A Cognitive Serverless Framework for the Cloud-Edge Continuum

D6.2 Communication and Dissemination Plan & Report - b

Version 1.0

07 July 2024

Abstract

COGNIT is an AI-enabled Adaptive Serverless Framework for the Cognitive Cloud-Edge Continuum that enables the seamless, transparent, and trustworthy integration of data processing resources from providers and on-premises data centers in the cloud-edge continuum, and their automatic and intelligent adaptation to optimise where and how data is processed according to application requirements, changes in application demands and behaviour, and the operation of the infrastructure in terms of the main environmental sustainability metrics. This document provides an update of the Communication and Dissemination Plan and Report. It also offers specific details about the communication and dissemination actions that have taken place during the corresponding reporting period.

Deliverable Metadata

Project Title:	A Cognitive Serverless Framework for the Cloud-Edge Continuum
Project Acronym:	SovereignEdge.Cognit
Call:	HORIZON-CL4-2022-DATA-01-02
Grant Agreement:	101092711
WP number and Title:	WP6. Dissemination, Communication, Exploitation, and Standardization
Nature:	R: Report
Dissemination Level:	PU: Public
Version:	1.0
Contractual Date of Delivery:	30/06/2024
Actual Date of Delivery:	07/07/2024
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Status:	Submitted

Document History

Version	Issue Date	Status[1]	Content and changes
0.1	03/07/2024	Draft	Initial Draft
0.2	05/07/2024	Peer-Reviewed	Reviewed Draft
0.3	07/07/2024	Submitted	Final Version

Peer Review History

Version	Peer Review Date	Reviewed By
0.1	05/07/2024	Torsten Hallmann (SUSE)
0.1	05/07/2024	Alberto P. Martí (OpenNebula)

Summary of Changes from Previous Versions

First Version of Deliverable D6.2

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[1] A deliverable can be in one of these stages: Draft, Peer-Reviewed, Submitted, and Approved.

Executive Summary

This is the first version of Deliverable D6.2, and as such it provides an update of the Communication and Dissemination Plan in WP6 ("Dissemination, Communication, Exploitation, and Standardization"), as well as a report of the communication and dissemination actions that have taken place during the reporting period (M7-M18).

The main communication and dissemination objectives of the Project are:

- Ensure broad visibility and raise awareness about COGNIT, spreading knowledge about its results.
- Reach, stimulate, and engage a critical mass of relevant stakeholders to consolidate an ecosystem around the Project.
- Facilitate exploitation of the Project's data and research outcomes.

The communication and dissemination tools that the Project uses include a website, a public blog, a variety of informative materials like banners, videos, flyers, and roll-ups, and social media posts on LinkedIn and Twitter. Different types of actions have been defined per each type of target audience, including scientific and commercial publications, conferences, workshops, exhibitions, and engagement with the rich EU industry and innovation ecosystem via relevant pan-European communities and initiatives such as the **EUCloudEdgeIoT** initiative and the new CSA **NexusForum.EU** (where RISE and OpenNebula participate as Coordinator and Core Partner, respectively).

These communication and dissemination actions have been executed up until M18:

- ✔ COGNIT Ambassador Programme in place
- ✔ 4 open source communities participation
- ✔ 5 EU initiatives participation
- ✔ 3 exhibition booths: 2 in open source conferences + 1 in industry events
- ✔ 7 presentations in open source conferences
- ✔ 2 presentations about the Use Cases in industry forums
- ✔ 1 project event (COGNIT Dat 2024)
- ✔ 4 internal webinars
- ✔ 1 technical workshop in open source events
- ✔ 2 published academic papers + 6 conference papers
- ✔ 1 research workshop in a scientific conference
- ✔ 1 commercial publication
- ✔ 1 press release
- ✔ 4 blog posts
- ✔ 18 public deliverables
- ✔ 80+ social media posts with 43,000+ total impressions

Both OpenNebula—as Coordinator—and CETIC—as leaders of WP6— regularly monitor the Communication and Dissemination KPIs of the Project to ensure they are in line with the original plan described in D6.1 and with any modifications described in this document.

This deliverable will be updated in month M36, at the end of the Project.

Table of Contents

Abbreviations and Acronyms

AI	Artificial Intelligence
AWS	Amazon Web Services
CSA	Coordination and Support Action
EDIH	European Digital Innovation Hub
FaaS	Function as a Service
GA	Grant Agreement
GDPR	General Data Protection Regulation
IoT	Internet of Things
KPI	Key Performance Indicator
LFE	Linux Foundation Europe
ML	Machine Learning
NGO	Non-governmental Organisation
OS	Operating System
PR	Press Release
RIA	Research and Innovation Action
UC	Use Case
URL	Uniform Resource Locator

1. Introduction

The general purpose of Deliverable D6.2 is to provide an update on the approach of the COGNIT Project in terms of communicating, disseminating, and sharing information, results, and research outcomes with relevant stakeholders, target audiences, and the general public. To this end, this document will be revised once more in M36 incorporating updates (if any) to the dissemination and communication plan of the Project as well as updates on the list of dissemination and communication actions executed during the reporting period, as well as a summary on level of completion of the associated KPIs.

This is a living document that is composed of an introductory section and five additional sections organised in two main blocks of content:

- **Part I** provides an update on the approach and structure of the Communication and Dissemination Plan. Thus, Section 2 updates on the Project's communication and dissemination plan, including any changes on the strategy, target audiences, and objectives; Section 3 describes the current communication and dissemination tools that the project is using; Section 4 provides an update on the monitoring and evaluation approach of the communication and dissemination actions of the Project, including the associated KPIs (as defined in the Grant Agreement).

- **Part II** focuses on reporting the specific progress in the execution of the Project's Communication and Dissemination Plan. Section 5 provides the details of the specific actions performed during the reporting period (M7-M18), whereas Section 6 summarises the impact that those actions have had on the Project's global KPIs associated with dissemination and communication.

PART I. Communication and Dissemination Plan

2. Communication Objectives and Approach

The Dissemination and Communication Plan describes the specific actions to be implemented in order to share (Dissemination) and promote (Communicate) the Project and its research results among potential users in the target groups. The aim of the Dissemination Plan is to enable the use and uptake of the results and gather feedback, to promote the benefits of the research carried out by COGNIT.

The Project's Communication and Dissemination Plan has witnessed no changes during the reporting period in terms of strategy, target audiences, and key objectives.

2.1. Communication strategy

The communication strategy of the Project as an industry-led open source R&D action involves methods to effectively promote and distribute the project to a wide audience of both the academia and industry worlds. The goal in both cases is to increase awareness, attract contributors/collaborations, and encourage adoption of the results of the Project.

There are no changes to report in the communication strategy.

2.2. Target audiences

The Communication and Dissemination Plan defined in Deliverable D6.1 (M6) already identified the following target audiences as relevant to disseminate the Project and explore mutually-beneficial collaborations:

- Academia: Universities, research organisations (university centres, non-profit organisations, or public research centres)
- Industry: Companies that can be end-users of the COGNIT Framework, or companies that develop technologies or services that are in the area of IoT and cloud/edge computing.
- Private and public entities in Europe: Government agencies (involved in digitalisation, or domain specific), and NGOs.
- End-users, networks and associations, and EU agencies: EDIHs, CSAs, RIA projects.
- COGNIT partners: Organisations that are already part of the Consortium.
- General public and the media.

There are no changes to report in the target audiences.

2.3. Key Objectives

There are no changes to report in the key objectives.

3. Communication and Dissemination Tools

3.1. Visual identity

The main visual identity elements of the Project (i.e. logo, presentation template, or acknowledgement slide) were already defined by M6 as part of Deliverable D6.1.

> *The Project's Communication and Dissemination Tools have witnessed no changes during the reporting period in terms of visual identity.*

3.2. Project website

The COGNIT website—based on a **WordPress** instance managed by OpenNebula Systems—is the main interface that connects the Project to its audiences. As such, during the reporting period it has been expanded with new contents and sections:
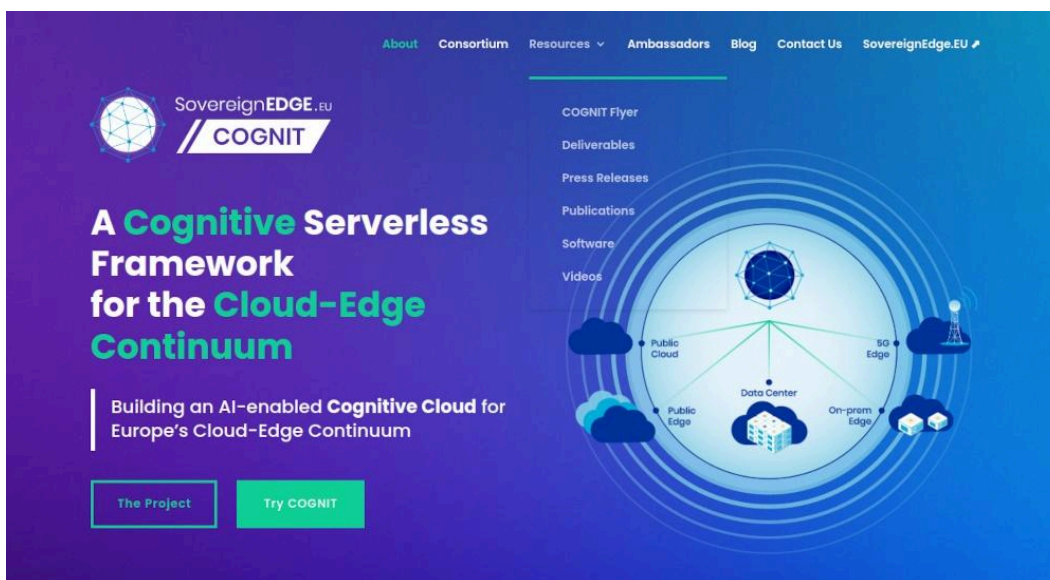
Figure 3.1. Current homepage of COGNIT.SovereignEdge.EU

The Project's current portal provides easy access to:

- Introductory video about the COGNIT Project

- Instructions about how to try COGNIT by using the technical resources and step-by-step documentation available through our GitHub repository.

- New section with expanded information about the Project's Consortium

- New section hosting all public Deliverables produced by the Project.

- New section with references to the Project's Ambassadors.

- A number of relevant links to Zenodo, GitHub, Vimeo, press releases, etc.

Figure 3.2. New section with expanded information about the Consortium.

As already reported in Deliverable 6.1 (M6), the project website uses **Matomo**, a GDPR -compliant open source web analytics application that has been integrated with our Wordpress instance to easily track visits:
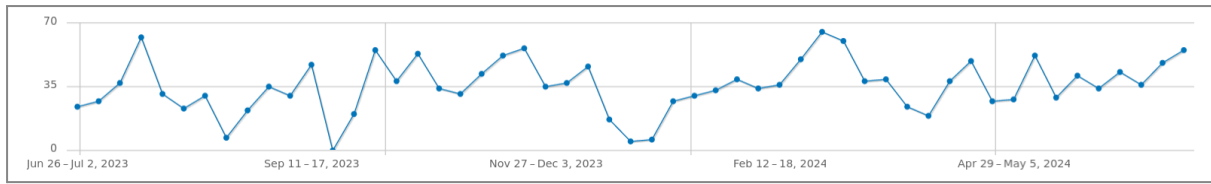
Figure 3.3. Visits to the COGNIT's project website during the reporting period (via Matomo).
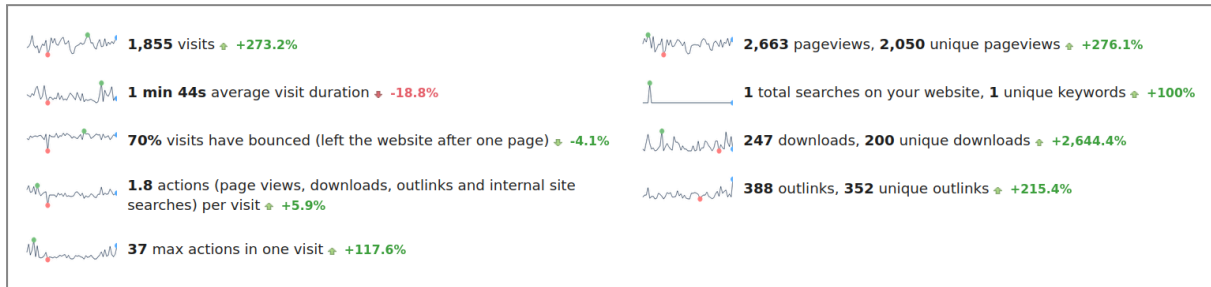
Figure 3.4. Main metrics for the COGNIT's project website for the reporting period, compared with the previous reporting period finishing in M6 (via Matomo).
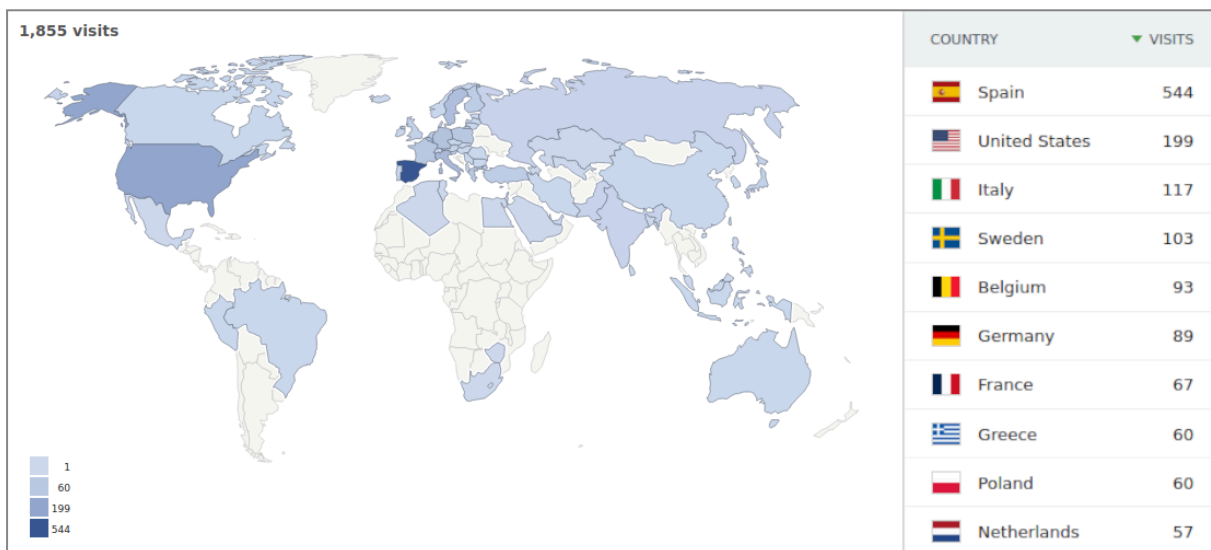
Figure 3.5. Origin of visits to the project website during the reporting period (via Matomo).

3.3. Promotional materials

In line with the Project's identity brand, additional materials have been designed and produced in order to support the Project's communication tasks.

Merchandising

Along with the Project's standard leaflet, a number of additional promotion items have been created for promoting the Project in technology events and open source conferences, including stickers, ballpens, sticky notes, and t-shirts.

Figure 3.6. The COGNIT sticker in action.

Videos

As already reported in Deliverable D6.1, the COGNIT Project has its own account on **Vimeo** to help disseminate the promotional videos that are created during the execution of the action. In this reporting period, the Project has produced three new videos:

- *Thank you for visiting our booth at Cloud Expo Europe Madrid!* (October 2023)
- *[DEMO] Energy Efficiency Optimisation for Cloud-Edge Orchestration* (October 2023)
- *[DEMO] Deploying the COGNIT Platform* (June 2024)
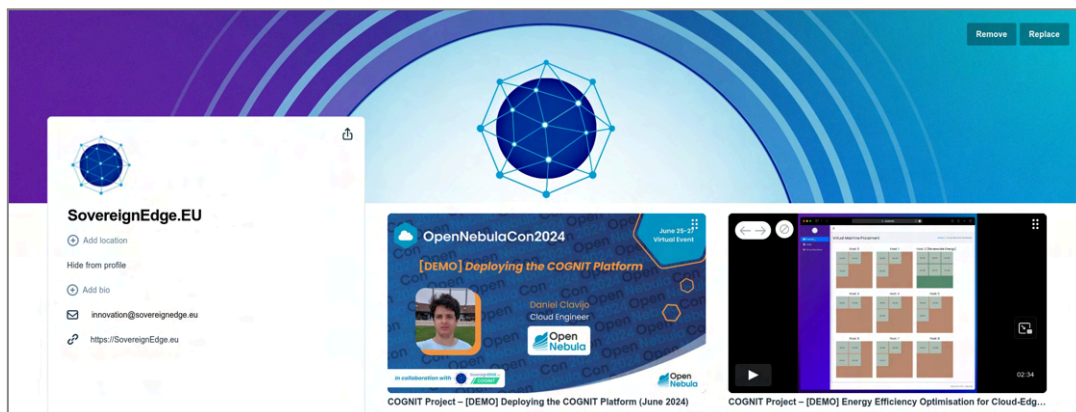
Figure 3.7. Vimeo profile, showing two of the new videos produced during the reporting period.

3.4. Social media

As already reported in Deliverable 6.1, social media platforms (LinkedIn and Twitter) are being used by COGNIT as an instrument to raise awareness about the Project, using the unique hashtag **#COGNITproject** through the SovereignEdge.EU accounts. The number of followers of these accounts have seen this evolution during the reporting period:

Platform	M6	M18
LinkedIn	159	334
Twitter	113	147

4. Monitoring and Evaluation

As already defined in Deliverable D6.1, the process of monitoring and evaluating the Communication & Dissemination actions carried out the Project is performed by:

1. Regularly collecting data about those communication and dissemination actions.

2. Analysing them against the established KPIs to identify shortcomings, bottlenecks, deviations, and other possible challenges.

3. Clearly reporting them to the EC in order to demonstrate the Project's progress.

4. Providing feedback to make the necessary adjustments and continuously improving the performance and communication/dissemination results.

No changes or updates to this process have taken place during the reporting period.

The table below presents the Project's dissemination and communication KPIs that are defined in the Grant Agreement and are being be used for evaluating the Project's communication and dissemination progress:

KPI #	Communication / Dissemination action	Audience	Target	Due Date	Description
KPI6.1	Champion Programme	Industry / Open Source	1	M18	Leveraging OpenNebula and SUSE's existing communities.
KPI6.2	Participation in communities: Linux Foundation, CNCF, and LF Edge	Industry / Open Source	3	M18	Targeting global open source communities.
KPI6.3	Participation in EU initiatives: GAIA-X, EOSC, IPCEI-CIS, and EU Cloud Alliance	Industry	4	M36	Targeting pan-European industry ecosystems.
KPI6.4a	Exhibition booths in relevant open source conferences	Industry / Open Source	3	M36	E.g. ETSI, OpenFog, OpenNebula, OSCON, LF Open Source Summit, and FOSDEM.
KPI6.4b	Exhibition booths in relevant cloud & edge industry forums	Industry	3	M36	E.g. VMworld, AWS re:Invent, Cloud Expo, IoT Tech Expo, and the Gaia-X Summit.
KPI6.4c	Presentations in open source conferences	Industry / Open Source	6	M36	E.g. ETSI, OpenFog, OpenNebula, OSCON, LF Open Source Summit, and FOSDEM.
KPI6.4d	Presentations with demonstrators from use cases in relevant cloud & edge industry forums	Industry	6	M36	E.g. VMworld, AWS re:Invent, Cloud Expo, IoT Tech Expo, and the Gaia-X Summit.
KPI6.4e	Technical workshops in relevant open source conferences and industry forums	Industry / Open Source	3	M36	Offering first-hand access to the new developments.
KPI6.4f	Webinars and Techdays	Industry	9	M36	Public training sessions.
KPI6.4g	Project events	Industry	2	M18, M36	Reaching to the EU ecosystem.
KPI6.5a	Papers published in relevant scientific journals	Academia	9	M36	E.g. IEEE Transactions on Cloud Computing, Journal of Grid Computing, Journal of Cloud Computing.
KPI6.5b	Presentations or special tracks in relevant scientific conferences	Academia	6	M36	E.g. IEEE IC on Fog & Edge Computing, IEEE Cloud Summit, ACM/IEEE Symposium on Edge Computing.

KPI #	Communication / Dissemination action	Audience	Target	Due Date	Description
KPI6.5c	Research workshops in relevant scientific conferences.	Academia	3	M36	E.g. IEEE IC on Fog & Edge Computing, IEEE Cloud Summit, ACM/IEEE Symposium on Edge Computing.
KPI6.6a	Commercial publications in online magazines and blogs	Industry	9	M36	About COGNIT and its pilot application in specific domains.
KPI6.6b	Press releases	General Public	6	M36	Main achievements of COGNIT.
KPI6.6c	Publications in newspapers	General Public	6	M36	High level benefits of COGNIT.

Table 4.1. Full list of Communication & Dissemination KPIs of the Project.

PART II. Communication and Dissemination Report

5. Current Communication and Dissemination Progress

5.1. Blog Posts

The Community Blog that was launched in M5 has been hosting new publications during the reporting period, a process that we expect to increase in frequency in the second half of the Project now that the first release of the COGNIT Platform has been released and the Consortium will engage in more Communication and Dissemination actions to spread the word about the tangible research and technological results of the Project.

Aggregated Impact [M7-M18]	
Published posts	2
Views	104
Geographic distribution	- Europe: 89% - USA: 8% - Others: 3%

Post-doctoral positions (2 years) in Cloud-Edge Computing	
Link	https://cognit.sovereignedge.eu/blog/post-doctoral-positions-in-cloud-edge-computing

Date	July 26, 2023
Author	● Prof. Paul Townend (Scientific Coordinator @ COGNIT | Associate Professor @ Umeå University)
Aim	This blog post is intended to promote two new post-doctoral positions available at Umeå University related to the COGNIT Project.

Post-Event Wrap Up: COGNIT Day 2024
Link   https://cognit.sovereignedge.eu/blog/post-event-wrap-up-cognit-day-2024
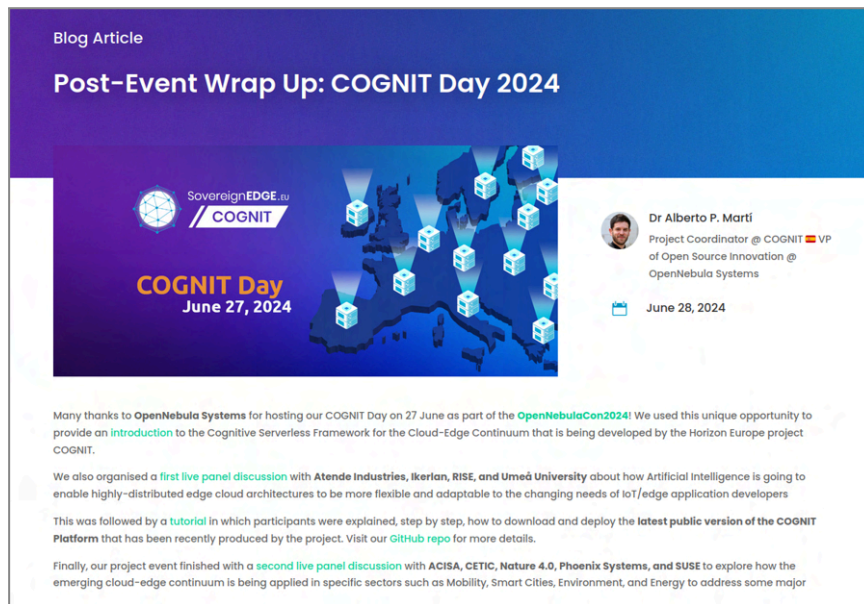
Date	June 28, 2024
Author	● Alberto P. Martí (Project Coordinator @ COGNIT | VP of Open Source Innovation @ OpenNebula Systems)
Aim	This blog post summarises the main contents of the COGNIT Day 2024, a Project event that took place on June 27 as part of the OpenNebulaCon2024.

5.2. Exhibition Booths

It is crucial for us to be able to position the COGNIT Project as a major player in the European research and innovation ecosystem, and also to create awareness among scientific and industry audiences, especially in connection with European open source technologies. That is the reason why we keep participating in physical events:

Aggregated Impact [M7-M18]	
Number of booths	2
Estimated audience	
● Cloud Expo Europe Madrid 2023	8,000
● Intertraffic Amsterdam 2024	30,000

Cloud Expo Europe Madrid 2023	
Website	https://www.cloudexpoeurope.es
Date	October 16–17, 2023
Location	Madrid (Spain)
Description	Cloud Expo Europe Spain is a specialised trade fair and conference deeply engaged with the latest developments and innovations in the realm of cloud technology. This annual event is held at the prestigious IFEMA (Feria de Madrid), an iconic venue in the vibrant Spanish capital.

Partners	**OpenNebula Systems** - Ikerlan - SUSE - ACISA
Aim	The main objective was to raise awareness about the Cognitive Cloud topic in the Horizon Europe programme, introduce COGNIT to the European cloud industry, and present the experiences and research conducted by several of the partners in the Consortium. The COGNIT booth hosted presentations about the Project's architecture and main components, as well as on some of its Use Cases.

Intertraffic Amsterdam 2024

Website	https://www.intertraffic.com/amsterdam

Date	April 16–19, 2024
Location	Amsterdam (Netherlands)
Description	Intertraffic connects mobility and traffic technology professionals on a global scale. All its initiatives are focussed on enhancing expertise and network expansion, creating and facilitating B2B and B2G engagement enabling innovation, business and sharing of solutions.
Partners	● **ACISA** ● Ikerlan
Aim	The main objective was to raise awareness about the COGNIT Project among the European industrial ecosystem involved in the Mobility sector, and to present some of the main novelties that the Smart Cities Use Case will bring in urban contexts in terms of speeding up the adoption of the cloud-edge computing paradigm in urban environments with a diversity of IoT devices involved in traffic control and requiring additional computational resource on-demand.

5.3. Presentations & Panels

As mentioned in the previous subsection, we are prioritising participation in events as one of the best ways to communicate the start of the Project and its progress and expected outcomes. We have been delivering presentations about COGNIT since M2:

Aggregated Impact [M7-M18]	
Number of events	**10**
Estimated audience	
● Linux Foundation Europe Member Summit 2023	1,500
● Linux Foundation Open Source Summit Europe 2023	100
● NexusForum2023 Summit	100
● eSAAM on Cloud-Edge Continuum @ EclipseCon 2023	450
● CODECO Workshop @ HiPEAC 2024	600
● FOSDEM 2024	8,000
● SGTech Week 2024	500
● EuCNC & 6G Summit 2024	900
● OpenContinuum Final Conference	100
● openSUSE Conference 2024	250

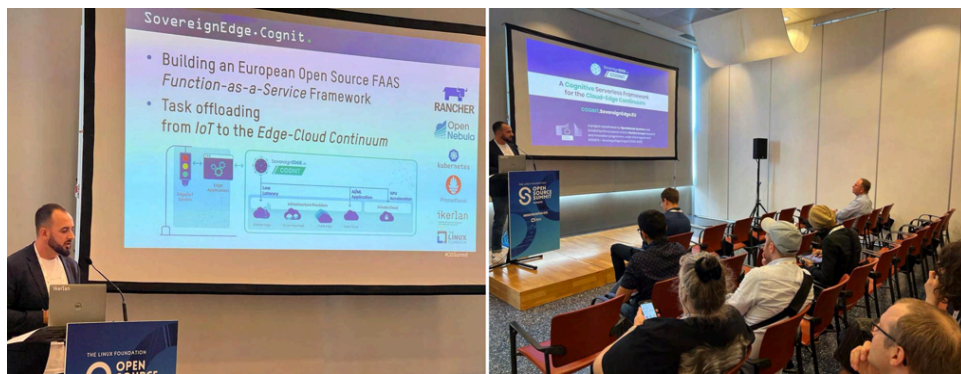| [PRESENTATION] *Linux Foundation Europe Member Summit 2023*	
Website	events.linuxfoundation.org/archive/2023/lf-europe-member-summit

Date	September 18, 2023
Location	Bilbao (Spain)
Description	The LFE Member Summit is an annual gathering for Linux Foundation Europe members, along with invited speakers, sponsors and media.
Speakers	• Alberto P. Martí (Project Coordinator @ COGNIT | VP of Open Source Innovation @ OpenNebula Systems)
Recordings	• *A sneak peak intro how Europe is building its future open source, sovereign Edge Cloud*
Aim	The main objective was to spread the word about the COGNIT Project and promote its unique model of European industry-research collaboration focused on ensuring a direct positive impact of the EU-funded R&D tasks of the Project on existing European open source technologies.

[PRESENTATION] *Linux Foundation Open Source Summit Europe 2023*

Website	events.linuxfoundation.org/archive/2023/open-source-summit-europe

Date	September 19–21, 2023
Location	Bilbao (Spain)
Description	The Linux Foundation Open Source Summit is the premier event for open source developers, technologists, and community leaders to collaborate, share information, solve problems, and gain knowledge, furthering open source innovation and ensuring a sustainable open source ecosystem.
Speakers	• Idoia de la Iglesia (Team Leader, IoT & Digital Platforms @ Ikerlan) • Marco González Hierro (Head of AI & Data @ Ikerlan)
Recordings	• *Using AI-enabled edge cloud technologies to strengthen Europe's Industry 4.0*

Aim	The main objective was to present the COGNIT Project as a project that is expected to have a significant impact on how the European industry is going to be able to adopt a serverless paradigm based on leveraging the emerging cloud-edge continuum.

[PRESENTATION + PANEL] *NexusForum2023 Summit*

Website	https://nexusforum.eu/nexusforum2023
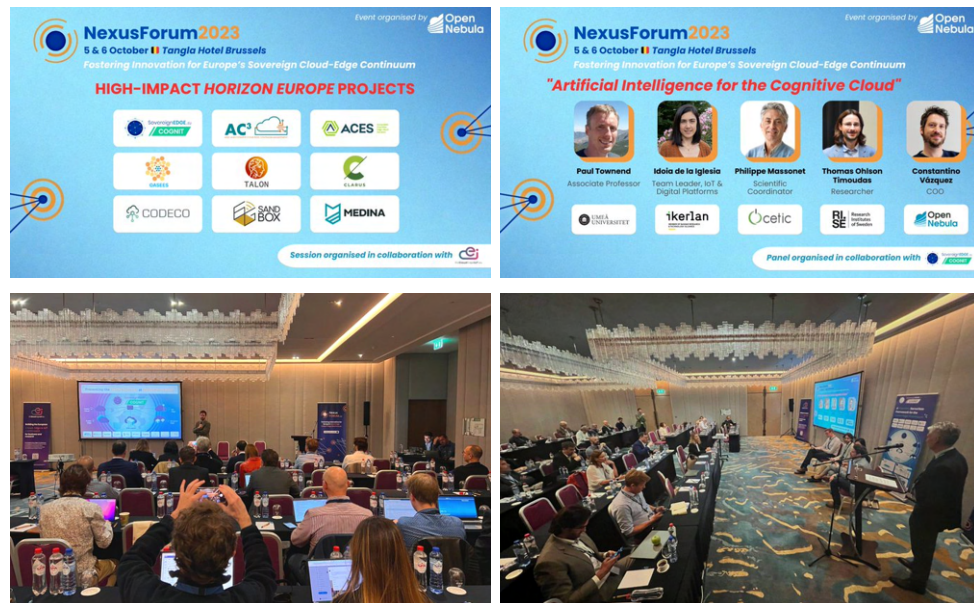
Date	October 5–6, 2023
Location	Brussels (Belgium)
Description	Organised and sponsored by OpenNebula Systems in anticipation of the official start of the EU-funded NexusForum.EU CSA in January 2024, and with the participation of key officials from DG CONNECT (including Pierre Chastanet) and several representatives of the Spanish Government as part of the Presidency of the Council of the EU, NexusForum2023 managed to create a unique space for exploring together potential collaborations between the research and industry ecosystems involved in Horizon Europe actions, the new IPCEI-CIS, and the EU Cloud Alliance.
Speaker & Panelists	● Alberto P. Martí (Project Coordinator @ COGNIT | VP of Open Source Innovation @ OpenNebula Systems). ● Paul Townend (Scientific Coordinator @ COGNIT | Associate Professor @ Umeå University). ● Constantino Vázquez (Technical Manager @ COGNIT | Chief Operating Officer @ OpenNebula Systems).

- Idoia de la Iglesia (Team Leader, IoT & Digital Platforms @ Ikerlan)
- Philippe Massonet (Scientific Coordinator @ CETIC)
- Thomas Ohlson Timoudas (Researcher @ RISE)
- Johan Kristiansson (Senior Researcher @ RISE)

| Aim | The main objectives was to present COGNIT as part of a series of presentations about HE projects developing the Cognitive Cloud, and to host a panel discussion in which partners of the Project shared their vision on the role that AI is expected to play in addressing the main challenges of operating multi-provider, highly distributed edge cloud environments. |

[PRESENTATION] *eSAAM on Cloud-Edge Continuum @ EclipseCon 2023*

Website	https://www.eclipse.org/events/2023/esaam2023/

Date	October 17, 2023
Location	Ludwigsburg (Germany)
Description	This conference brought together industry experts and researchers working on innovative software and systems solutions for the next generation of Cloud-to-Edge continuum, specifically focusing on Security and Privacy, Artificial Intelligence and Machine Learning, Systems and Software Architecture, Modelling and related challenges.
Speakers	• Marco González Hierro (Head of AI & Data @ Ikerlan)
Slides	• *AI and Edge Computing: Driving Competitive Advantage for Businesses*
Aim	Based on IKERLAN's first-hand experience as members of the Mondragon Corporation—the largest industrial group in the Basque Country—this Keynote focused on examining the practical implementation of edge-cloud solutions in EU strategic sectors, and to present COGNIT as a powerful serverless platform leveraging the cloud-edge continuum.

[PANEL] *CODECO Workshop @ HiPEAC 2024*

Website	https://www.hipeac.net/2024/munich/#/program/sessions/8105/
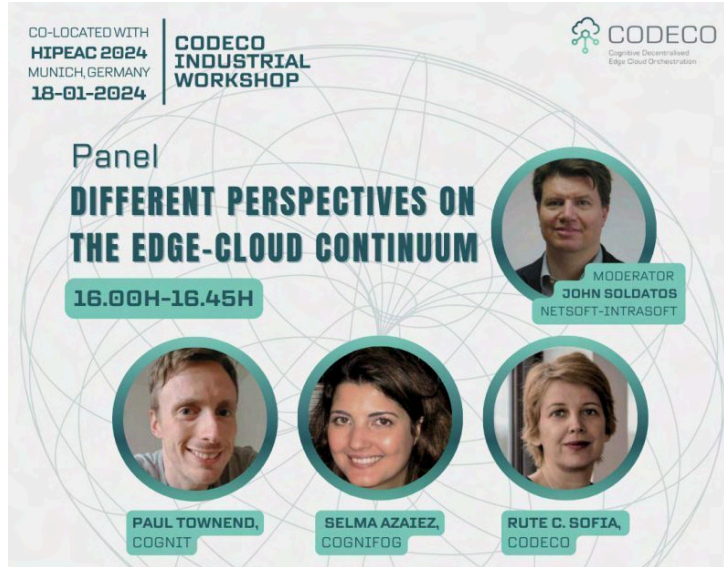
Date	January 17–19, 2024
Location	Munich (Germany)
Description	HiPEAC (High Performance, Edge And Cloud computing) is the premier focal point for networking, dissemination, training, and collaboration activities in Europe for researchers, industry, and policy related to computing systems.
Panelist	● Prof. Paul Townend (Scientific Coordinator @ COGNIT | Associate Professor @ Umeå University)
Details	● *Different perspectives on the Edge-Cloud Continuum*
Aim	The main objective was to disseminate the research performed by the Project through this first industrial workshop organised by the CODECO Project, which was directed to the research community and aimed at discussing novel concepts on smart Edge-Cloud Orchestration.

[PRESENTATIONS] *FOSDEM 2024*

Website	https://fosdem.org/2024
Date	February 3–4, 2024
Location	Brussels (Belgium)

Description	FOSDEM is a huge annual event that brings thousands of open source developers from all over the world to Brussels to learn about new projects, share their developments, and look for ways of collaboration. Participants included team members from OpenNebula, ACISA and CETIC.
Speakers	● Víctor Palma (Cloud Engineer @ OpenNebula Systems)
Recordings	● *AI-Driven Observability and Operations in Cloud-Edge Systems*. ● *Deploying a hyper-converged infrastructure with Ceph across the Cloud-Edge Continuum*.
Aim	The main objective was to introduce COGNIT to the European open source community and explore some of the approaches and technological foundations that will contribute to the implementation of the Project, including the benefits of using AIOps and a SDS-based hyper-converged infrastructure architecture across the cloud-edge continuum.

[PRESENTATION] *SGTech Week 2024*

Website	https://www.smartgrid-forums.com
Date	March 18–22, 2024
Location	Noordwijk (Netherlands)

| Description	SGTech Week 2024, organised by Smart Grid Forums, provides smart grid technical teams with crucial insights into the latest lessons learnt from innovation projects in key grid domains: substations, control centres, telco networks, smart energy meter infrastructure, big data, and cybersecurity.

Speakers	● Marco González Hierro (Head of AI & Data @ Ikerlan)
Details	● *Leading innovation and knowledge transfer to enable secure, resilient automation workloads with edge computing and 5G*
Aim	The main objective was to present COGNIT as an innovative serverless platform that enables a key sector such as Energy to speed up the adoption of 5G/edge infrastructure across the computing continuum.

[PRESENTATION] *EuCNC & 6G Summit 2024*

Website	https://www.eucnc.eu
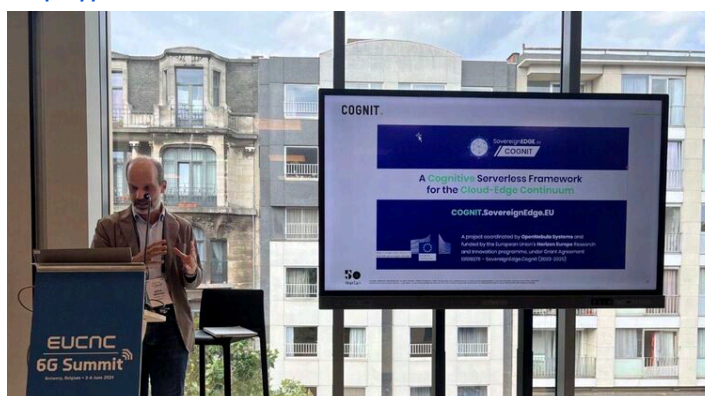
Date	June 3–6, 2024
Location	Antwerp (Belgium)
Description	The 2024 EuCNC & 6G Summit builds on putting together two successful conferences in the area of telecommunications: EuCNC (European

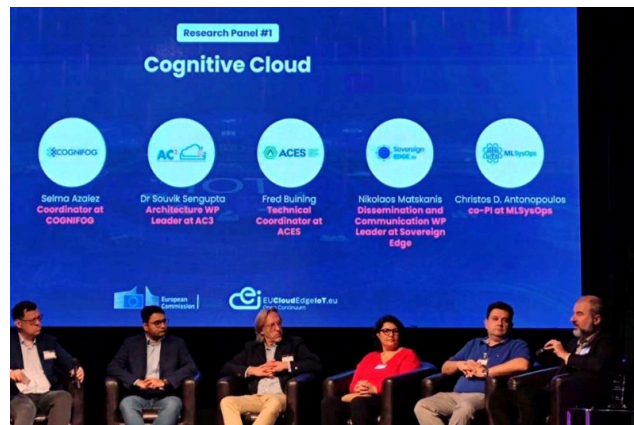|	Conference on Networks and Communications), supported by the European Commission, and the 6G Summit, originated from the 6G Flagship programme in Finland, one of the very first in its area.
Speakers	● Aitor Arriola (Team Leader, Smart Connectivity @ Ikerlan)
Details	● *AI in the Edge-Cloud Continuum: Driving Competitive Advantage for Businesses*
Aim	The main objective was to share with the audience the role that AI plays in the COGNIT Project and explore synergies with the application of smart orchestration techniques in the context of Advanced 5G & 6G networks implementing a Multi-access Edge Computing (MEC) paradigm.

[PANEL] *OpenContinuum Final Conference*

| Website	EUCloudEdgeIoT.eu
Date	June 18, 2024
Location	Brussels (Belgium)
Description	This end-of-project event focused on the value of the EUCloudEdgeIoT initiative for the industry and research ecosystems, highlighting the latest advancements and results of the OpenContinuum CSA and the more than 50 research and innovation actions that it has supported up until now.
Speakers	● Nikolaos Matskanis (Senior Project Manager @ CETIC)
Details	● *Research Panel #1: Cognitive Cloud*
Aim	The main objective was to discuss the novelties in the development of the Cognitive Cloud with the rest of Horizon Europe projects working on this topic in the context of the EC-sponsored EUCloudEdgeIoT initiative.

[PRESENTATION] *openSUSE Conference 2024*

Website	https://events.opensuse.org/conferences/oSC24
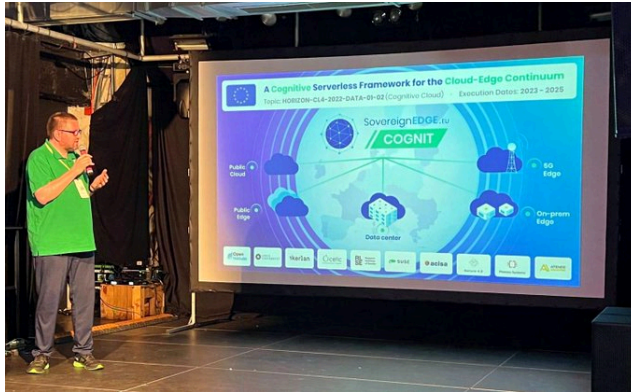
Date	June 27–29, 2024
Location	Nürnberg (Germany)
Description	The openSUSE Conference is an annual gathering of openSUSE Project and Open Source Communities. It features a blend of virtual and in-person presentations as well as workshops and social gatherings.
Speakers	● Torsten Hallmann (Head of Public Affairs @ SUSE)
Recording	● *Accelerating IoT with a Cognitive Serverless Framework*
Aim	The main objective of this presentation was to explain to the openSUSE community how the COGNIT Project is leveraging SUSE's open source technologies as part of its R&D tasks and to spread the word about the recently established COGNIT Ambassador Programme.

5.4. COGNIT Day 2024

The first major COGNIT Project event—**COGNIT Day 2024**—took place on 27 June co-located with the OpenNebula Conference. This approach and the format of this virtual community event allowed us to leverage its audience of around 400 registered attendees in order to maximise the dissemination of the results of the Project, providing:

- An introduction to the COGNIT Project and its architectural features.
- A first live panel discussion with Atende Industries, Ikerlan, RISE, and Umeå University about how Artificial Intelligence is going to enable serverless edge-cloud environments to respond to the needs of IoT/edge application developers.
- A tutorial explaining how to download and deploy the latest version of COGNIT.
- A second live panel discussion with ACISA, CETIC, Nature 4.0, Phoenix Systems, and SUSE that explored how COGNIT is going to be applied in strategic EU sectors.

Figure 5.1. Visual summary of the main sessions of the COGNIT Day 2024.

5.5. Project Deliverables

Apart from other repositories (see D1.1 for more details), all public deliverables can be downloaded from the "Resources" section on the Project's website:
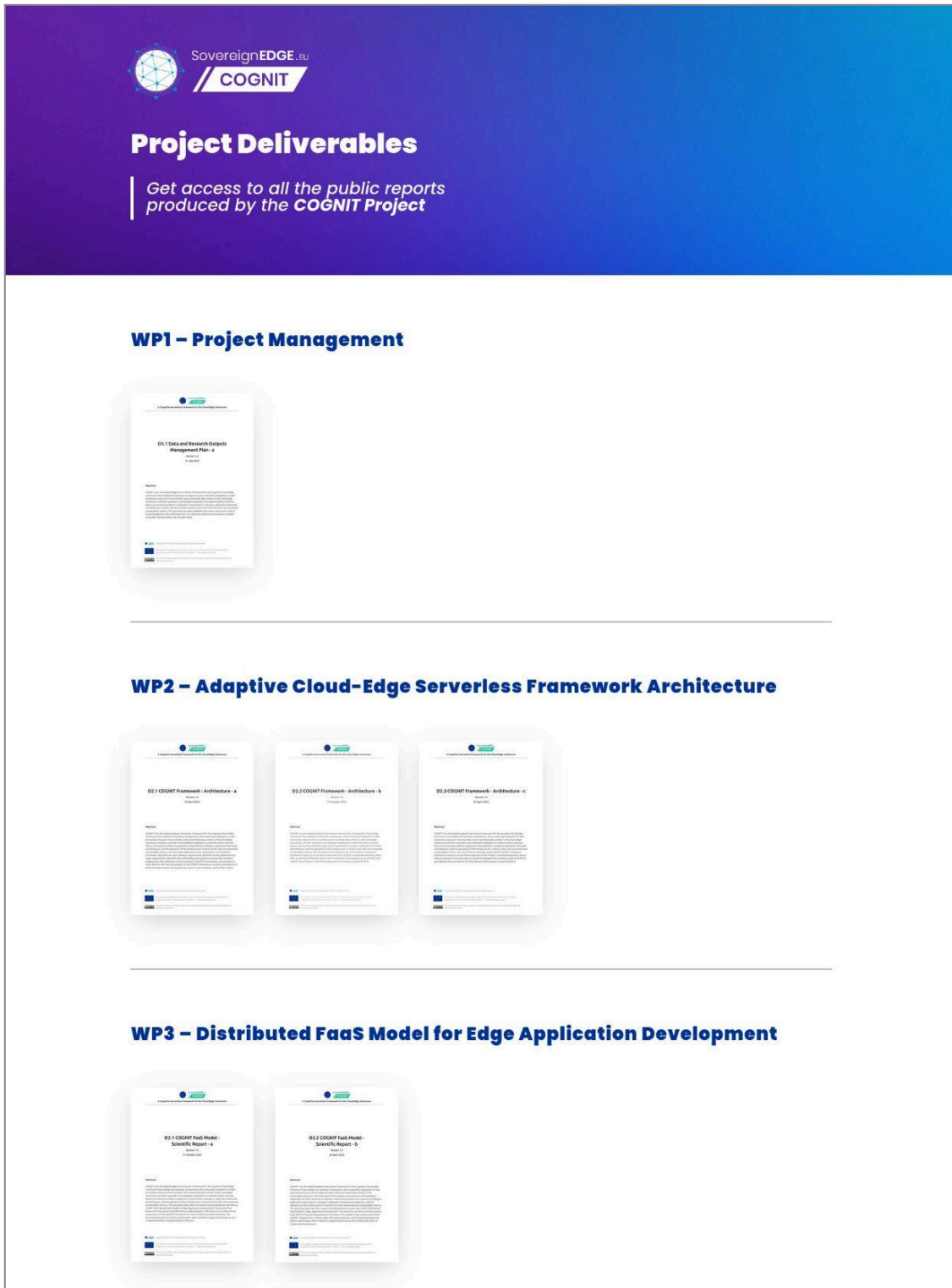
Figure 5.2. New section of the COGNIT website hosting the Project's public deliverables.

Aggregated Impact [M7-M18]	
New Deliverables	16

New Public Deliverables:

WP1 – Project Management

- D1.1 Data and Research Outputs Management Plan - a

WP2 – Adaptive Cloud-Edge Serverless Framework Architecture

- D2.1 COGNIT Framework - Architecture - a
- D2.2 COGNIT Framework - Architecture - b
- D2.3 COGNIT Framework - Architecture - c

WP3 – Distributed FaaS Model for Edge Application Development

- D3.1 COGNIT FaaS Model - Scientific Report - a
- D3.2 COGNIT FaaS Model - Scientific Report - b
- D3.6 COGNIT FaaS Model - Software Source - a
- D3.7 COGNIT FaaS Model - Software Source - b

WP4 – AI-enabled Distributed Serverless Platform and Workload Orchestration

- D4.1 COGNIT Serverless Platform - Scientific Report - a
- D4.2 COGNIT Serverless Platform - Scientific Report - b
- D4.6 COGNIT Serverless Platform - Software Source - a
- D4.7 COGNIT Serverless Platform - Software Source - b

WP5 – Adaptive Serverless Framework Integration and Validation

- D5.1 Use Cases - Scientific Report - a
- D5.2 Use Cases - Scientific Report - b
- D5.3 Use Cases - Scientific Report - c
- D5.7 COGNIT Framework - Software Source - a
- D5.10 Framework - Demo - a

WP6 – Dissemination, Communication, Exploitation, and Standardization

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- D6.1 Communication and Dissemination Plan & Report - a

5.6. Social Media Posts

As mentioned before, social media platforms (i.e. LinkedIn and Twitter) are being used by COGNIT as an instrument to raise awareness about the Project and the Cognitive Cloud topic in Horizon Europe, and to communicate specific messages to the Project's target audiences. All posts generated by COGNIT use the unique hashtag **#COGNITproject**.

Aggregated Impact [M1-M6]		
Twitter	Number of posts:	27
	Total impressions:	4,500
LinkedIn	Number of posts:	33
	Total impressions:	23,178

We include in this report only a few examples of the social media posts generated by the Project, illustrating the tone and approach we are using in these communications:

[TWITTER] *Example #1*	
Link	https://x.com/SovereignEdgeEU/status/1770447245478854687
Date	March 20, 2024
Aim	This post confirms the successful celebration in Barcelona of the Project's General Assembly in March 2024 and announces the imminent launch of the first public release of the COGNIT Platform.

[TWITTER] *Example #2*

Link	https://x.com/SovereignEdgeEU/status/1808100567576629640
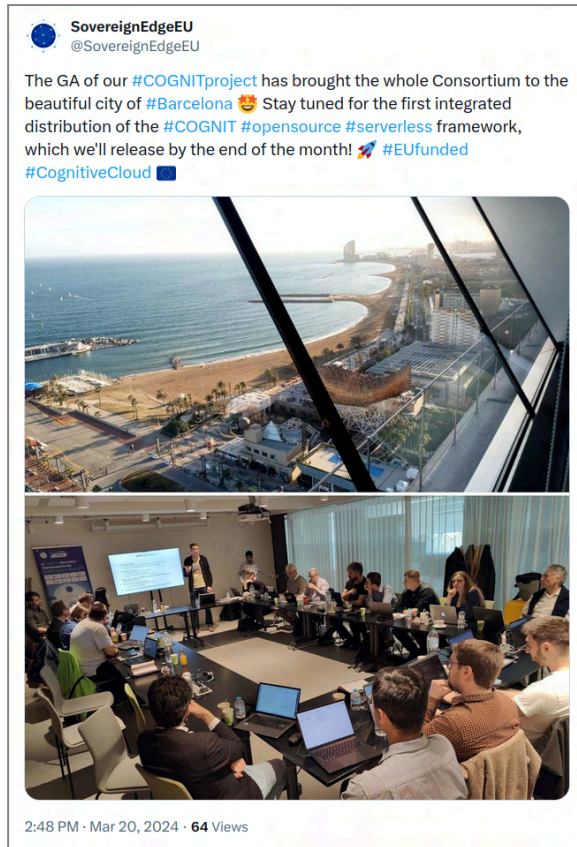
Date	July 2, 2024
Aim	This post works as a reminder about the successful celebration of the COGNIT Day 2024 event and the availability of the recorded sessions.

[LINKEDIN] *Example #1*

Link	https://www.linkedin.com/feed/update/urn:li:activity:7018592638211682304

Date	July 26, 2023
Aim	This post contributes to spreading the word about the available post-doctoral positions offered by UMU in connection with the COGNIT Project.

[LINKEDIN] *Example #2*

Link	https://www.linkedin.com/feed/update/urn:li:activity:7115283735587041281

Date	October 4, 2023
Aim	This post announced the successful celebration in Brussels of the Project's General Assembly in early October 2023.

5.7. Webinars & TechDays

In parallel to the public training sessions and webinars that the Project will organise during its execution, we keep running a series of internal webinar to explore and discuss among the COGNIT partners a number of specific topics that are relevant to the Project:
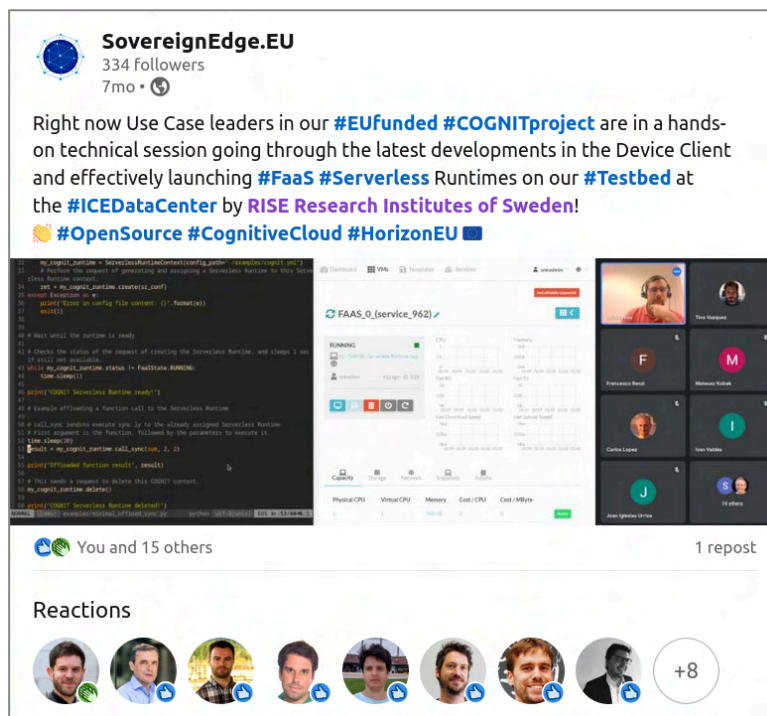
Aggregated Impact [M1-M6]	
Number of events	2 Internal Webinars
Number of participants	30

| [INTERNAL WEBINAR] *COGNIT Device Client for Python*	
Speaker	● Aritz Brosa (Researcher @ Ikerlan)
Date	November 30, 2023
Description	This internal webinar for COGNIT partners was aimed at helping Use Case leaders within the Consortium to familiarise themselves with the Device Client for Python already available at the COGNIT Platform.

[INTERNAL WEBINAR] *COGNIT Testbed*

Speaker	● Jean-Baptiste Piacentino (Cloud Diplomat @ Clever Cloud)
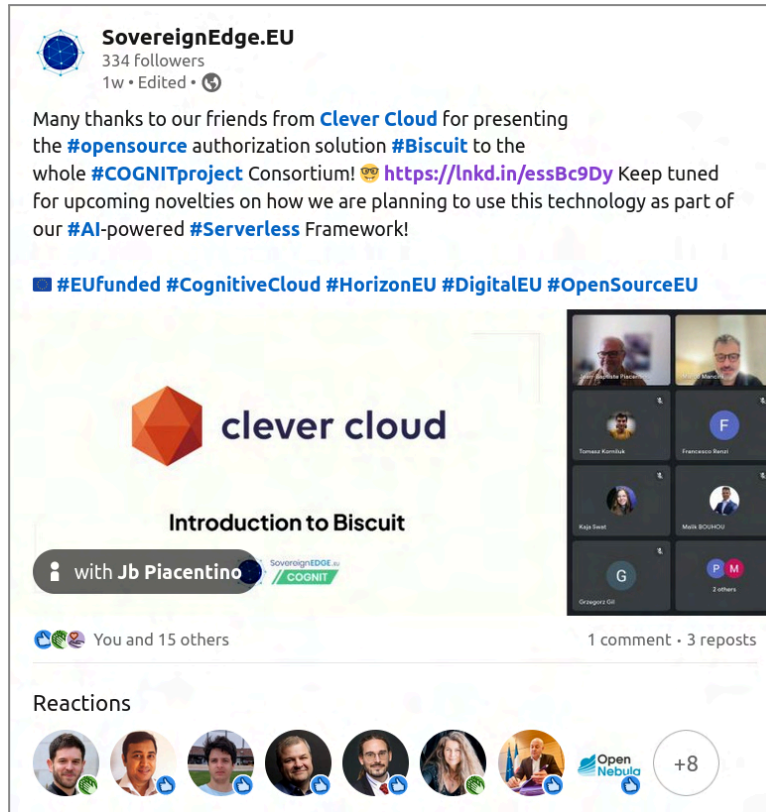
Date	June 27, 2024
Description	Biscuit is an open-source, token-based authorization system. This internal webinar for COGNIT partners was used to explore this technology (Clever Cloud being one of the main European companies behind its development) and discuss the plans for its integration as part of the COGNIT Platform.

5.8. Ambassador Programme

During the reporting period—in line with the associated KPI defined by the Grant Agreement—the Project has recruited the following representatives from the OpenNebula and SUSE communities as COGNIT Ambassadors, with a commitment to collaborate with the members of the team in Communication & Dissemination actions:

- **Katerina Arzhayev** (Director of Product Management, Healthcare Edge @ SUSE)
- **Joao Pita Costa** (AI Research Scientist @ OpenNebula Systems)
- **Daniel Rahn** (Senior Product Manager @ SUSE)
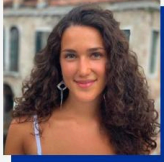- **Chiara Zincone** (EU Digital Policy Analyst @ OpenNebula Systems)

Figure 5.3. New website section with references to the Project's Ambassadors.

5.9. Scientific Papers
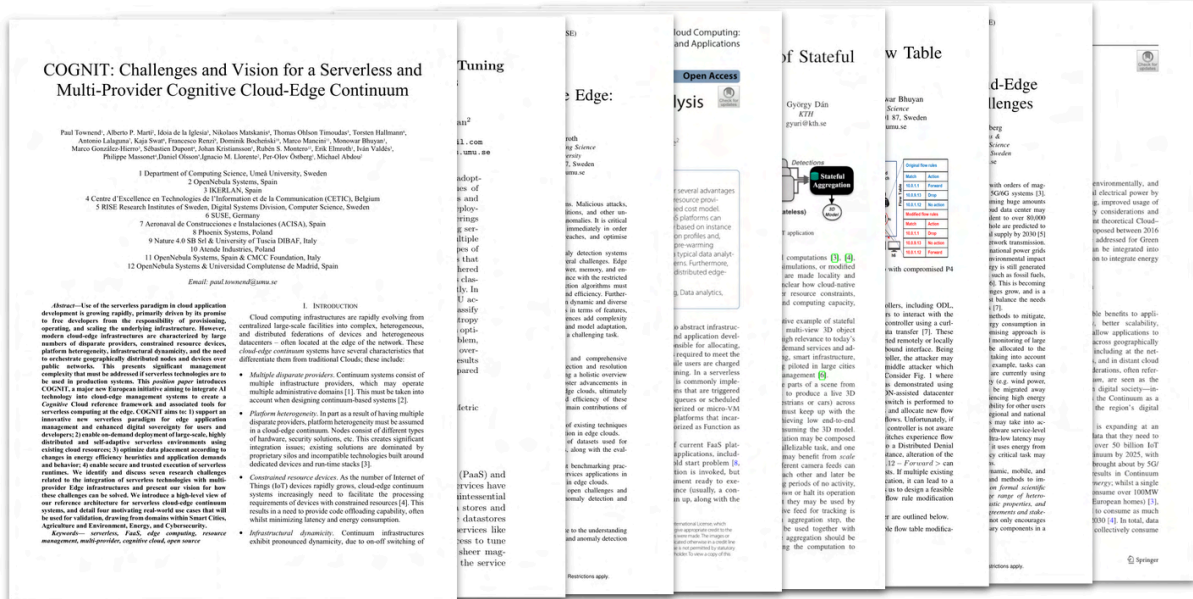
Figure 5.4. The eight scientific papers produced by the Project during the reporting period.

P. Townend, et al., "**COGNIT: Challenges and Vision for a Serverless and Multi-Provider Cognitive Cloud-Edge Continuum**," in *2023 IEEE International Conference on Edge Computing and Communications (EDGE)*, Chicago, IL, USA, 2023 pp. 12-22. DOI: 10.1109/EDGE60047.2023.00015

Use of the serverless paradigm in cloud application development is growing rapidly, primarily driven by its promise to free developers from the responsibility of provisioning, operating, and scaling the underlying infrastructure. However, modern cloud-edge infrastructures are characterized by large numbers of disparate providers, constrained resource devices, platform heterogeneity, infrastructural dynamicity, and the need to orchestrate geographically distributed nodes and devices over public networks. This presents significant management complexity that must be addressed if serverless technologies are to be used in production systems. This position paper introduces COGNIT, a major new European initiative aiming to integrate AI technology into cloud-edge management systems to create a Cognitive Cloud reference framework and associated tools for serverless computing at the edge. COGNIT aims to: 1) support an innovative new serverless paradigm for edge application management and enhanced digital sovereignty for users and developers; 2) enable on-demand deployment of large-scale, highly distributed and self-adaptive serverless environments using existing cloud resources; 3) optimize data placement according to changes in energy efficiency heuristics and application demands and behavior; 4) enable secure and trusted execution of serverless runtimes. We identify and discuss seven research challenges related to the integration of serverless technologies with multi-provider Edge infrastructures and present our vision for how these challenges can be solved. We introduce a high-level view of our reference architecture for

serverless cloud-edge continuum systems, and detail four motivating real-world use cases that will be used for validation, drawing from domains within Smart Cities, Agriculture and Environment, Energy, and Cybersecurity.

J. Forough, M. Bhuyan and E. Elmroth, "**Anomaly Detection and Resolution on the Edge: Solutions and Future Directions**," *IEEE International Conference on Service-Oriented System Engineering (SOSE)*, Athens, Greece, 2023, pp. 227-238. DOI: 10.1109/SOSE58276.2023.00034

Anomaly detection and resolution are crucial in edge clouds to ensure that distributed systems operate reliably and securely. This survey presents a comprehensive overview of anomaly detection and resolution strategies specifically designed for edge cloud environments, exploring their strengths, limitations, and applicability in different scenarios. It explores the unique challenges and characteristics of edge cloud systems, providing an in-depth analysis of existing works and tools. Evaluation metrics and datasets used by different methods are examined to provide insights into assessing the performance and efficacy of anomaly detection and resolution approaches. The paper concludes by identifying open challenges, future research directions, and offering practical recommendations, making it a valuable resource for researchers and practitioners involved in enhancing the reliability and security of edge cloud systems.

Y. S. Patel, P. Townend and P. -O. Östberg, "**Formal Models for the Energy-Aware Cloud-Edge Computing Continuum: Analysis and Challenges**," *IEEE International Conference on Service-Oriented System Engineering (SOSE)*, Athens, Greece, 2023, pp. 48-59, DOI: 10.1109/SOSE58276.2023.00012

Cloud infrastructures are rapidly evolving from centralised systems to geographically distributed federations of edge devices, fog nodes, and clouds. These federations (often referred to as the Cloud-Edge Continuum) are the foundation upon which most modern digital systems depend, and consume enormous amounts of energy. This consumption is becoming a critical issue as society's energy challenges grow, and is a great concern for power grids which must balance the needs of clouds against other users. The Continuum is highly dynamic, mobile, and complex; new methods to improve energy efficiency must be based on formal scientific models that identify and take into account a huge range of heterogeneous components, interactions, stochastic properties, and (potentially contradictory) service-level agreements and stakeholder objectives. Currently, few formal models of federated Cloud-Edge systems exist - and none adequately represent and integrate energy considerations (e.g. multiple providers, renewable energy sources, pricing, and the need to balance consumption over large-areas with other non-Cloud consumers, etc.). This paper conducts a systematic analysis of current approaches to modelling Cloud, Cloud-Edge, and federated Continuum systems with an emphasis on the integration of energy considerations. We identify key omissions in the literature, and propose an initial high-level architecture and approach to begin addressing these - with the ultimate

goal to develop a set of integrated models that include data centres, edge devices, fog nodes, energy providers, software workloads, end users, and stakeholder requirements and objectives. We conclude by highlighting the key research challenges that must be addressed to enable meaningful energy-aware Cloud-Edge Continuum modelling and simulation.

Kumar, G., Sahoo, K.S., Bhuyan, M. (2023). "**Towards a Workload Mapping Model for Tuning Backing Services in Cloud Systems**". In: Strauss, C., Amagasa, T., Kotsis, G., Tjoa, A.M., Khalil, I. (eds) *Database and Expert Systems Applications. DEXA 2023. Lecture Notes in Computer Science*, vol 14146. Springer, Cham. DOI: 10.1007/978-3-031-39847-6_19

With the increasing advent of applications and services adopting cloud-based technologies, generic automated tuning techniques of database services are gaining much attraction. This work identifies and proposes to overcome the potential challenges associated with deploying a tuning service as part of Platform-as-a-Service (PaaS) offerings for tuning of backing services. Offering an effective database tuning service requires such tuners whose architecture can support tuning multiple databases and numerous database versions deployed on various types of underlying hardware configurations with varying VM plans. Tuners that offer such capabilities usually attempt to leverage experiences gathered previously. By taking advantage of relevant past experiences, tuners classify the current workload to the most pertinent workload seen recently. In this work, a five-layered, fully connected neural network with ReLU activation function is being employed as the classification model to classify data points into relevant workload classes. The categorical cross-entropy function is employed as the loss function and optimized using Adam optimizer. The work handles the challenges related to the cold-start problem, issues in mapping, and cascading errors. The proposed solution can overcome these issues in a large-scale production environment. The results show that the model has 93.3% accuracy in 93.8% F1-score as compared to the previous model like Ottertune.

Moreno-Vozmediano, R., Huedo, E., Montero, R.S. *et al*. **Latency and resource consumption analysis for serverless edge analytics**. *Journal of Cloud Computing*, vol. 12, no. 108 (2023), Springer. DOI: 10.1186/s13677-023-00485-9

The serverless computing model, implemented by Function as a Service (FaaS) platforms, can offer several advantages for the deployment of data analytics solutions in IoT environments, such as agile and on-demand resource provisioning, automatic scaling, high elasticity, infrastructure management abstraction, and a fine-grained cost model. However, in the case of applications with strict latency requirements, the cold start problem in FaaS platforms can represent an important drawback. The most common techniques to alleviate this problem, mainly based on instance pre-warming and instance reusing mechanisms, are usually not well adapted to different application profiles and, in general, can entail an extra expense of resources. In this work, we analyze the effect of instance pre-warming and instance reusing on both

application latency (response time) and resource consumption, for a typical data analytics use case (a machine learning application for image classification) with different input data patterns. Furthermore, we propose extending the classical centralized cloud-based serverless FaaS platform to a two-tier distributed edge-cloud platform to bring the platform closer to the data source and reduce network latencies.

A. Hasselberg, T. O. Timoudas, P. Carbone and G. Dán, "**Cliffhanger: An Experimental Evaluation of Stateful Serverless at the Edge**," *2024 19th Wireless On-Demand Network Systems and Services Conference (WONS)*, Chamonix, France, 2024, pp. 41-48, IEEE. DOI: 10.23919/WONS60642.2024.10449637

The serverless computing paradigm has transformed cloud service deployment by enabling automatic scaling of resources in response to varying demand. Building on this, stateful serverless computing introduces critical capabilities for data management, fault tolerance, and consistency, which are particularly relevant in the context of distributed deployments, notably in edge computing environments. In this work, we explore the feasibility of stateful serverless computing in resource-limited edge environments through an empirical study utilizing a multi-view object tracking application. Our results show that while these systems perform well in cloud environments, their effectiveness is severely affected at the edge due to state, application, and resource management solutions optimized for cloud environments. Existing solutions are most detrimental to applications with intermittent workloads, as typical combinations of concurrency handling and resource reservation can lead to minutes of unstable system behavior due to cold starts. Our results highlight the need for a tailored approach in stateful serverless systems for edge computing scenarios.

B. A. Reddy, K. S. Sahoo and M. Bhuyan, "**Securing P4-SDN Data Plane against Flow Table Modification Attack**," *IEEE/IFIP Network Operations and Management Symposium (NOMS)*, Seoul, Republic of Korea, 2024, pp. 1-5, DOI: 10.1109/NOMS59830.2024.10575461

Security in Software Defined Network (SDN) architecture is becoming the most substantial challenge. This paper introduces a novel threat model focused on flow table modification in the P4-programmable SDN data plane, outlining an attacker's stochastic manipulation of flow rules from a compromised switch. A detection framework is proposed to identify the malicious switch within the network by utilizing the thrift port. Moreover, a fuzzy-rule-based mitigation strategy has been proposed to identify the severity of attacks. The feasibility and effectiveness of the methodology are evaluated using a developed testbed setup by employing Facebook datacenter fabric topology in a Mininet emulator and BMv2 switch.

Patel, Y.S., Townend, P., Singh, A. *et al.* **Modeling the Green Cloud Continuum: integrating energy considerations into Cloud–Edge models**. *Cluster Computing* (2024), Springer. DOI: 10.1007/s10586-024-04383-w

The energy consumption of Cloud–Edge systems is becoming a critical concern economically, environmentally, and societally; some studies suggest data centers and networks will collectively consume 18% of global electrical power by 2030. New methods are needed to mitigate this consumption, e.g. energy-aware workload scheduling, improved usage of renewable energy sources, etc. These schemes need to understand the interaction between energy considerations and Cloud–Edge components. Model-based approaches are an effective way to do this; however, current theoretical Cloud–Edge models are limited, and few consider energy factors. This paper analyses all relevant models proposed between 2016 and 2023, discovers key omissions, and identifies the major energy considerations that need to be addressed for Green Cloud–Edge systems (including interaction with energy providers). We investigate how these can be integrated into existing and aggregated models, and conclude with the high-level architecture of our proposed solution to integrate energy and Cloud–Edge models together.

Figure 5.5. Zenodo repository of the COGNIT Project.

6. Current KPI Status

KPI #	Communication / Dissemination action	Audience	Target	Due Date	Current KPI Status
KPI6.1	Champion Programme	Industry / Open Source	1	M18	**1** [COGNIT Ambassadors Programme]
KPI6.2	Participation in communities	Industry / Open Source	3	M18	**4** [Linux Foundation, LF Europe, CNCF, LF Edge]
KPI6.3	Participation in EU initiatives	Industry	4	M36	**5** [Gaia-X Association, 6G-IA, EOSC, IPCEI-CIS, EU Cloud Alliance]
KPI6.4a	Exhibition booths in relevant open source conferences	Industry / Open Source	3	M36	**1** [FOSDEM 2023]
KPI6.4b	Exhibition booths in relevant cloud & edge industry forums	Industry	3	M36	**2** [Cloud Expo Madrid 2023, InterTraffic Amsterdam 2024]
KPI6.4c	Presentations in open source conferences	Industry / Open Source	6	M36	**7** [FOSDEM 2023, OpenNebulaCon2023, LF Open Source Summit Europe 2023, LFE Member Summit 2023, Eclipse eSAAM 2023, FOSDEM 2024, openSUSE Conference 2024]
KPI6.4d	Presentations with demonstrators from use cases in relevant cloud & edge industry forums	Industry	6	M36	**2** [Cloud Expo Madrid 2023, InterTraffic Amsterdam 2024]
KPI6.4e	Technical workshops in relevant open source conferences and industry forums	Industry / Open Source	3	M36	**1** [OpenNebulaCon2024]
KPI 6.4f	Webinars and Techdays	Industry	9	M36	**4** [Internal Webinars on *Colonies*, the COGNIT Testbed, the COGNIT Device Client for Python, and *Biscuit*]
KPI6.4g	Project events	Industry	2	M18, M36	**1** [COGNIT Day 2024]
KPI6.5a	Papers published in relevant scientific journals	Academia	9	M36	**2** [Journal of Cloud Computing, Cluster Computing]
KPI6.5b	Presentations or special tracks in relevant scientific conferences	Academia	6	M36	**6** [IEEE EDGE 2023, IEEE SOSE 2023 (2), DEXA 2023, WONS 2024, IEEE/IFIP NOMS 2024]
KPI6.5c	Research workshops in relevant scientific conferences.	Academia	3	M36	**1** [CODECO Workshop @ HiPEAC 2024]
KPI6.6a	Commercial publications in online magazines and blogs	Industry	9	M36	**1** [Madrid Tech Show Newsletter 2023]
KPI6.6b	Press releases	General Public	6	M36	**1** [June 2023]
KPI6.6c	Publications in newspapers	General Public	6	M36	**0**

Table 6.1. Status of Communication & Dissemination KPIs at the end of the reporting period.