscribers, 13 as of 20 June 2024.

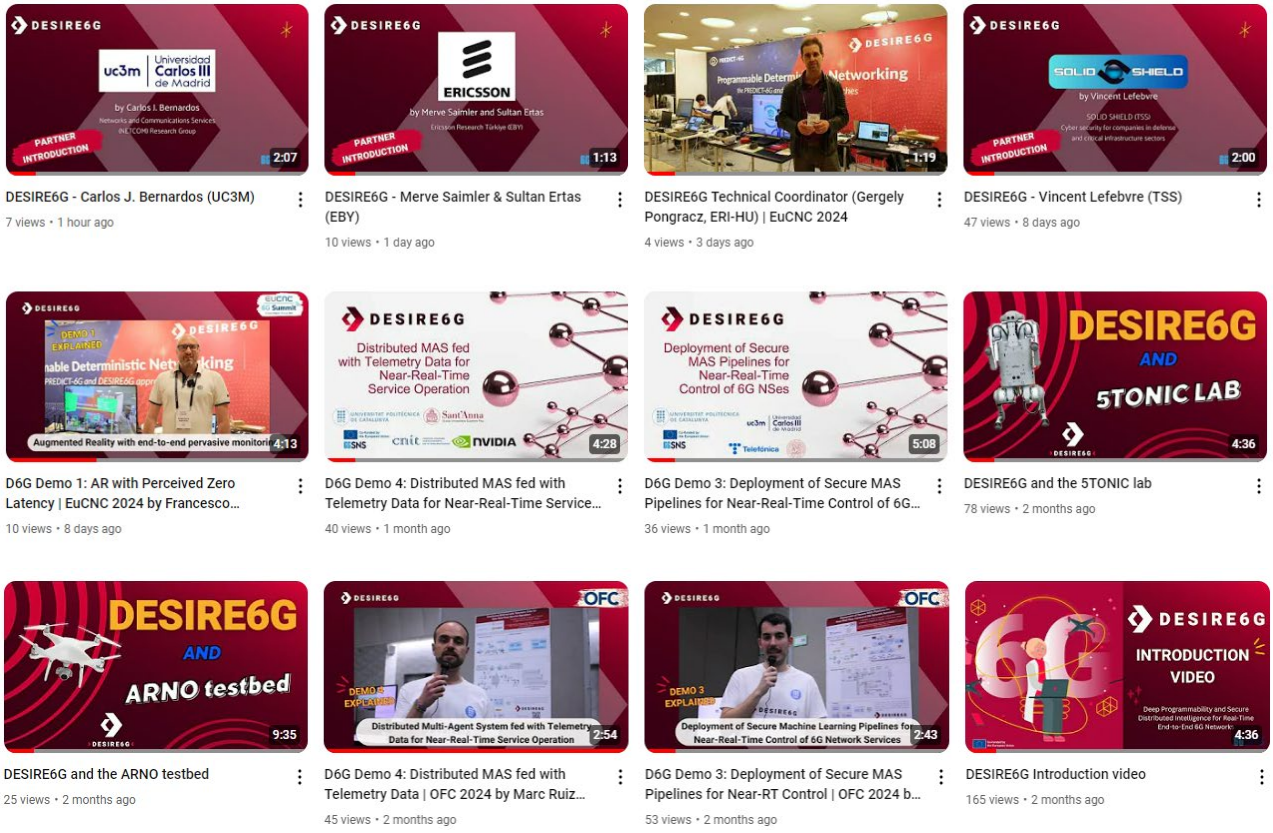

FIGURE 11: OVERVIEW VIDEOS UPLOADED ON YOUTUBE

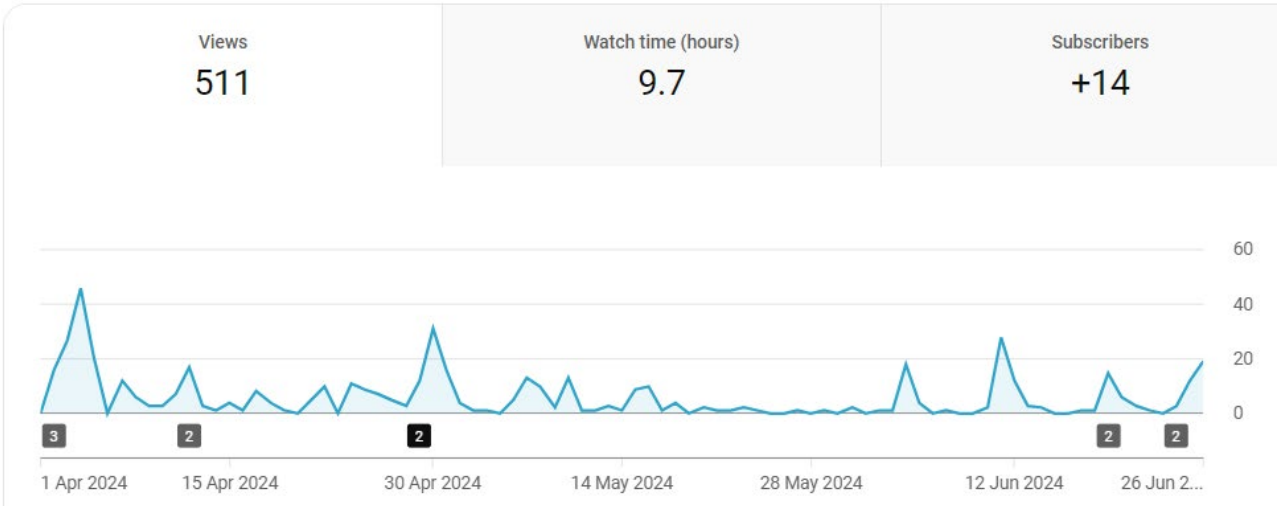

FIGURE 12: YOUTUBE CONTENT ANALYTICS FROM 1 APRIL TO 26 JUNE 2024

2.1.3. Communication Talks and other actions

Press Releases

An initial news piece was published by the University of Amsterdam, containing an interview to the project coordinator Dr. Chrysa Papagianni, accessible here. [2] Secondly, a public press release was published in June 2023, which was shared on the project website, announced through social media and by the partners' own channels and networks.

After the successful organization of 6G-PDN (MobiHoc2023) in Washington, another release was published jointly with PREDICT-6G and shared through 6G SNS channels.

At the end of year one, a technical summary was created by WP Leaders and the Project and Technical coordinators, with details about the main achievements in the work packages, technical challenges encountered and how they were faced by the consortium. It also included a summary of main outputs generated and dissemination and communication activities.

Lastly, marking the end of the first reporting period, we published a release summarizing our achievements in the first half of the project.

TABLE 6. OVERVIEW PRESS RELEASES BY DESIRE6G

Press release title (link to document included)	**Publication date**
Halfway through DESIRE6G: a look at our achievements	June 2024
DESIRE6G : One year review	December 2023
PREDICT-6G and DESIRE6G co-organise "6G-PDN Workshop" at MobiHoc 2023	November 2023
EU project DESIRE6G lays foundation for 6G system architecture	June 2023

Communication Talks and other actions since June 2023

Continuing on with the effort done by all partners to raise awareness of the project, Table 7 contains an update of the individual communication activities done from June 2023 to June 2024. Earlier activities from January to June 2023 were reported in D6.1 [1].

TABLE 7: COMMUNICATION ACTIVITIES ABOUT DESIRE6G. JUNE 2023 – JUNE 2024

Communication action	Partner
Seminar "Towards extreme network KPIs with programmability in 6G" at HyNet lab, University of Maryland, 19 October 2023.	UVA
Project presentation DESIRE6G "Towards Extreme Network KPIs with Deep Programmability in 6G" in the 6G SNS JU brokerage event in Istanbul.	UVA
Press release First year overview of DESIRE6G	UVA, ERI-HU, UC3M, TID, CNIT, NUBIS
HTE Seminar Budapest about the project goals and the proposed data plane concepts	ELTE
4th Preparatory workshop for the Hungarian EU presidency, 05 December 2023 – 15 minutes talk about the SNS program and showing DESIRE6G as an example	ELTE
6G Work Group meeting of the Hungarian 5G Coalition, 06 December 2023 – 15 minutes talk about the goals of DESIRE6G	ELTE
LinkedIn post about ARNO testbed	CNIT, SSSA
YouTube video introducing ARNO testbed and WP5 federated testbeds	CNIT, SSSA
Internal communication of project results to internal stakeholders.	NEC
Presentation "Automatizing CyberThreat Intelligence" at Universidad de Comillas for the Master's program Cybersecurity.	NEC
Presentation for Master students at University of Amsterdam	ERI-HU
YouTube video about 5TONIC lab and its use in the project	UC3M
Content about the project objectives published in the TUBITAK's newsletter	EBY
Supported the SNS Brokerage Event organized by TUBITAK and Sabanci University in Istanbul	EBY
DESIRE6G was represented in the 6G-IA WiTaR working group	EBY
Organization of the joint booth at EuCNC2024	UC3M, UVA, CNIT

Internal dissemination within Telefonica group.	TID
DESIRE6G was introduced as part of the initiatives carried out in Telefonica for facing advanced guaranteed services in the talk entitled “Telefónica initiative for E2E latency and jitter analysis” at the second edition of the webinar event Understanding Latency	TID
Co-creation of website content about demos and OFC2024 presence	UPC, NVIDIA, SSSA, UVA
Creation of communication material for EuCNC2024: news, LinkedIn event and social media activation and strong interaction with PREDICT-6G	UVA
LinkedIn post about collaborative 6G research with D6G partners and dissemination of publications and achievements	NVIDIA, ACC
Offered VR experience to EuCNC visitors at D6G booth and posted on social media	SSSA, CNIT
Presented DESIRE6G during INCYBER Fair	TSS
Made DESIRE6G t-shirts to wear during the demo sessions at OFC2024	UPC
Presented D6G and brought leaflets to KubeCom and FOSDEM2024	NUBIS
Weekly LinkedIn activity to support project posts	ACC
Organization of EuCNC joint booth together with PREDICT-6G, photo and video recording at the venue and social media activity during the conference	Uc3M
LinkedIn content based on dissemination talks and publications	SSSA
Talk on 5G applications at the workshop called “Robotica e macchine intelligenti” at the “Festival della Robotica” for general public	SSSA, CNIT
DESIRE6G robotic dog and AR experience at EuCNC 2024 booth	UC3M, ELTE, NUBIS, UVA
Spanish network-related podcasts: RTS/CTS” (Spotify) and ”Tecnología en 5 minutos”, episode devoted to 6G” (Podtail)	UC3M
“Innovation and testbed projects for the evolution of mobile networks” talk during Telefonica’s 100th anniversary event	UC3M
Youtube video introducing the partner, motivation and contribution to the project	TSS, Uc3M, EBY
Video of Technical coordinator from EuCNC on hi sview of the key objectives of D6G	ERI-HU

2.2. Dissemination activities

In this section we report the dissemination activities of the project. DESIRE6G has carried out multiple dissemination activities, leveraging every opportunity at a project and individual partner level to spread the project results, this included presentations in multiple workshops, conferences, seminars and fora.

2.2.1. Publications and technical dissemination

Table presents peer-reviewed articles in scientific journals and studies/demos/posters in scientific conferences from January 2023 to June 2024. Item titles contain links to the articles in Zenodo. Only published or accepted publications are shown.

TABLE 8: DESIRE6G PUBLICATIONS IN SCIENTIFIC JOURNALS AND CONFERENCES (CONF.)

Type	Title	Publication/Conference	Publication date
journal	P4 FANET In-band Telemetry (FINT) for AI-assisted wireless link failure forecasting and recovery	Computer Networks	June 2024
journal	DESIRE6G: Meeting extreme KPIs through Deep Programmability in 6G AI-Native Systems	European 6G Annual Journal 2024	June 2024
conf.	Near Real-Time Autonomous Multi-Flow Routing with Dynamic Optical Bypass Management	Int. Conference on Optical Network Design and Modelling (ONDM 2024)	May 2024
conf.	Header Proposal for the DetNet Application Layer	Int Conference on Transparent Optical Networks (ICTON 2024)	May 2024
conf.	Reliability in deterministic networks: Comparison of FRER (TSN) and PREOF (DetNet)	Int Conference on Transparent Optical Networks (ICTON 2024)	May 2024
conf.	Distributed Genuine Intelligence: From Agent Integrity to Secure Inter-Agent Communications	European Conference on Networks and Communications (EuCNC24 & 6G SUMMIT)	April 2024
conf.	Distributed Multi-Agent System fed with Telemetry Data for Near-Real-Time Service Operation	Optical Fiber Communication Conference (OFC24)	January 2024

conf.	Deployment of Secure Machine Learning Pipelines for Near-Real-Time Control of 6G Network Services	Optical Fiber Communication Conference (OFC24)	January 2024
journal	Autonomous Flow Routing for Near Real-Time Quality of Service Assurance	IEEE Transactions on Network and Service Management	December 2023
journal	Radio Propagation Digital Twin Aided Multi-Point Transmission With In-Network Dynamic On-Off Switching	IEEE Access	November 2023
conf.	Performance evaluation of Private and Public Blockchains for multi-cloud service federation	Int. Conference on Distributed Computing and Networking (ICDCN24)	November 2023
conf.	Towards extreme network KPIs with programmability in 6G	MobiHoc23	October 2023
conf.	In-Network Quality Control of IP Camera Streams	Int. Symposium on Theory, Algorithmic Foundations, and Protocol Design for Mobile Networks and Computing (MobiHoc23)	October 2023
conf.	Integration of Network Slice Controller for Enhanced Intent-Based Networking in 5G/6G Networks	Int. Conference On Mobile Computing and Networking (MobiCom23)	October 2023
conf.	Federated Learning Gamed for Reconfigurable Intelligent Surfaces via Causal Representations	IEEE Global Communications Conference (Globecom23)	September 20233
journal	SLA Decomposition for Network Slicing: A Deep Neural Network Approach	IEEE Networking Letters	August 2023
conf.	Dynamic Traffic Prediction Model Retraining for Autonomous Network Operation	Int. Conference on Transparent Optical Networks (ICTON23)	July 2023
conf.	DIN: A Decentralized Inexact Newton Algorithm for Consensus Optimization	IEEE Int. Conference on Communications (ICC23)	June 2023
journal	DESIRE6G: Deep Programmability & Secure Distributed Intelligence for Real-Time E2E 6G Networks	European 6G Annual Journal (SNS)	May 2023
conf.	Comparison of Statistical and Machine Learning-Based Approaches for Telemetry Data Size Reduction	Int. Conference on Transparent Optical Networks (ICTON23)	May 2023

conf.	Securing Multi-Agent Systems for Near Real-Time Control of 6G Services	EuCNC23 & 6G SUMMIT	May 2023
journal	P4-assisted seamless migration of serverless applications towards the edge continuum	Future Generation Computer Systems	April 2023
conf.	Pervasive Monitoring and Distributed Intelligence for 6G Near Real-Time Operation	European Conference on Networks and Communications (EuCNC23 & 6G SUMMIT)	April 2023
journal	P4 Telemetry collector	Computer Networks	March 2023
conf.	V2N Service Scaling with Deep Reinforcement Learning	IEEE/IFIP Network Operations and Management Symposium	February 2023
journal	Deep Learning-Based Adaptive Compression and Anomaly Detection for Smart B5G Use Cases Operation	Sensors	January 2023

Table 9 presents an overview of the talks at scientific conferences, seminars and forums, where D6G innovations and results have been presented between January 2023 and June 2024. An example of a demo session at OFC24 is shown in Figure 13, as well a presentation at INCYBER fair.

TABLE 9: DESIRE6G TALKS IN SCIENTIFIC CONFERENCES AND TECHNOLOGY FORA

Title	Date	Description
Towards extreme network KPIs with programmability in 6G	14 June 2024	Chrysa Papagianni (UvA), at the 6G Programmable Deterministic Webinar Series
Autonomous LLM agents for cybersecurity and more	5 June 2024	Roberto González (NEC), Data Week 2024 in Belgium
Network Telemetry short course at the SSSA Seasonal School	5 June 2024	Andrea Sgambelluri (SSSA), "ARTIST - Pervasive ARTIficial Intelligence for Next-G Softwarized neTworks"
Towards extreme network KPIs with programmability in 6G	3 June 2024	Gergely Pongracz (ERI-HU), Architecture WS, EuCNC24
Exploring Kata-Containers: Enhancing Cloud Security and Performance	3 June 2024	Anastassios Nanos (NUBIS), OpenInfra Days Hungary 2024

Intelligence for IOT Networks Towards Reliability, Robustness, And Beyond	24 May 2024	Sumudu Samarakoon (UOU), AIIOT24
QKD endpoint software security: A talk to better grasp attacks plausibility and their remediations.	7 May 2024	Vincent Lefebvre (TSS), ONDM24. QKD workshop.
DESIRE6G – Distributed Genuine Intelligence for 6G	28 March 2024	Vincent Lefebvre (TSS), INCYBER24
Deployment of Secure Machine Learning Pipelines for Near-Real-Time Control of 6G Network Services	26 March 2024	Pol González, (UPC), OFC24
Distributed Multi-Agent System fed with Telemetry Data for Near-Real-Time Service Operation	26 March 2024	Marc Ruiz (UPC), OFC24
Unikernels in K8s: Performance and Isolation for Serverless Computing with Knative	22 March 2024	Ioannis Plakas and Anastassios Nanos (NUBIS), KUBECON24
Performance evaluation of Private and Public Blockchains for multi-cloud service federation	26 February 2024	Adam Zahir (UC3M), ICDCN24
From Containers to Unikernels: Navigating Integration Challenges in Cloud-Native Environments	3 February 2024	Georgios Ntoutsos and Ioannis Plakas (NUBIS), FOSDEM24
A Modular Approach to Effortless and Dependency-Aware Unikernel Building	3 February 2024	Charalampos Mainas and Anastassios Nanos (NUBIS), FOSDEM24
Towards extreme network KPIs with programmability in 6G (Hexa-X-II WS)	26 January 2024	Gergely Pongracz (ERI-HU), online workshop by Hexa-X-II
DESIRE6G – a 6G Architecture Based on Deeply Programmable Networks	6 December 2023	Sandor Laki (ELTE), 6G Work Group of Hungarian 5G Coalition
Pályázói tapasztalatok: a Horizon Europe 6G SNS programban	5 December 2023	Sandor Laki (ELTE), 4th Preparatory workshop for the Hungarian EU presidency
Attesting What and How? Novel Forms of Attestations	15 November 2023	Vincent Lefebvre (TSS), Attestation Workshop at ORANGE Applied Cryptography Group
Towards extreme network KPIs with programmability in 6G	23 October 2023	Chrysa Papagianni (UvA), 6G-PDN Workshop at MobiHoc23
In-Network Quality Control of IP Camera Streams	23 October 2023	Csaba Györgyi (ELTE), 6G-PDN Workshop at MobiHoc23

Edge Intelligence over Wireless: Present & Future	9 October 2023	Mehdi Bennis (UOU), Siemens EDA Forum Finland 23
On the way to 6G – Distributed intelligent control, Deep programmability and Hardware acceleration	9 October 2023	Sandor Laki (ELTE), WG meeting of Hungarian Scientific Association for Infocommunications (HTE)
Integration of Network Slice Controller for Enhanced Intent-Based Networking in 5G/6G Networks	6 October 2023	Alejandro Muñiz (TID), Mobility in the Evolving Internet Architecture workshop (MobiArch) MobiCom23
DESIRE6G presentation at SNS JU Steering Board meeting	5 September 2023	Chrysa Papagianni (UvA), Athens
Comparison of Statistical and Machine Learning Based Approaches for Telemetry Data Size Reduction	3 July 2023	Marc Ruiz (UPC), ICTON23
A brief Introduction to DESIRE6G – A 6G Architecture based on deeply programmable networks	22 June 2023	Sándor Laki (ELTE), Plenary meeting of 5G Coalition, Budapest
Employing deep programmability and distributed intelligence for real-time 6G networks	6 June 2023	Chrysa Papagianni (UvA), The 6G series workshop at EuCNC23
End-to-end data plane abstraction for supporting deep slicing in 6G	6 June 2023	Sándor Laki (ELTE), Future deterministic programmable networks for 6G at EuCNC23
Programmability and Distributed Intelligence: a way towards predictability?	10 May 2023	Gergely Pongracz (ERI-HU), ONDM23 workshop
6G SNS Official start DESIRE6G presentation	23 February 2023	Chrysa Papagianni (UvA), SNS JU Lunchtime Webinars

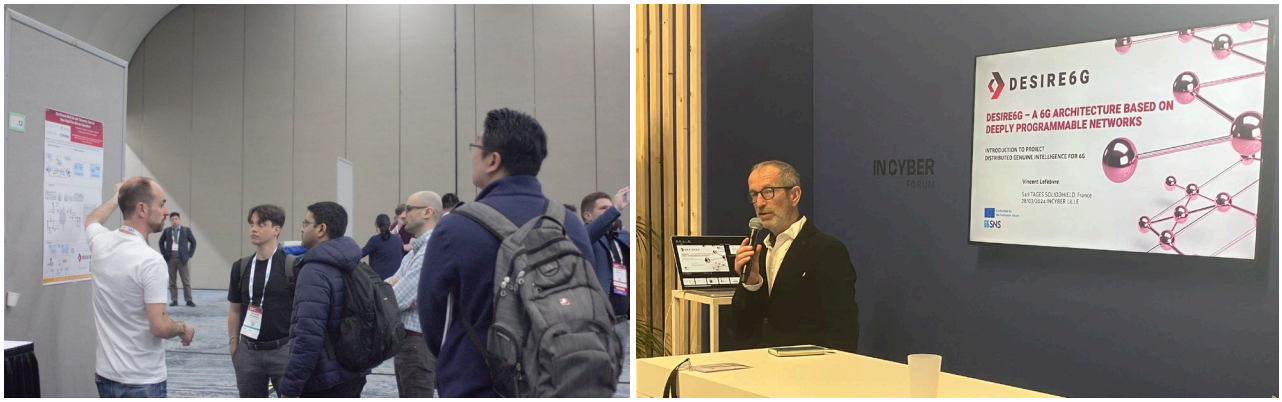

FIGURE 13: DR. MARC RUIZ AT OFC 2024 (LEFT), AND VINCENT LEFEVBRE AT INCYBER 2024 (RIGHT)

In the table below we highlight the most relevant events attended or organized by the project or partners in relation to their work in DESIRE6G.

TABLE 10. OTHER EVENTS ATTENDED OR ORGANIZED (MIGH BE REPEATED IN OTHER TABLES)

Date	Item	Partner
June 2023	Co-organized Workshop at EuCNC2023	UVA, UC3M
June 2023	Participated in the Kick off of the Unikernels Alliance in Aachen	NUBIS
June 2023	Co-organization of IEEE NetSoft 2023 conference in Madrid	UC3M
October 2023	Co-organized 6G-PDN Workshop at MobiHoc 2023	UVA
June 2024	Organization of Special Issue in IEEE Network: "Deterministic, Reliable, Resilient and Programmable Networks for 6G"	UC3M, UVA
June 2024	Participated in "Architectural Considerations Enabling the IMT 2030 Framework by European 6G R&D Activities" workshop	UC3M
June 2024	Co-organization of 2nd 6G-PDN workshop for MobiCom24	UVA, UC3M

Demonstrations

Five technical demonstrations have been achieved stemming from WP5, two of which (Demo 3 & 4) have been presented already in a flagship event, and two more (Demo 1 & 5) to be presented in July 2024.

TABLE 11. DEMOS PRODUCED IN RP1

Date	Demo title	Dissemination activity
March 2024	Demo 3: Deployment of Secure Machine Learning Pipelines for Near-Real-Time Control of 6G Network Services [3] Authors: UPC, UC3M, TID	Presented to the Advisory Board in April 2024 and at the OFC24 demo zone in April 2024 (video here) [1]. Slides presentation here [2].
March 2024	Demo 4: Distributed Multi-Agent System fed with Telemetry Data for Near-Real-Time Service Operation [4] Authors: UPC, SSSA, CNIT, NVIDIA.	Presented to the Advisory Board in April 2024 and at the OFC24 demo zone. Video available here [4].

June 2024	D6G Demo 1: AR with Perceived Zero Latency Authors: CNIT, SSSA, UPC, ACC, NVIDIA	Will be presented at ICTON 2024 in July 2024. Early video version available here [3].
June 2024	D6G Demo 2: Real Time Digital Twin Authors: UC3M, NUBIS, ELTE	Initial video is available here [4].
March 2024 June 2024	D6G Demo 5: In-network Control for Flow Steering Authors: UVA, SSSA, CNIT	Early version demonstrated at OFCnet booth 923. To be presented at ICTON 2024 Demo Zone.

2.2.2. Synergies with other projects

The following table reports collaborative activities with other EU and international research projects towards a coordinated action inside the SNS JU, from June 2023 to June 2024. As an example, Figure 14 shows the joint booth co-organized with PREDICT-6G for EuCNC2024 in Antwerp, Belgium.

TABLE 12: COLLABORATIVE ACTIVITIES WITH EU AND INTERNATIONAL RESEARCH PROJECTS

Date	Item	Explanation
June 2024	6G-PDN Workshop: 6G Programmable Deterministic Networking with AI	Co-organized by C. Papagianni (UvA) with PREDICT-6G and DETERMINISTIC6G at MobiCom 2024, Washington DC, USA (November 2024)
14 June 2024	"Architectural enhancements for 6G programmable and deterministic networks"	1st event of a webinar series with PREDICT-6G and DETERMINISTIC6G
3 June 2024	"Hyper Reliable and Low-Latency Communications for Robotics"	Joint presentation for IMT 2030 WS at EuCNC2024, with FLEXCALE, DETERMINISTIC-6G, PREDICT-6G, ETHER, and 6G-SANDBOX
3 June 2024	"Secure, Reliable and Trustworthy AI and Communication in 6G"	Joint presentation for IMT 2030 WS at EuCNC2024, with SEASON, VERGE, RIGOUROUS, and HORSE
3 – 6 June 2024	"Programmable deterministic networking: the PREDICT-6G and DESIRE6G approaches"	Joint booth at EuCNC 2024 with PREDICT-6G
26 January 2024	Online workshop on 6G by Hexa-X-II	Technical workshop organized by Hexa-X-II, together with seven other SNS JU projects
23 November 2023	Info Day & 6G SNS JU 2024 Brokerage	Event with Phase 1 success story presentation in Istanbul, Türkiye
23 October 2023	6G-PDN Workshop: 6G Programmable Deterministic Networking with AI	Co-organized by C. Papagianni (UvA) with PREDICT-6G at MobiHoc 2023, Washington DC, USA

6 June 2023	”Future deterministic programmable networks for 6G” Workshop	Co-organized with PREDICT-6G and DETERMINISITIC6G at EuCNC 2023
10 May 2023	“Challenges of optical communications in the 6G era” Workshop	6 EU projects discussed their approach to optical communications in 6G at ONDM 2023
24 March 2023	Inteligencia Artificial en el control remoto de un brazo robótico.	Joint scientific dissemination activity for high school students, with PREDICT-6G, Hexa-X-II, 6G-EDGEDT and 6G-DATADRIVEN

FIGURE 14: JOINT BOOTH AT EUCNC2024. AR DEMO (LEFT), D6G CONSORITUM MEMBERS GROUP PICTURE (RIGHT)

2.2.3. Bachelor, Master, PhD Theses, and Internships

The following table reports bachelor, master and PhD theses as well as internships on matters related to DESIRE6G.

TABLE 13: DESIRE6G-RELATED BACHELOR, MASTER AND PHD THESES, AND INTERNSHIPS

Type (PhD/Master/Int.)	**Partner**	**State** (Ongoing /Finished)	**Title**
PhD	UPC	Finished	Ahmad El Sayed, “Smart and efficient sensor network operation for 5G and beyond ecosystems”
PhD	UC3M	Ongoing	Carlos Barroso, “Enhanced, time sensitive, reliable and available wireless networks based on AI”

PhD	UC3M	Ongoing	Pablo Picazo, "Development of reliable SDN-based wireless and virtualization technologies for real-time scenarios"
MSc	UC3M	Finished	Adam Zahir "Diseño y Desarrollo de un Gemelo Digital para un Robot Cuadrúpedo con Simulación en Tiempo Real"
BSc	UVA	Finished	Jan Laan, "Extending a simulation framework for virtualised infrastructures"
BSc	UVA	Finished	Tim van der Hoeven, "Platform for evaluating INT solutions on PDPs"
BSc	UVA	Ongoing	Merijn Laks "VNFNet a simulation framework for orchestration virtualised infrastructures",
MSc	UVA	Ongoing	Gesualdo Di Perna, "Porting the implementation of the CU-UP on the Netronome Agilio SmartNIC"
MSc	UVA	Ongoing	Ralph Erkamps, "P4 Collector: Collecting and Processing values in the data-plane"
MSc	UVA	Ongoing	Wendy Roks "O-RAN: Design & Implementation of the Central Unit on a SmartNIC with XDP/eBPF"
PhD	UVA	Ongoing	Cyril Hsu, "Machine Learning for Network Slice Management
PhD	UVA	Ongoing	Angelo Dimoglis, "Data-plane programmability towards a transparent, reliable and controllable Internet"
MSc	UOU	Finished	Chamith Mawela: "A Web-Based Solution for Federated Learning with LLM-Based Automation"
PhD	ELTE	Ongoing	Hiba Mallouhi: "Foundations of Zero-Touch Computer Networks"

PhD	ELTE	Ongoing	Dávid Kis: "Advanced traffic engineering in telecommunication networks with the support of PPOV"
MSc	ELTE	Finished	Ádám Farkas: Congestion signal-based load balancing between network paths (Hungarian, original title: Torlódásjelzés alapú terheléselosztás útvonalak között)
PhD	SSSA/CNIT/NVDIA	Ongoing	Faris Alhamed: PhD program in Emerging Digital Technologies (funded by NVIDIA)
PhD	SSSA/CNIT/NVIDIA	Ongoing	Rana Abu Bakar: PhD program in Emerging Digital Technologies (funded by NVIDIA)
PhD	SSSA	Ongoing	Alessandro Pacini: A flexible and modular approach towards Zero Touch Networks

2.3. Standardization and Open Source

The target for the DESIRE6G project is 10 contributions to SDOs, such as 3GPP, IETF, ETSI, IEEE, O-RAN, ITU over the lifetime of the project. Up to now, specific actions and contributions have been produced for IETF, 3GPP and O-RAN, in relation with technical aspects of relevance for the project, where D6G activities have served as input. The following table summarizes current SDO activities and candidate contributions (some of them already adopted or accepted).

TABLE 14 CURRENT SDO ACTIVITIES AND CANDIDATE CONTRIBUTIONS

SDO	Type of Document (Contribution / Dissemination)	Partner	Link to Candidate contribution
IETF (DetNet WG)	Contribution (adopted)	UC3M	https://datatracker.ietf.org/doc/draft-ietf-detnet-controller-plane-framework/06/
IETF (DetNet WG)	Contribution on multidomain support	UC3M	https://datatracker.ietf.org/doc/draft-bernardos-detnet-raw-multidomain/02/
O-RAN (WG9)	Contribution on DetNet overview as discussion input for the Xhaul packet switching specification	TID	https://oranalliance.atlassian.net/wiki/pages/viewpageattachments.action?pageId=2653487497&preview=%2F2653487497%2F2774335856%2FTEF-2023.02.06-WG9-XPAAS-DetNet-v0.pptx&search_id=9e0b9630-e3fa-435e-bcfb-6df1c7a37452
3GPP (SA5)	Contribution to improve EP_Transport model of TS 28.541 in Release 18 to clarify connection point for network slicing when interworking with transport networks	TID	https://www.3gpp.org/ftp/tsg_sa/WG5_TM/TSGS5_149/Docs/S5-234742.zip
IETF (DetNet WG)	An Evolution of Cooperating Layered Architecture for SDN (CLAS) for Compute and Data Awareness	UC3M	https://datatracker.ietf.org/doc/draft-contreras-coinrg-clas-evolution/02
IETF (DetNet WG)	Contribution on relevant use cases (adopted)	UC3M	https://datatracker.ietf.org/doc/draft-ietf-detnet-raw-industrial-req/00
3GPP SA2	FS_eEDGE_5GC_Ph3 / Rel-19	ERI-HU	https://www.3gpp.org/ftp/tsg_sa/WG2_Arch/TSGS2_162_Changsha_2024-04/Docs/S2-2404482.zip

O-RAN (WG1 – WG9)	WG9-2024.001 Work Item Proposal – Inclusion of Transport in SMO (accepted and created)	TID	Not available publicly (file name: VZW.AO-2024.05.31-WG9-D-Transport-Inclusion-Data_Exposure)

Regarding Open Source contributions, at the time of writing this deliverable it is still too early to have specific project-centred contributions (focus is on the architecture and specification work). The plan is to make some pieces of the DESIRE6G stack available as open source in the project Github repository: https://github.com/DESIRE6G.

TABLE 15: OPEN SOURCE CONTRIBUTIONS SINCE JANUARY 2023, SUBMITTED AND ACCEPTED

Community and Title	Info	Partner	Link
kata-containers runtime-rs: add parameter for propagation of (u)mount events	code to facilitate AWS Firecracker execution in sandboxed container runtimes. Accepted.	NUBIS	https://github.com/kata-containers/kata-containers/commit/6787c63900c6d4dc2de903a076f3230ecec4259b
containerd	filesystem support for containerd to allow rumprun unikernels to execute Code merged in 2023, included in containerd v1.7.0 release. Accepted.	NUBIS	https://github.com/containerd/containerd/releases/tag/v1.7.0
Unikraft: Update GICv2 compatible list	Enable Unikraft unikernels to be executed on aarch64 nodes (such as low-power edge nodes). Accepted.	NUBIS	https://github.com/unikraft/unikraft/commit/404c280443c1caec7027924973c64a9aa3f78dd6
kata-containers runtime-rs: update rust to 1.69.0	Helper contribution to support easier building of sandboxed container runtime (kata-containers) Accepted.	NUBIS	https://github.com/kata-containers/kata-containers/commit/e4eb664d27f6cf7169c5d10f4383bdd8f3b892f6
kata-containers runtime-rs: Firecracker hypervisor backend	Support AWS Firecracker on the rust runtime. Pending.	NUBIS	https://github.com/kata-containers/kata-containers/pull/8070

Open source involvement

NUBIS has been actively involved in the open source ecosystem (see Table 15) , with notable contributions to the Kata Containers project, the only mature sandboxed container runtime, and a significant initiative under the OpenInfra Foundation. Highlighting this involvement, Anastassios Nanos, WP3 leader, from NUBIS, has been elected[1] to the Architecture Committee of Kata Containers. This committee, responsible for architectural decisions and maintaining the project's governance, embodies the "four opens": open source, open design, open development, and open community. Dr Nanos' involvement in the Kata containers AC is a testament DESIRE6G commitment to fostering diversity, openness, and encouraging new contributors within the open source community.

[1] https://github.com/kata-containers/community?tab=readme-ov-file#architecture-committee

3. Plan for second reporting period (July 2024 - December 2025)

3.1. Communication plan

The following table is an update of the first version of the Communication Plan presented in D6.1 (June 2023) [1]. It includes the targeted audience, the related activities, the timing, and the metrics of the communication activities, including quantified goals.

3.1.1. Communication work plan for reporting period 2

TABLE 16: COMMUNICATION PLAN FOR RP2

Audience	Activity	Timing	Metric
All, General public, Research	**Project website.** DESIRE6G shares its concepts, results and achievements through the project website. The website is the primary tool of communication and promotion of the project	Continuous update	Number of unique visits, Most visited pages,
All, General public	**Press releases, posters, leaflets.** DESIRE6G has a general project poster, and leaflets to raise public awareness at events. Press releases are published regularly to update on project progress or relevant events such as workshop organization	Event-driven and twice a year	1 leaflet and 1 poster available Published press releases (target: two per year)
General public	**Public Communication.** DESIRE6G project is regularly being promoted through participation and organization of events for society at large and distribution through social media. For RP2 we will also make use of EC communication tools and magazines	Event-driven and weekly social media updates	Num. of events organized / attended (target: at least one per year) LinkedIn and Twitter metrics

General public, Interest groups	**Videos.** DESIRE6G keeps working on the creation of public videos to raise awareness and to advertise the proposed network scenarios and their capabilities. For RP2 we will create a partner series, where each D6G explains their role and learnings from the project	M36 and event-driven	Explanatory video and all demo activities available in the web. Partner video series available. YouTube metrics.
Students	**Lecture materials** related with DESIRE6G will be introduced in academic courses taught by partners	Pot. every 6 months	Num. of courses related with project topics

3.2. Dissemination plan

The purpose of the dissemination plan is to guarantee that all concepts and technologies developed in the DESIRE6G project are disseminated adequately to relevant entities, including standards development organizations. Dissemination and Collaboration (primarily within the SNS JU) activities will continue during the second reporting period 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. 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, IEEE SP) and reputed international conferences (e.g., IEEE ICC, IEEE Globecom, IEEE IM, ACM Conext).
- **Collaborations** with other EU and international research projects through SNS JU working groups, networld2020, and other Horizon Europe projects in support of the SNS JU 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 DESIRE6G technology and applications.
- **Organization of events**, such as workshops collocated with well-established conferences (e.g., IEEE ICC, IEEE Globecom, ACM Mobihoc) to showcase DESIRE6G results.

3.2.1. Dissemination work plan for reporting period 2

The dissemination activities will be steered towards generating impact through peer-reviewed publications, presentations, talks, demonstrations, panels, workshops, and events. The plan for the second reporting period is to continue our activities as conducted in the first reporting period, with an expected increase on the papers related to experimental results, and the demos, due to the nature of the work at the end of the project. The goals set for the Reporting period 2 include[2]:

- Submission of at least 15 scientific articles for publication at reputed conferences and journals. The goal for the whole lifetime of the project is to have 30 published/accepted publications.
- 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 8 commits to Open source projects/efforts 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 SNS JU working groups, or working groups of other platforms, such as networld2020).
- 4 demonstrations of project related prototypes or solutions during the lifetime of the project.

[2] Note that some of the goals set in the Description of Action (DoA) can be easily split into the two reporting periods, while others tend to be done just in the last one (e.g., demonstrations). This is the reason that some goals are still referred to the whole lifetime of the project.

- Organization of at least 2 research and 1 industry-oriented workshops during the lifetime of the project.
- Participation to 5 research- or industry-oriented events during the lifetime of the project.
- Editing of 2 special issues during 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 17: DESIRE6G DISSEMINATION PLAN (REPORTING PERIOD 2)

Audience	Activity	Timing	Metric
Academic and industrial research	DESIRE6G 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. An appropriate balance between academic and industrial awareness will be sought.	Continuous	At least 15 publications per reporting period in top-tier scientific journals and conferences.
Other research projects	**Collaboration with other EU and international research projects** (e.g., through SNS JUworking groups, or working groups of other platforms, such as networld2020) will also be key towards a coordinated action inside the SNS JU and with other HEU projects related with topics addressed in the project	SNS JU 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,	Participation in one per year One workshop	Organization of one 30-people workshop co-located with a major conference (e.g., EUCNC, IEEE WCNC, ICC,

	panelist, etc., thanks to important vendors, technology providers and operators, high-tech SMEs, and reputed academic organizations within the consortium.		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 M34	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 reporting period. More demonstrations in several events are targeted.

Undergraduate, Master and PhD students	**Dissemination in BSc, MSC and PhD courses** of DESIRE6G related technology, including BSc, MSc and PhD thesis. Through academic partners, DESIRE6G aims at disseminating and training students on relevant DESIRE6G technologies.	Continuous	Num. of impacted courses and thesis supervised.

3.2.2. Synergies with other projects

In this section, we enumerate a set of ongoing projects (at the time of publishing this deliverable) which results may impact DESIRE6G. This list remains the same as during the First Reporting period (but we report it here for self-completeness of the document). For all the projects identified, there is an involved DESIRE6G 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 DESIRE6G design.

TABLE 18: OVERVIEW SYNERGIES WITH OTHER PROJECTS

Project name	Short Description	Technical relationships	Contact
On-going EU/Horizon Europe projects			
PREDICT-6G https://predict-6g.eu/	PREDICT-6G aims to create a secure, modular, interoperable, and extensible deterministic network and management framework that automates the definition, provisioning, monitoring, fulfillment, and life-cycle management of end-to-end deterministic services over multiple network domains. This will hide the complexity of continuously balancing and re-configuring the constituent domain specific enablers to maintain a consistent end-to-end determinism	Complementary to the efforts in DESIRE6G towards supporting extreme URLLC requirements, PREDICT-6G aims at enabling deterministic behaviour in multi-domain multi-technology wireless networks	UC3M, TID, UPC, ERI-HU
DETERMINISTIC6G	DETERMINISTIC6G addresses three central challenges of future deterministic end-to-end	Deterministic6G is primarily	ERI-HU, CNIT/SSSA

https://deterministic6g.eu/	communication enabled by 6G: (*i*) a new architecture for 6G systems providing deterministic performance and secure integration of 6G systems and new edge computing solutions into deterministic communication contexts, e.g., TSN and DetNet; (*ii*) 6G system awareness enabled by novel data-driven approaches including novel deep neural network-based classifiers and regressors; (*iii*) leveraging novel digital twins of both 6G networks and cyber-physical systems, to anticipate situational circumstances impacting determinism of networks and safety of cyber-physical systems	interested in making the 6G system deterministic and secure integration of 6G systems into wireline deterministic communication technologies such that some key use cases are considered as guidelines to build successful business relations between the apps and the network. DESIRE6G could utilize the use cases and the API work	
Hexa-X-II https://hexa-x-ii.eu/	Hexa-X-II is the flagship project for the first definition of a 6G framework architecture. As such, it has the mandate of coordinating other SNS projects from Phase I towards the achievement of designing features relevant for 6G	DESIRE6G is one of the Stream B SNS Phase 1 projects. As such it should be kept in touch with Hexa-X-II	UC3M, TID, ERI-HU
ADROIT6G https://adroit6g.eu/	ADROIT6G is an SNS JU project aiming at introducing distributed AI into 6G networks, which are expected to be programmable	DESIRE6G focuses on programmability aspects of 6G networks, whereas ADROIT6G focuses on how to	CNIT, NVIDIA

		leverage that programmability and introduce distributed AI solutions. Initial bilateral engagements are in place ADROIT6G-DESIRE6G towards a joint workshop to identify synergies	
BeGREEN https://www.sns-begreen.com/	BeGREEN focusses on energy efficiency in the 5GS and especially in the RAN, including the intelligence brought by Open RAN. One complementary aspect of BeGREEN research has been user/data plane programmability for energy efficiency of UPF (currently using DPDK but looking towards eBPF/XDP), which has synergies with the D6G WP4 research on XDP for CU-UP and DU	Potential for collaboration in joint dissemination activities	ACC
National Projects, Celtic program, and Internal projects			
CATRIN (NWO) https://www.catrin.nl	The *Controllable, Accountable, Transparent: The Responsible Internet* (CATRIN) projects allows users (e.g., providers of critical services) to request descriptions of the chains of network operators that handle their data flows, for instance in terms of their security and administrative properties and their interrelations (Transparency) Based on these details, users can request network operators to handle their data flows in a particular way, exploiting data plane programmability, for example by allowing them to only pass-through operators whose	Complementary to the work on In Band Telemetry envisioned for DESIRE6G. The outputs of the CATRIN project can influence and provide insights on service requirements in	UVA

	equipment and geolocations they have specified (Controllability). The Responsible Internet also allows users to verify whether operators act as they declared and to trace incidents and attacks to their root cause (Accountability)	terms of trust and security	
FNS (2024-2029) https://futurenetworkservices.nl	The Dutch Flagship Project on 6G supported by the Minister of Economic Affairs and Climate Policy (EZK) aims at building a strategic and leading position in the development and application of 6G networks for unlocking the innovation potential of the Dutch industry, contributing to the European pre-standardization efforts, and training the next generation of engineers and researchers. The project will develop intelligent hardware and AI-driven network management schemes for 6G networks.	FNS PL2 focuses on AI-assisted network automation to improve network performance and energy-efficiency, thus is highly aligned with the objectives of DESIRE6G. It is also aims to build upon the IML layer of DESIRE6G for delivering a HAL.	UVA, ERI-HU, NVIDIA
6G-DATADRIVEN https://unica6g.it.uc3m.es/en/6g-datadriven/	6G-DATADRIVEN is an Spanish project (2022-2024) that is committed to develop data-driven approaches by (i) designing and incorporating distributed AI/ML tools exploiting distributed data collection and processing within edge computing platforms; (ii) creating plug-and-play solutions to flexibly deploy and operate non-public 5G networks, building on the platforms developed in previous projects; (iii) developing secure data distribution schemes; (iv) implementing zero-touch, AI-based network and service management, fully meeting the specific needs of smart manufacturing and emergency support environments	Some efforts in 6G-DATADRIVEN are complimentary to the URLLC support from DESIRE6G, namely those related to the implementation of zero-touch, AI-based network management	UC3M, TID

Furthermore, project partners participate in multiple SNS JU and 6G-IA working groups. The project is also part of the SNS JU boards towards a tight coordination with the rest of SNS JU projects, i.e.: the project coordinator is in the steering board, and the technical manager in the technology board.

At the time of writing this deliverable, the following are the 6G-IA working groups, chaired by 6G-IA members (we underline those that are potentially relevant to DESIRE6G and that we are already participating, either with active contribution or monitoring, partners involved between brackets):

- **Vision WG,** aiming at developing a vision for Smart Networks and Services beyond 2030. (UC3M, UVA)
- **Open SNS,** aiming at exploring open solutions for 5G and beyond 5G/6G networks.
- **Trials,** developing a European Trial Roadmap for beyond 5G/6G systems in the contexts of SNS.
- **Pre-standardization,** facilitating impact creation in particular towards relevant standardization bodies and open source. (TID)
- **5G/6G for Connected and Automated Mobility – R&I Stream,** aimed at establishing a knowledge base and facilitating the exchange of information on ongoing R&I activities in the field.
- **Spectrum WG,** focusing on the regulatory and technical aspects that relate to spectrum for beyond 5G and 6G systems.
- **Security WG,** fostering development of 5G/6G Security Community. (TSS)
- **6G-IA SNS Forum WG,** proposed to serve as a forum for open technical discussions on any technological topics of interest.
- **WiTaR (Women in Telecommunications and Research) WG,** proposed to promote a gender-balanced approach in European R&I activities including industry and academia. (EBY, UVA)

Additionally, the following is the list of SNS JU Projects WGs, chaired by SNS Projects members (we underline those that are potentially relevant to DESIRE6G that we are already participating, either with active contribution or monitoring):

- **SNS 6G Architecture WG,** with the goal of collecting, analyzing, and consolidating information from SNS projects on architecture research requirements and results (with a clear link to SNS Stream B). (ERI-HU, UVA)

- **SNS Reliable Software Networks WG,** aimed at analyzing how 6G networks will be designed as software enabled platforms and include topics related to AI/MAL, service provision/orchestration as well as security (DevSecOps) (with a clear link to SNS Stream B). (UVA, ELTE)
- **SNS Test Measurement and KPI Validation WG,** bringing together SNS projects that have common interest in the development and progress of topics related to test and measurement methods, test cases, procedures, etc. The current proposal is that at least all Stream C and D projects should participate, as well as any other Stream A and B projects that are planning to provide at least a PoC or higher TRL solutions. (CNIT, SSSA)
- **Communication technologies and Devices WG,** bringing together SNS projects working in the areas of wireless communications as well as communication infrastructure and devices. This WG will deal with topics related to 6G RAN enablers and solutions as well as optical communications, integration of NTN with 6G networks, short range communications and IoT evolution (with a clear link to SNS Stream B).

3.2.3. Open Science

DESIRE6G is following thoroughly all the required actions to be aligned with the Open Science practices as they are defined in the Horizon Europe guidelines. In particular, the open science practices are supported by five pillars:

- **1: Early and open sharing of research**. During DESIRE6G project lifetime, all partners will follow methods that assure the early and open sharing of the project outcomes. More specifically, plans are shared in advance of implementation. This methodology enhances the research results as it addresses a point which is often underemphasized, that a research hypothesis can only be truly held before the data are looked at and usually before the data are collected.
- **2 and 3: Research output management and measures to ensure reproducibility of research outputs**. DESIRE6G will pay attention to ensure reproducibility of outputs by covering the three research processes that reproducibility is based on: reproduction, replication, and re-use, which rest on the availability of data and methods from the original study.
- **4 and 5: Open access to research outputs and participation in open peer-review**. Open Access (OA) has been a core strategy by the European Commission to improve knowledge circulation and re-usability. All projects receiving Horizon funding are required to provide online access to

any peer-reviewed scientific research article published in scholarly journals, free and reusable (Article 17 of the Model Grant Agreement). DESIRE6G fully embraces this vision.

DESIRE6G leverages the services provided by the Open Access Infrastructure for Research in Europe (OpenAIRE), which is an active service provider of the European Open Science Cloud (EOSC). This European initiative, which lists 37+ million publications and 9+ million research data, has the mission to promote open scholarship and improve the discoverability, accessibility, shareability, reusability, reproducibility and monitoring of data-driven research results, across scientific disciplines.

A more detailed explanation on how DESIRE6G plan to manage open data and publications can be found in D1.1 [2].

3.3. Standardization Plan

From its inception, DESIRE6G has had a clear goal of contributing to both standardization and open source activities. This purpose is perceived as a bidirectional interaction between the project and external communities. This means that any progress in the standardization and open source arenas can influence the development of DESIRE6G architecture and innovations, and vice versa. Any progress derived from the project execution advancing beyond the state of the art can be contributed to the preeminent Standards Development Organizations (SDOs) and open source (OS) projects in specific technological areas.

The DESIRE6G project counts on an important set of industrial and academic partners with a relevant presence in both SDOs and open source communities. This is the foreseen vehicle for facilitating the bidirectional interaction previously mentioned.

It is also the aim of the project to benefit other partners in the consortium with less tradition of participating in SDOs and/or OS communities by working on joint contributions that could involve them in these kinds of activities as a means of increasing impact and outreach in the overall 6G ecosystem.

3.3.1. Standardization bodies of relevance for DESIRE6G

The overall standardization ecosystem in the telecom and IT industry is characterized by an extensive and diverse base of bodies, alliances, and groups, leading to significant fragmentation that complicates participation and influence for most institutions involved. Only very large companies and organizations can ensure broad and continuous participation across all SDOs in the ecosystem.

The aforementioned fragmentation is driven by several factors. One obvious reason is geographical, with regional standardization bodies having overlapping or related scopes. Another motivation for SDO fragmentation arises from their charters focusing on specific subsets of technologies or techniques. Additionally, differing industrial strategic interests sometimes lead to the emergence of overlapping and competing technical approaches targeting the same problem space, resulting in divergence across the industry. All of these factors make it challenging for participating organizations, including RIA projects, to influence and impact standards effectively.

To overcome these limitations, DESIRE6G is undertaking an internal exercise to identify and prioritize relevant standardization bodies. Given the described fragmentation, rationalizing project efforts is

necessary. The initial step involves identifying SDOs of interest where the project can maximize its impact. This approach allows concentrating efforts on SDOs where the project's influence can be most significant, while also establishing complementary actions (e.g., collaboration with other projects and initiatives) in less impactful SDOs.

It's important to note that as the project progresses, areas of potential impact may evolve. Primary contributions will stem from the defined architecture, ongoing development of technical enablers, and proposed innovations, which continually identify gaps and new needs.

Moreover, with regard to 6G, it is anticipated that SDOs themselves will evolve, potentially seeing the emergence of new bodies, the decline of existing ones, or shifts in their scopes over time. This evolution similarly applies to open source communities. A recent example of changing standards-related ecosystems is the transition of activity from the Open Networking Foundation (ONF) to the Linux Foundation.

Furthermore, institutions participating in the consortium may also evolve their interests concerning target SDOs, aligning with their own exploitation plans, which may change during the project's lifespan. Consequently, the set of relevant bodies for the project will require periodic updates to align with project execution, partner interests, SDO evolution, and the broader development of the 6G ecosystem.

The initial considerations outlined in the project proposal for maximizing DESIRE6G's impact on standardization and industry forums include:

- Establishing a standardization roadmap regularly updated to align with the latest focus areas in defining 6G.
- Continuously monitoring and aligning with standardization activities that could benefit the project, integrating the latest industry approaches during project execution.
- Seizing opportunities to incorporate technological contributions into ongoing specifications or recommendations resulting from the project's innovations.
- Actively promoting the project's concepts and solutions at standardization-related workshops, panels, and summits.

Regarding specific SDOs, the DESIRE6G project aims to enhance and contribute new technical capabilities with potentially significant impacts on various relevant standardization groups such as

3GPP, ETSI, ITU-T, IETF/IRTF, O-RAN, etc. The framework for engagement was established in the Description of Action, as outlined in Table 19 .

TABLE 19: INITIAL STANDARDIZATION PLAN OF DESIRE6G

SDO	Partners	Expected impact
3GPP	ERI-HU, EBY, NVIDIA, TID	Architectural considerations for sharing telemetry information to external entities, e.g., DESIRE6G, as well as architecture enhancements for tactile and multimodality communications services. Exposure of DESIRE6G network and management capabilities through APIs in a controlled, secure, and auditable way. Architectural considerations for CU/DUs enabling telemetry interfaces serving DESIRE6G AI algorithms for traffic treatment
ETSI ZSM	TID	Contributions of DESIRE6G Zero-touch service management, multi-domain, and closed-loop automation.
O-RAN	ACC, TID	Contribution to Use Cases and Overall Architecture Workgroup and The Near-Real-Time RAN Intelligent Controller (Near-RT RIC) and E2 Interface Workgroup (O-RAN WG3), as well as contributions to the Xhaul transport solutions (O-RAN WG9).
IETF COINRG	UC3M, TID	Contributions on how the hyper-distributed edge can be applied for computing in the network.
IETF ICCRG	UC3M, ERI-HU, TID	Contributions to the implementation, standardization and performance of traffic management solutions for deep slicing.

As can be seen for the reported contributions, the actual areas of activity in the project are very much aligned with the initial plan, with contributions to 3GPP, IETF and O-RAN. In fact, for all the three, the impact is satisfactory in the sense that some of the contributions have been already accepted or adopted.

3.3.2. Open source communities of relevance for DESIRE6G

While standardization helps to define effective mechanisms to guarantee interoperability between distinct implementations, the open source initiatives foster the validation of solutions in a fast and open way, allowing demonstration of feasibility and viability of technical approaches.

The network softwarization trend in the last decade has made evident the need of a very tight and efficient integration and reliance on software components of modern communication-oriented networks. Virtualization, programmability, learning and data processing are clear examples of such dependency. The expectation is that in 6G such as dependency will become even higher than in the past generations.

Similarly to the case before in regards the SDOs, there is a multiplicity of OS communities of relevance for the project. The purpose of the OS projects range from orchestration, management and control of a system up to the very specific programmability of the device's data plane. Different OS projects are subject to receiving contributions from DESIRE6G depending on the specific role they could play in the overall architecture, with the aim of validating the conceptual design.

It is also relevant to note that, in some cases, there is an intersection between SDOs and OS communities. For instance, this is what happens with ETSI Open source MANO (OSM) or ETSI TeraFlow SDN (TFS) projects. This results in a very effective way of validating proposed standard specifications while at the same time providing the proper feedback from an implementation standpoint.

As a starting point for open source activities, the Description of Action establishes some initial lines of action. For instance, it is foreseen to contribute with relevant communities such as Open Network Foundation–P4-Education WG and other initiatives such as PyTorch, TensorFlow, or ONOS.

In this respect, the project by now has contributed to basic open source tooling rather than providing specific sub-components or modules of the D6G architectural framework. This is left for a later phase once the developments become mature and, up to some point, functionally validated against project use cases.

3.4. Project reach

In order to provide visibility and guidance on what can be the perimeter of the project at the initial stage, an SDO matrix was created in order to understand what the actual reach is.

The following figure shows the involvement declared by the partners in the consortium involved in standardization and open source matters. The legend of the table is as follows:

- DC stands for Direct Contribution, which reflects the capability of actively contributing to some specific working group or OS project results coming from DESIRE6G, through participants in the project that can directly contribute to the corresponding SDO or OS community.
- IC that stands for Indirect Contribution, which reflects the capability of influencing contributions from DESIRE6G results through representatives from a consortium partner that can contribute to the corresponding SDO or OS community, but who are not participating directly in the project.
- M standing for Monitoring, which implies a follow up of the activities of the SDO and/or OS group, which can result in a potential capability of contributing results from DESIRE6G.

TABLE 20: INVOLVEMENT OF DESIRE6G PARTNERS IN STANDARDIZATION AND OPEN SOURCE INITIATIVES

		Manufacturers				Oper.	SMEs			Academics						
SDO Body	**WG**	ERI-HU	EBY	NEC	NVIDIA	TID	ACC	NUBIS	TSS	UvA	UPC	UoU	UC3M	ELTE	CNIT	SSSA
ETSI	NFV	M				DC							M			
	MEC	M											M			
	OSM	M				IC		M					M			
	ZSM	M	M			M	M									
	ENI	M														
	TFS	M				DC										M
ITU-T	IMT-2030	M	M			M										
	SG13					M										
IETF	TEAS					DC							M			
	CCAMP					DC							M			
	DetNet	IC				M							DC			
	RAW	IC				M							DC			
	IPPM					M										
	MPLS					M										
	ALTO					DC							DC			
	CATS					DC							DC			
	PIM					DC										
IRTF	NMRG	M				DC							DC	M		
	MAPRG												M			
	COINRG	M				DC							DC	M		
ONF	TAPI					M									M	
	CORD															
	P4	M			M	M								IC	M	
ORAN	WG1	M	M				IC									
	WG2		M													
	WG9	M				DC	IC									
TIP	DCSG					DC										
	DDBR					DC										
	MUST					DC										
IEEE	802	IC											M			
TMForum			M													
3GPP	SA2	IC					M									
	SA5		IC			IC	M									
NGMN						M										
GSMA						M										
OCI	Spec							IC								
containerd								IC								
OpenInfra	OpenStack							M						M		
	Kata-containers							DC								
ONOS														M	IC	M
In-house open source								DC		DC	M	DC	DC		DC	DC

During the period reported in this deliverable the initially identified project reach has not changed, being yet valid.

The project reach can be also described in terms of the direct interaction with SDOs and OS groups for the participation in standardization events, such as hackathons, plugfests, etc.

3.4.1. Topics for additional contribution

Apart from the already generated contributions, the project keeps in its horizon potential additional areas for contribution. The following lists collects some of the potential topics identified so far:

- Influence of standardization and open source in DESIRE6G (i.e., SDOs/OS communities → DESIRE6G)
    - 3GPP: support of Deterministic Networking (DetNet) capabilities in 3GPP architecture, initial analysis of 6G requirements and capabilities, etc.
    - TMForum and ETSI ZSM: zero touch service provision and lifecycle management. In this case, intent-based approach is identified as relevant topic for D6G.
    - IETF / IRTF: DetNet, mobility support, in-network and edge compute, technology-agnostic network slicing data models, etc. Additional activities such as the role of AI for network operation and management are under discussion, but without a formal structure in terms of working or research group.
    - O-RAN: smart control, slicing extended to CU/DU interfaces, etc. As reported, the just accepted inclusion of transport configuration and management capabilities integrated in / with the SMO enables interactions as the ones foreseen in D6G.
    - Kubernetes: lightweight instantiation of functions and components.
    - P4: mechanisms for data plane programmability, with the development of D6G related capabilities (e.g. PREOF).
    - Grafana and Prometheus: means of exposing telemetry information.
- Influence of DESIRE6G in standardization and open source (i.e., DESIRE6G → SDOs/OS communities)
    - WP2: KPIs to be considered.

- WP3: Definition of Intents, multi-domain orchestration.
- WP4: Programmability of the data plane
- WP5: Testing architecture and methodology

The project has now effectively contributed to SDOs and OS communities, with the expectation of consolidating the transfer flow of technical inputs to both of them.

3.4.2. Involvement in SNS JU activities related to standardization and open source

DESIRE6G is committed and engaged with the working groups relevant for the impact on standardization and/or open source contributions.

The participation in the working group(s) dealing with standardization and open source is perceived from the project as strategical action since it permits the collaboration with other projects of the same phase, but also from future phases. This can allow a quick alignment of proposals and a fast development of the overall technologies surrounding the evolution towards 6G from a European dimension.

Linked also with this idea of collaboration, it is the aim of DESIRE6G to strength links with other projects, mainly from Stream-B, but also from the other streams, in order to join forces in the area of standardization and open source so that the impact of the projects innovations can be maximized. Initial steps in this direction have started, being yet to soon to report any specific action in this direction.

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