HORIZON EUROPE FRAMEWORK PROGRAMME

CloudSkin

(grant agreement No 101092646)

Adaptive virtualization for AI-enabled Cloud-edge Continuum

D6.2 Communication Report

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1.0	28-06-2024	Maria A. Serrano (NRB)	Final version.

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List of Abbreviations and Acronyms

AI   Artificial Intelligence

API   Application Programming Interface

CAS   Computer-Assisted Surgery

CEI   Cloud, Edge and IoT

DOI   Digital Object Identifier

GPU   Graphics Processing Unit

IPR   Intellectual Property Rights

KER   Key Exploitable Result

KPI   Key Performance Indicator

ML   Machine Learning

MWC   Mobile World Congress

QMR   Quarterly Management Report

SME   Small and Medium-sized Enterprise

TRL   Technology Readiness Level

1   Introduction

The CloudSkin Work Package 6 "Promoting Impact" is responsible for the Dissemination, Communication, Exploitation and Standardization activities towards raising awareness of the project and ensuring it lives on beyond the project's end. The objectives pursued by this work package include:

1. Fostering the adoption of results

2. Maximizing project impact

3. Creating a community of interest around project results

4. Identifying key exploitable results and providing a long-term sustainability plan for CloudSkin technology

An initial communication plan was laid out in M6, in the form of *D6.1 Community Plan*[1]. This deliverable, *D6.2 Communication Report*, presents a detailed overview of the activities undertaken from M1-M15 and provides an update on intended work to be carried out from M16-M36.

From M1-M15, the CloudSkin project consortium actively raised awareness of the project and reached target audiences through the tools and channels defined in D6.1. The first part of the project was also devoted to creating a recognizable brand around the project and the tools and channels that would help access potential stakeholders.

The content of this deliverable reports CloudSkin dissemination and communication activities, project's interaction with other research projects, community involvement activities, open science contributions, and a preliminary exploitation plan, during the first period of the project. In specific, the project identity and promotion material is presented in Chapter 2; the online communication channels and press strategy is described in Chapter 3. As the project has developed, the consortium's dissemination and communication activities have increased, as has interest in the project and its technologies and solutions. Chapter 4 provides information on all kind of activities and interactions, being evaluated against the goals that were set in *D6.1 Communication plan*. Moreover, the ongoing open source contributions of the project are detailed in Chapter 6, while the exploitation plan, and the objectives and achievements at standardization are also described is Chapter 7. Finally, Chapter 8 presents a final evaluation of performance and key performance indicators (KPIs) until M16 and Chapter 9 concludes this document.

For the second part of the project, the strategic perspective of the CloudSkin dissemination and communication effort will continue to serve the overall success of the project and maximize the dissemination and communication impact within the communities of target stakeholders. Such effort includes:

1. Continuation of the active promotion of project activities through different channels (such as project website, social media, newsletter, and other relevant initiatives and channels).

2. Conferences and ad hoc events.

3. Organisation of workshops and webinars.

4. Publication of scientific articles and presentations in international peer-reviewed journals and conferences.

Moreover, future actions also involve a collaboration with partners to ensure a sustainable exploitation of the CloudSkin technologies.

2 Dissemination material

We have developed communication and dissemination materials to assist partners in efficiently, consistently, and accurately (including proper acknowledgment and branding) creating and disseminating materials. These resources will enable them to effectively promote awareness of the project and its objectives in an engaging manner.

2.1 Project brand and identity

Developing a distinct brand and establishing a project identity served as a crucial initial step in enhancing visibility and recognition for the project. To ensure the creation of a memorable and cohesive brand, the dissemination team of WP6 worked on a design to conceptualize and craft a unified graphic identity.

The brand guidelines, logos, and templates have been disseminated to all consortium members through the internal repository. All created materials feature the project name, website, EU acknowledgment, and a version of the project logo, all adhering to the project's signature colors and style. A comprehensive description of the graphic identity is accessible in the deliverable *D6.1 Communication plan*[1]. Project partners have consistently integrated the project brand into their communication and dissemination endeavors.

2.2 Flyer

A brochure has been developed that offers complete information about the project, its objectives and the implemented use cases, therefore produced to be very clear and ease the understanding of specific and general public alike. Figure 1 shows the CloudSkin brochure. They have been used in multiple events, including the Cloud-Edge Continuum Workshop and Mobile World Congress, among others.
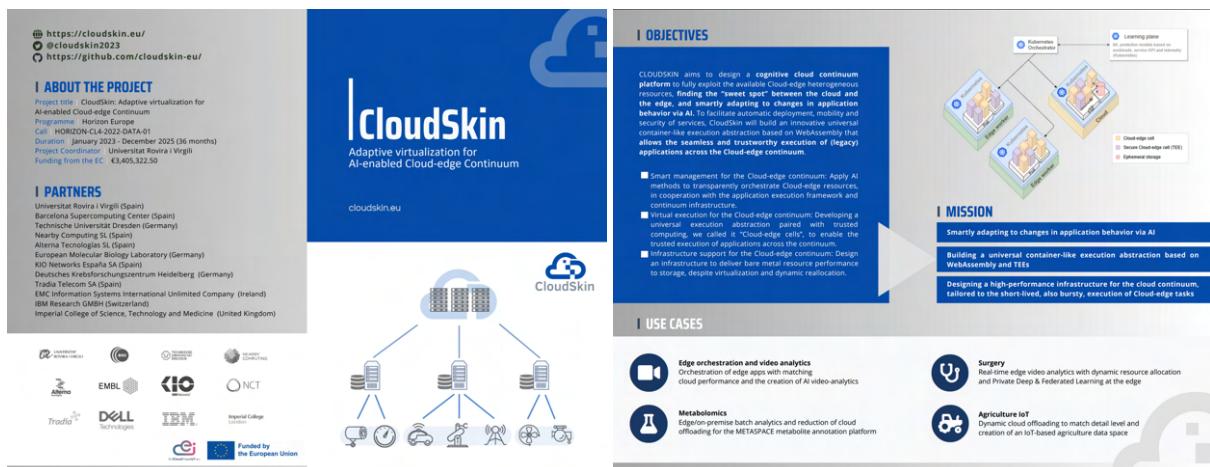
Figure 1: CloudSkin Brochure.

2.3 Poster

A comprehensive overview display was created for all partners to utilize. This display features project goals, partner information, software and use cases. Partners are encouraged to incorporate this display into their own communication efforts. Partner DELL printed the display for use in the Cloud-Edge Continuum Workshop' among others uses. Figure 2 depicts the CloudSkin poster.

2.4 Other material

Presentation templates, quarterly management report (QMR) templates, logos, Latex deliverable templates and the stylebook (containing font types) are available at the consortium's internal Google
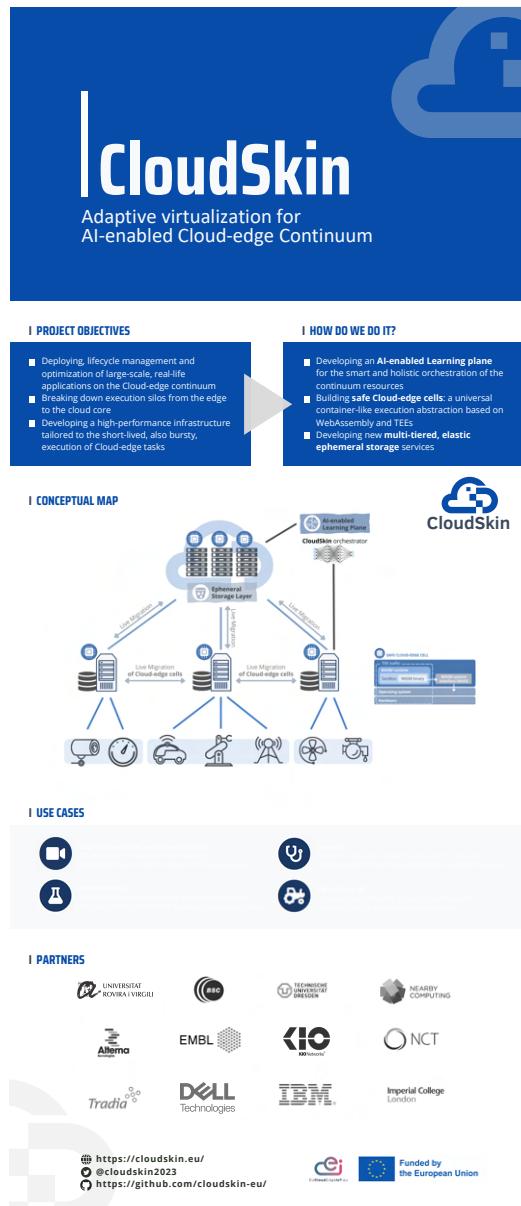
Figure 2: CloudSkin project overview poster.

Drive storage [2]. Figure 3 represents the CloudSkin slides template.

Figure 3: CloudSkin presentation template.

3   On-line presence

One of the main objectives pursued by CloudSkin communication and dissemination activities is to promote broad visibility and awareness about CloudSkin with an adequate project's online presence, spreading knowledge about the project and its results in the stakeholders' community. Three main activities are defined to ensure online communication with diverse audiences: 1) project website, 2) social media, and 3) press strategy.

Moreover, a CloudSkin Zenodo and GitHub repositories have been created to promote open science resources like publications, and open source software, respectively. More details on the Zenodo and GitHub repositories can be found in sections 4.2 and 6, respectively.

3.1   Project Website
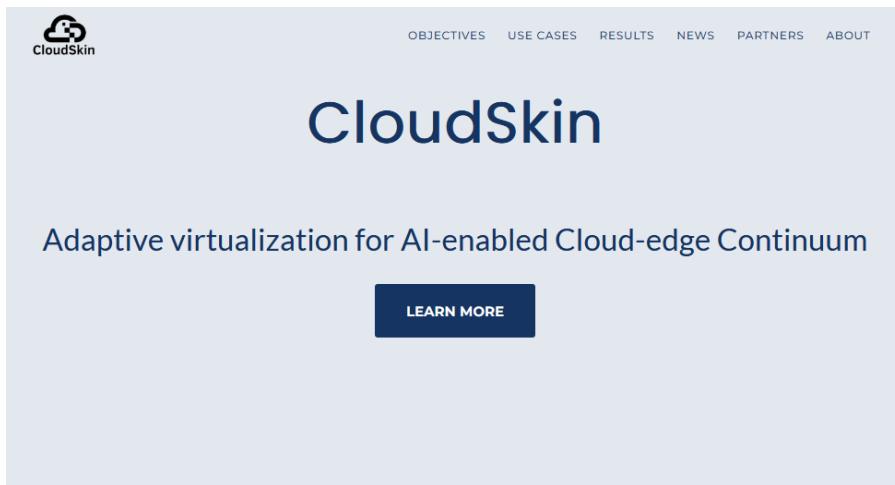
The project's website can be found at the following URL:

> https://cloudskin.eu/

The website is managed by the Universitat Rovira i Virgili (URV), and it is updated regularly to reflect the consortium's endeavors. Serving as the primary public communication platform, the website offers comprehensive details about the project, including information about partners, branding, objectives, use cases, project outcomes (such as publications, deliverables, and demos), as well as news and events.

The CloudSkin public deliverable *D1.1 Public Project Website* [3] summarizes the structure, the content and the functionalities of the website.

Figure 4 shows a screenshot of the main page of the CloudSkin website.

Figure 4: Main page of the CloudSkin website

3.2 Video

Promotional videos are a compelling and succinct method for showcasing the project. Partner Alterna has created a video to illustrate its agricultural IoT use case. It will serve as an introduction to the technology and its application in the designated use case. Figure 5 depicts video snapshots from this video.
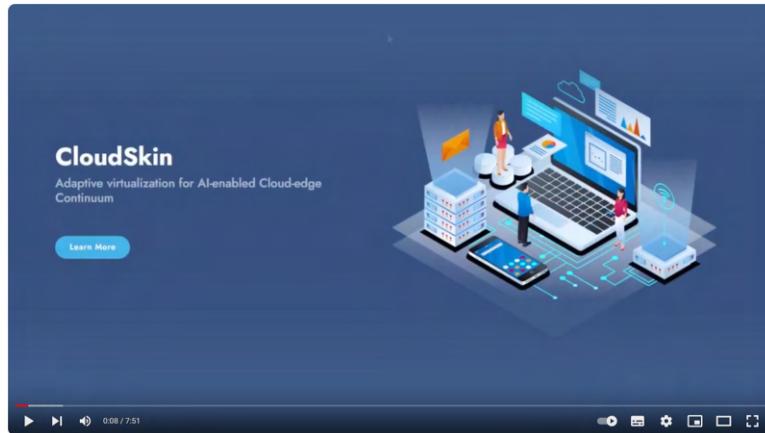
Figure 5: Agricultural IoT use case video.

The video has been published and promoted in the CloudSkin website and social media, being available in the following link:

```
https://www.youtube.com/watch?v=HJxf5fhtlAs
```

3.3 Social Media

The project maintains a presence on X (formerly known as Twitter). CloudSkin X account can be found in the following link:

```
https://x.com/cloudskin2023
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This platform serves as avenue to heighten awareness regarding the project's initiatives and to drive traffic to the project website. Additionally, social media serves as a vital tool for broadening communication outreach to diverse audiences and fostering engagement with stakeholders in the political and industrial sectors.

This social media platform is strategically utilized to reach distinct target demographics and convey tailored messages. X is leveraged to engage with a wider audience, emphasizing partner involvement in events and highlighting updates to the project website. Due to its character limit, X is particularly suited for concise and less technical announcements.

In this channel, we follow hashtags #compute #continuum #CloudComputing #cloud #edge #HorizonEurope. We engage with and follow projects from our cluster (HORIZON-CL4-2022-DATA-01-02) and the EUCloudEdgeIoT iniciative, and European Health and Digital Executive Agency (@EU_HaDEA) implementing the EU funding programmes for health, food safety, digital, industry and space with 8,927 followers, among others.

With its vast user base of 368 million individuals, X provides the project with a global reach spanning various demographics. Utilizing this channel enables the project to connect with diverse audiences, including the general public, policymakers, and industry stakeholders. The project's X

account has been operational since the project's inception and has achieved moderate success. Figure 6 shows the official CloudSkin account on the X platform. In M18, the account has amassed 48 followers and over 60 post have been published.
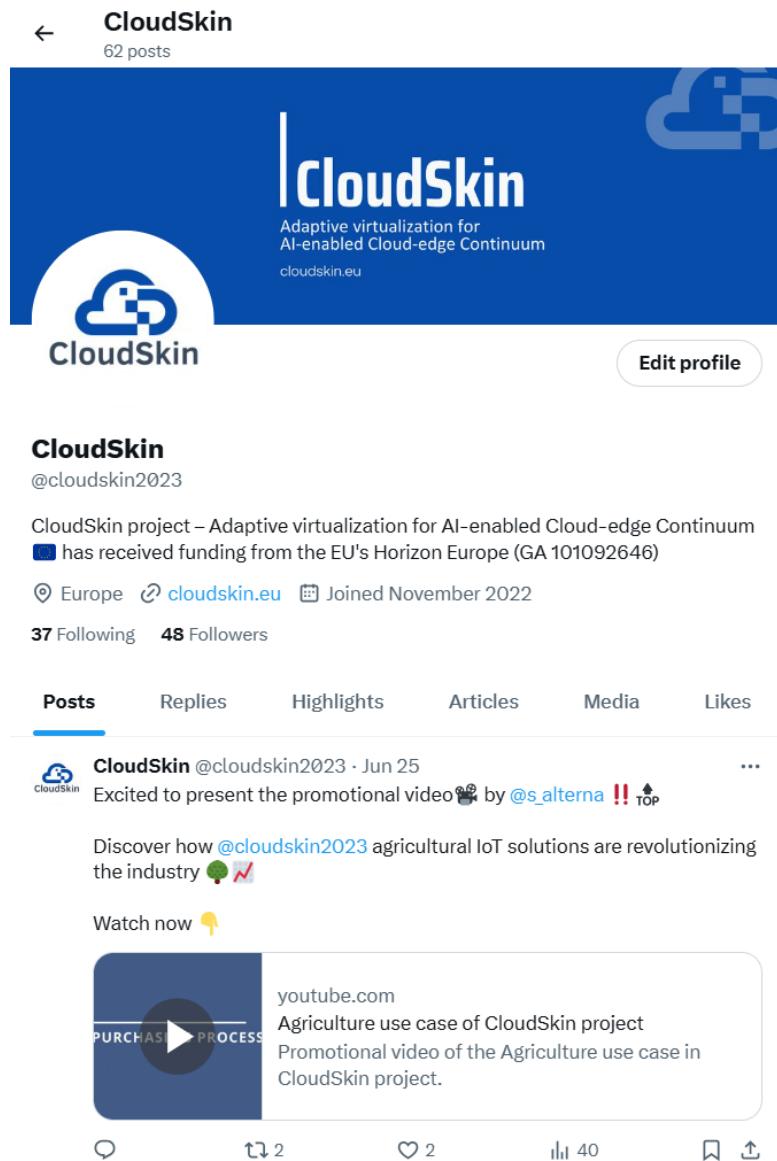
Figure 6: Official CloudSkin account on the X platform

The relatively modest follower count may stem from several factors not accounted for in *D6.1 Communication plan*[1]. Firstly, since the project's initiation, this platform has undergone shifts in ownership, business strategies, and operational models, resulting in turbulent changes and conflicting agendas. Most recently, the platform underwent a rebranding from Twitter to X, potentially causing some organizations and individuals to reduce their usage or altogether abandon the newly branded X platform.

The project has relied on X analytics to evaluate the effectiveness of its communication strategy. Nonetheless, the availability of analytical tools is somewhat limited, and comparisons are constrained to three-month historical data. This limitation hampers our ability to conduct comprehensive analyses of success trends over an extended period.

Figure 7 shows the X analytics in relation to the impressions received on the official CloudSkin account in the last three months. The X channel of the CloudSkin project garnered 255 impressions.

Figure 7: X Analytics Providing Snapshot of the last 3 months impressions

The spikes in impression counts predominantly aligned with specific social media initiatives. For instance, the peaks observed in March coincide with tweets regarding CloudSkin participation in Mobile World Congress (MWC) 2024, with several tweets strategically deployed to the MWC, which took place on February 26-29, 2024 (see Section 4.1.4). Another notable surge occurred in May 2024, corresponding to the presentation announcement of the publication "Dataplug: Unlocking extreme data analytics with on-the-fly dynamic partitioning of unstructured data" in the 24th IEEE/ACM international Symposium on Cluster, Cloud and Internet Computing that took place in Philadelphia on May 6-9, 2024. Figure 8 shows two examples of X posts.

Figure 8: Examples of X posts.

The dissemination team for WP6 will persist in tracking the analytics of social media platform and adjust as necessary to guarantee the dissemination of pertinent and current information to our designated audiences.

3.4 Press strategy

As part of the communication strategy for the CloudSkin project, a press strategy was considered to disseminate project updates and achievements to technical media outlets. This strategy involves the issuance of several press releases that serve as an effective means of conveying information about the project to technical media and their respective audiences. Furthermore, they can serve as valuable reference materials and foundational documents for project partners to utilize in their communications.

As an example, two press releases published in different media are detailed below. On one hand, Figure 9 depicts the press release published on the Xartec Salut website that explains how the URV's projects, including CloudSkin, have a significant impact in the field of Health:

https://xartecsalut.com/cloud-data-technologies-revolutionizing-healthcare/

The Xartec Salut network is made up of 81 research groups that belong to 23 different institutions and it aims to be a catalyst for R+D+I in the field of HealthTech.
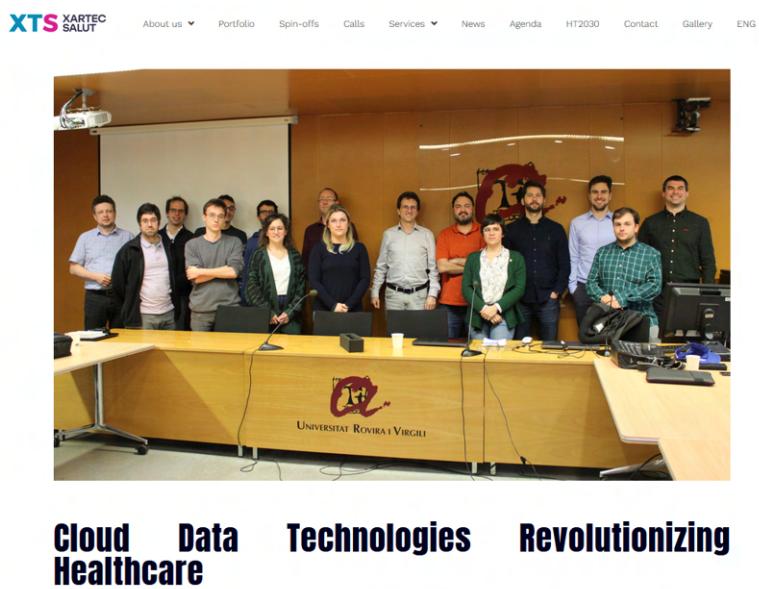
Figure 9: Press release on Xartec Salut website

On the other hand, Figure 10 shows another press release related to the project is published by DELL on the Pravega website, where they explain how Pravega has been included as part of the architecture of the CloudSkin projects:

https://cncf.pravega.io/blog/2023/06/06/pravega-in-european-research-projects/

Figure 10: Press release on Pravega website

4 CloudSkin dissemination and communication activities

4.1 Participation in conferences, exhibitions and events

Events represent a key dissemination channel. Industrial events or High-level peer-reviewed conferences in particular allow the consortium to present the latest updates of the projects and effectively involve different audiences in technological discussions early on. CloudSkin team is continuously looking for opportunities that will allow the consortium to access its target audiences.

*D6.1 Communication Plan* [1] presented the initial dissemination and communication activities during the first months of the project. This deliverable provides and update of the activities that took placed from M5 to M17. The consortium participated in four mayor events and other 20 events with academic, research and industrial audiences, all presented in the next sections.

4.1.1 European Big Data Value Forum 2023

The European Big Data Value Forum (EBDVF 2023) [4] took place on 25-27 October 2023 in Valencia, Spain and counted with +400 speakers. It was a good opportunity for networking and let important players (Siemens, Amazon, IDC, to name a few) in the big data market to learn about CloudSkin. One particular outcome from attending this event was establishing new links with HPC and companies players around opportunities to the upcoming calls on Digital Twins for Destination Earth. Figure 11 depicts pictures of EBDFV 2023.

Figure 11: Pictures of EBDVF 2023 (October 2023).

4.1.2 HiPEAC 2024 conference

The 2024 HiPEAC conference [5] took place in January 17th to 19th 2024. The conference had around 600 attendees and gathered experts from various fields related to computer architecture, programming models, compilers, and operating systems.

CloudSkin project was presented by Peini Liu, from the Barcelona Supercomputing Center (BSC), in the Deep Learning for IoT (DL4IoT) workshop, which highlighted its potential impact on advancing the orchestration for computing continuum through its Learning Plane solution. Additionally, CloudSkin was featured in the EU projects' poster session, attracting significant interest and engagement from attendees, demonstrating the project's relevance and appeal within the European research community. Figure 12 shows two pictures of the CloudSkin presentations at HiPEAC.

4.1.3 SPIE medical imaging 2024

SPIE, the international society for optics and photonics, organizes the medical imaging event where the science of medical imaging is explored. The 2024 edition took place in San Diego, California (USA) between the 18th and the 22nd of February 2024.

In this edition, Stefanie Speidel, from the Nationales Centrum für Tumorerkrankungen Dresden (NCT), was invited to present the work "Democratizing surgical skills via surgical data science" in the Image-Guided Procedures, Robotic Interventions, and Modeling conference [6].

Figure 12: CloudSkin presentation and poster session at HiPEAC.

Figure 13 shows two pictures of NCT presenting their work of computer-assisted Surgery at SPIE medical imaging 2024.
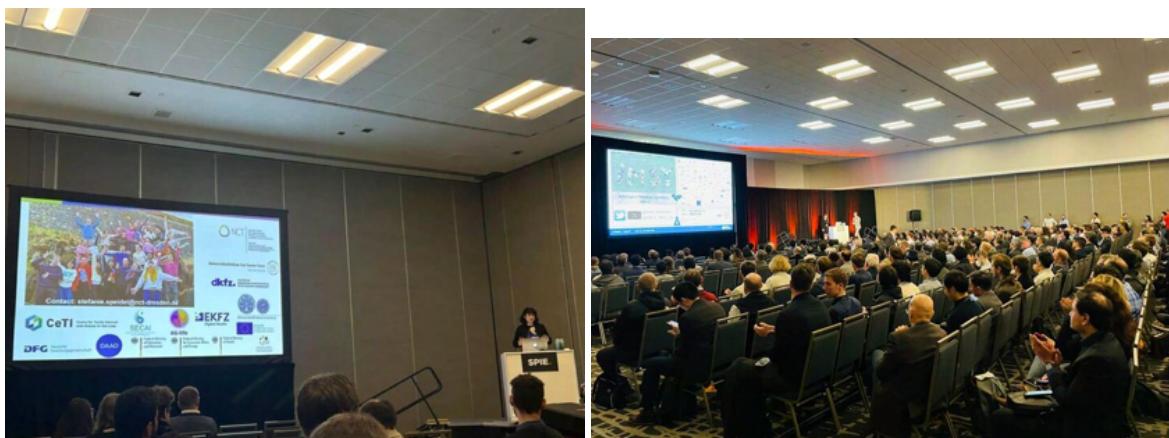
Figure 13: NCT is presenting their work of computer-assisted Surgery at SPIE medical imaging 2024.

4.1.4 Mobile Word Congress 2024

An important event where CloudSkin was presented is the Mobile Word Congress 2024 (MWC24), one of the major international industrial events, that took place the 26th to the 29th of February 2024 in Barcelona, Spain.

Three partners, Nearby Computing, Cellnex/Tradia and DELL, had a booth where the CloudSkin project was disseminated. According to the event organization, MWC convened more than 101,000 in-person attendees from 205 countries and territories, including policymakers and business leaders from the mobile ecosystem and beyond [7]. Figure 14 shows the CloudSkin presentation at NRB and Cellnex booths.

4.1.5 Other events

Besides the participation in the main events described in previous sections, consortium partners attended other events like congress, conferences, meetings, and festivals where the CloudSkin project was presented and demonstrated.
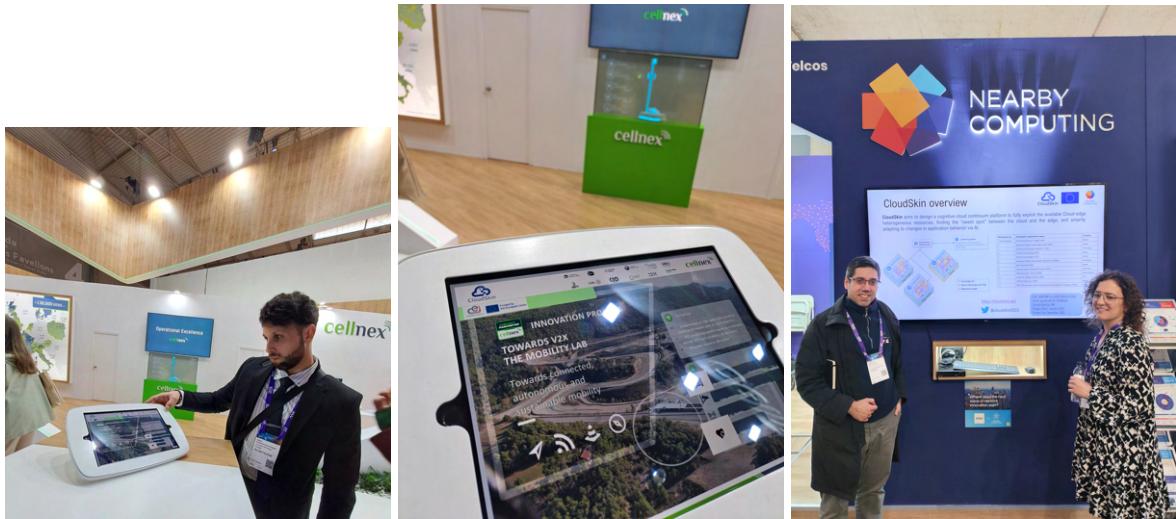
Figure 14: CloudSkin presentations at NRB and Cellnex booths (MWC24).

The full list of activities is presented in Table 1. Figure 15 shows pictures of different CloudSkin dissemination activities by NCT.

Figure 15: Demos and presentations of NCT at selected dissemination and commnication activites: Clinical AI Day Dresden, SECAI/CeTI International Summer School Dresden, School Programme Girls for Robots, and Workshop for students Visit from Karlsruhe.

Table 1: CloudSkin dissemination and communication activities (M6-M17).

Activity	Date and place	Audience type and size
Demonstrator (Endoscopic Vision with SYMIC and UCL) at 2023 IEEE 6G Summit Dresden (by NCT)	9-10 May 2023 Dresden (Germany)	Scientific community (300)
Demonstrator (Demo Remote Robotic Surgery and Surgical Instruments) at 6G-life General Assambly (by NCT)	11-12 May 2023 Dresden (Germany)	Scientific community (200)
Presentation (Computer- and Robotic-assisted Surgical Oncology and Surgical Data Science) at the Joint Retreat with other two teams from UCL and DKFZ (by NCT)	21-24 Jun 2023 Schlierrsee (Germany)	Scientific community (50)
Presentation (Scientific Highlight: EU-project Cloudskin) at NCT Scientific Advisory Board Meeting (by NCT)	10-11 Jul 2023 Dresden (Germany)	Hospitals (150)
Presentation (Artificial intelligence in improving the outcome of surgical oncology) at 20 Years University Cancer Center celebration in NCT/UCC Dresden (by NCT)	21 Aug 2023 Dresden (Germany)	Scientific Community (100)
Workshop, Demonstrator and Hands-on Experiment at SECAI/CeTI International Summer School Dresden (by NCT)	11-15 Sep 2023 Dresden (Germany)	Scientific community (100)
Presentation to General Council of Official Colleges of Technical Engineering in Computer Science, CONCITI Congress (by ALT)	23 Sep 2023 Madrid (Spain)	Industry (4)
Research presentation (Towards Multi-cloud Function-as-a-Service: Lithops as a case study) at Dell TEx12 Conference (by DELL)	18 Oct 2023 (online, DELL internal)	Industry (15)
Presentation (Computer and robotic-assistied Surgery) at Thinknet 6G Summit 2023 (by NCT)	26 Oct 2023 Dresden (Germany)	Scientific community (100)
Workshop (Translationale Surgical Oncology: Computer and robotic-assistied Surgery) at CeTI all-day programme Girls for Robots (by NCT)	07 Nov 2023 Dresden (Germany)	Students (20)
Pravega Community Meeting [8] (by DELL)	08 Nov 2023 (online)	Industry, Scientific community (25)
Research presentation (Re-discovering Dell Streaming Data Platform: From Present to Future Use-cases) at DellTech Technical Community	02 Feb 2024 (online, DELL internal)	Industry (30)

cont.		
Presentation at Industry & Institution Networking event (by NCT)	07 Feb 2024 Dresden (Germany)	Industry (15)
Presentation at German Cancer Congress (by NCT)	23 Feb 2024 Berlin (Germany)	Scientific community (50+)
Workshop (Translationale Surgical Oncology: Computer and robotic-assistied Surgery) for students Visit from Karlsruhe (by NCT)	14 Mar 2024 Dresden (Germany)	Students (30)
Presentation (Edge Video Analytics with Pravega: Supporting a Computer-Assisted Surgery Use Case) at Dell TEx13 Conference (by DELL)	26 Mar 2024 (online, DELL internal)	Industry (25)
Research presentation (Managing Multi-cloud Data for Private LLMs) at Dell TEx13 Conference (by DELL)	05 Apr 2024 (online, DELL internal)	Industry (20)
Presentation and demo (Clinical AI Hotspot in Dresden: transformative AI application in medicine) at Clinical AI Day Dresden (by NCT)	12 Apr 2024 Dresden (Germany)	Scientific c., Industry, Government (150)
Panel (Scientific perspective into AI opportunities and challenges for healthcare) at Saxon AI-Congress 2024 (by NCT)	16-17 Apr 2024 Chemnitz (Germany)	Goverment, Industry, Scientific c. (100+)
Poster (Scanflow-k8s and its usage for CloudSkin) in the *Jornada Anual de la Xarxa RDI-IA* [9] (by BSC)	22 May 2024	Scientific community, Industry

4.2   Publications in conferences, journals and magazines

Peer-reviewed publications are an important way for the consortium to disseminate its findings and to ensure that CloudSkin technical results are shared openly and as widely as possible with the research community. Partners have been informed that all CloudSkin publications should include the following acknowledgment sentence:

The research leading to these results has received funding from the European Union´s Horizon Europe Programme under the CloudSkin project, grant agreement number 101092646.

With the aim of ensuring a proper dissemination process and the file preservation even after the end of the project, a CloudSkin Zenodo repository and its corresponding community have been created:

> `https://zenodo.org/communities/cloudskin-eu/`

From M1-M17 fourteen new publications were published, while two publications are under revision. Table 2 presents the list of CloudSkin scientific publications.

4.3   Direct dissemination activities and external interactions

Effective direct dissemination activities and external interactions like visits or meetings with appropriate stakeholders (e.g., mobile network operators, vendors, SMEs, regulators, etc.) or members of

Table 2: List of CloudSkin publications (M1 to M17)

Publication type	Title	Authors (Partner)	Journal, Conference or equivalent	Date
Conference paper	*On Data Processing through the Lenses of S3 Object Lambda*	P. Gimeno Sarroca and M. Sánchez-Artigas (URV)	IEEE International Conference on Computer Communications (IEEE INFOCOM)	May 2023
Workshop paper	*The Nanoservices Framework: Co-locating Microservices in the Cloud-Edge Continuum*	E. Caron and R. Gracia-Tinedo (DELL)	Cloud-Edge Continuum (CEC) Workshop @ IEEE 31st International Conference on Network Protocols (ICNP ´2023)	Oct. 2023
Workshop paper	*Is Performance of Object Storage Predictable for Serverless I/O Workloads? A Comparative Study*	G. T. Eizaguirre; M. Sánchez-Artigas (URV)	Cloud-Edge Continuum (CEC) Workshop @ IEEE 31st International Conference on Network Protocols (ICNP ´2023)	Oct. 2023
Conference paper	*A Last-Level Defense for Application Integrity and Confidentiality*	G. Pereira Fernandez, A. Brito, A. P. P. Hartono, M. U. Sardar, and C. Fetzer (TUD)	IEEE/ACM 16th International Conference on Utility and Cloud Computing (UCC 2023)	Dec. 2023
Conference paper	*Practical Storage-Compute Elasticity for Stream Data Processing*	R. Gracia-Tinedo, F. Junqueira, B. Zhou, Y. Xiong, L. Liu (DELL)	24th International Middleware Conference (Middleware'2023)	Dec. 2023
Conference paper	*SinClave: Hardware-assisted Singletons for TEEs*	F. Gregor, R. Krahn, D. L. Quoc, and C. Fetzer (TUD)	24th International Middleware Conference (Middleware'2023)	Dec. 2023
Conference paper	*Glider: Serverless Ephemeral Stateful Near-Data Computation*	D. Barcelona-Pons, P. García-López, and B. Metzler (URV)	24th International Middleware Conference (Middleware'2023)	Dec. 2023
Conference paper	*Pravega: A Tiered Storage System for Data Streams*	R. Gracia-Tinedo, F. Junqueira, T. Kaitchuck, S. Joshi (DELL)	24th International Middleware Conference (Middleware'2023)	Dec. 2023
Workshop paper	*Scaling a Variant Calling Genomics Pipeline with FaaS*	A. Arjona, A. Gabriel-Atienza, S. Lanuza-Orna, X. Roca-Canals, A. Bourramouss, T. K. Chafin, L. Marcello, P. Ribeca, P. García-López (URV)	9th International Workshop on Serverless Computing (WoSC '2023)	Dec. 2023
Conference paper	*Triad: Trusted Timestamps in Untrusted Environments*	G. Pereira Fernandez, A. Brito, and C. Fetzer (TUD)	14th IEEE international conference on Cloud Computing Technology and Science (CloudCom'2023)	Dec. 2023
Journal	*MLLess: Achieving cost efficiency in serverless machine learning training*	P. Gimeno Sarroca, M. Sánchez-Artigas (URV)	Journal of Parallel and Distributed Computing	Jan. 2024
Workshop paper	*CloudSkin: ML-based Smart Management for the Cloud-Edge Continuum*	P. Liu, A. M. Nestorov, M. Palacín, J. Guitart, J. Ll. Berral (BSC)	3rd Workshop on Deep Learning for IoT (DL4IoT-2024)	Jan. 2024
PhD Thesis	*Optimizing serverless architectures for data-intensive analytics workloads*	Anna Maria Nestorov (BSC)	Universitat Politècnica de Catalunya. Departament d'Arquitectura de Computadors	May 2024
Journal	*Practicable live container migrations in high performance computing clouds: Diskless, iterative, and connection-persistent*	Jordi Guitart (BSC)	Journal of systems architecture, vol. 152, article 103157.	Jul. 2024

the research community are crucial for the success of any project, as they ensure that the project's results and benefits reach the intended audience, stakeholders, and the wider community.

The following list includes the activities performed to spread awareness about the CloudSkin concepts and its benefits sustained on the results of the project, that can significantly enhance the impact, visibility, and sustainability of the project:

- Presentation to Murcia (Spain) regional companies (by ALT), 15 May 2023 Murcia (Spain)

- Presentation to NTU Singapore (by URV), 12 Jul 2023, Singapore.

- Presentation of Agriculture Use Case to Proexport (by ALT), 24 Jul 2023, Murcia (Spain)

- Presentation to Kookmin University in South Korea (by URV), 29 Sep 2023, Tarragona (Spain)

- Research meeting with Telefonica I+D in the Department of Computer Engineering and Maths, presentation "WebAssembly security risks" (by URV), 22 Nov 2023, Tarragona (Spain)

- Project Dissemination organized by I2cat, Gencat and Mobile World Capital at URV "Training session in Advanced Digital Technologies" (by URV), 25 Nov 2023, Tarragona (Spain)

- Research meeting with OpenNebula, Department of Computer Engineering and Maths, presentation "EU Next Generation Edge Cloud Platform" (by URV), 28 Nov 2023, Tarragona (Spain)

- Presentation of the CloudSkin project and KIO's delivered testbed to the "Instituto de Investigación Sanitaria La Fe" belonging to the Consellería de Sanidad Valencia, business meeting (by KIO), 26 Jan 2024, Valencia (Spain)

- Presenation of CloudSkin to RISE Research Institutes of Sweden (by URV), 05 Ma 2024, online.

- Presentation of the CloudSkin project and KIO's delivered testbed to enterprises in the Valencia and Murcia Region (internal meeting at KIO Networks headquarters), 10 Apr 2024, Valencia (Spain)

4.4 Science for society

It is incumbent upon the members to convey the project, its activities, and the achieved outcomes to the general public. The project partners are exerting genuine efforts to disseminate the project to the society, some examples are:

URV published the information and poster of the CloudSkin project in the European corner [1], as part of the **European Night of Research**. This event is celebrated every year on the last Friday of September in more than 300 cities in 30 countries across Europe. Its aim is to bring research, innovation and its protagonists, the scientists, to the public in a fun and flat way. Thus, all types of public, from schools, families and children to young people or adults of all ages, will be able to learn about and participate in the science of your territory through different activities such as workshops, talks, shows, experiments, astronomical observations and games.

URV has the **T-Systems Cloud Computing Chair**[2] whose main mission is to analyze the impact of Cloud technology on the business world and society in general, through research, training and dissemination. It seeks to deepen the knowledge about Cloud Computing and its implications in different aspects, train students and professionals in this area and bring knowledge about this technology to society in general. All this with the aim of contributing to the development and expansion of Cloud Computing in different areas of society. Along these lines, the T-Systems Cloud Computing Chair has given 21 presentations on four different cloud computing subjects, during which the CloudSkin project was presented to around 500 secondary school students in the Tarragona region. Figure 16 shows a presentation on Cloud Computing, Big Data and Artificial Intelligence that took place on September 28, 2023.

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[1] https://lanitdelarecerca.cat/cloudskin-adaptive-virtualization-for-ai-enabled-cloud-edge-continuum/
[2] https://www.urv.cat/ca/societat-empresa/catedres/cloud-computing/

Figure 16: One of the 21 presentations of the T-Systems Cloud Computing Chair.

Other activities targeting a general audience like the civil society or policy makers are listed be-
low:

- CloudSkin demonstrator at *Lange Nacht der Wissenschaften* (Dresden Science Night) (by NCT),
  30 Jun 2023, Dresden (Germany).

- Presentation at a high school as part of the European Researchers' Night (by URV), 26 Sep 2023,
  Tarragona (Spain)

- Presentation of the CloudSkin Agriculture Use Case to Cartagena Council (by ALT), 29 Sep
  2023, Cartagena (Spain)

- CloudSkin mention in the report of the 2022-2023 academic year of URV [10], 01 Oct 2023,
  online.

- CloudSKin presentation "Computer and robotic-assistied surgery" at Saxony SPIN2030 science
  festival (by NCT), 08 Mar 2024, Dresden (Germany)

4.5   CloudSkin Workshops

As planned in *D6.1 Communication Plan* [1], the CloudSkin consortium aims to participate in strategi-
cal events where CloudSkin workshops are organized. The list of planned workshops is summarize
in Table 3.

4.5.1   CloudSkin internal Workshop at JCSD23

The consortium celebrated an internal workshop for M6 within Jornadas de Concurrencia y Sistemas
Distribuidos (JCSD23)[3] on June 20, 2023, at the Universitat Rovira i Virgili. Where we were able to
discuss different internal issues of the project and draw up future plans.

We took the JCSD23 conference to have meetings with partners of two other projects: the EU
Project NEARDATA (Extreme Near-Data Processing Platform, GA 101092644) and the Spanish DALEST
(Distributed Analytics and Learning in Edge-to-Supercomputing Technologies) project.

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[3]`https://cloudlab-urv.github.io/jcsd2023/`

Figure 17: NCT at Saxony SPIN2030 scientific fest.

Table 3: Strategic events for CloudSkin

Planned month	Type of event	Example of target conference	Status
M6	Internal workshop	-	DONE
M12	Open workshop	NSDI	DONE
M24	Open workshop	USENIX ATC	Planned
M30	Major industrial event	CNCE, PyCon	Pending
M36	Final workshop in major conference	USENIX, Middleware	Pending

This type of meeting constitutes an excellent opportunity to establish cooperation links between the different research groups of the different Spanish universities. This cooperation usually translates later into the coordinated request for funding in joint research projects. The Conferences also constituted an excellent forum for industry and research centers to meet and exchange interests and opinions.

4.5.2 Cloud-Edge Continuum Workshop 2023 CEC´23

This was the M12 open workshop of the project. Dell Technologies is making an important effort in disseminating research activities and promoting new partnerships that are beneficial for CloudSkin. Scientific conferences and workshops are an integral part of such activities. In addition to presenting our work in peer-reviewed venues, this year we set out to organize a workshop of our own that aligns with Dell's strategic research themes. The workshop, named 2023 Cloud Edge Continuum (CEC'23[4]) Workshop, was held on October 10th, 2023, in Reykjavik, Iceland and was co-located with 31st IEEE International Conference on Network Protocols (IEEE ICNP 2023[5]), which is a well-established scientific conference in the field of computer networks.

CEC'23 was supported by Dell Technologies and several European research projects that Dell participates in. These projects are funded by the EU commission and are conducting research in the areas of cloud, multi-cloud, and edge computing. Dissemination and publications in scientific events are a key activity and objective defined in these projects. To amplify the dissemination efforts of the team across multiple European research projects, we decided to organize a scientific workshop and bring together researchers and practitioners from academia and industry to discuss the latest research, trends, and challenges in ecosystems and environments based on Cloud-Edge Continuum paradigm.

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[4]https://cec23.github.io/

[5]https://icnp23.cs.ucr.edu/

The key themes of the workshop focused on challenges in a Cloud-Edge continuum revolving around AI-enabled resource allocation, security, energy and carbon footprint, system architectures, confidence, and optimization. The workshop program comprised of two keynote speeches, 12 presentations from peer-reviewed accepted papers, and 8 posters based on work and research from different EU research projects. Figure 18 represents pictures of the CEC Workshop (October 2023) organized by Dell Technologies.

Figure 18: Pictures of the CEC Workshop (October 2023) organized by Dell Technologies.

Outcomes from the workshop

- Organization of a workshop focused on a key strategic area of Dell Technologies (Multi-cloud, Edge) and generating novel ideas and solutions in this domain.

- Building a technical program committee (TPC) for the workshop with 36 senior engineers and researchers from academia and industry.

- Setting up a public webpage for the workshop[6] and advertising the workshop call for papers (CFP) through various channels.

- The workshop accepted 10 original research papers (out of 13 submissions). 2 more papers were added to the program from a co-located workshop on a similar topic.

- The technical program committee carried out 30+ paper reviews to grade, select, and suggest improvements to the original submissions.

- 2 inspiring talks from keynote speakers on life and challenges at Edge. Prof. Cormac Sreenan (Head of Computer Science School, University College Cork) and Steve Todd (Fellow, Dell Technologies).

- 8 posters were displayed and presented at an interactive poster session during the workshop. The posters shared research, use-cases, challenges, and novel designs being developed in various EU projects.

- There was 25+ attendees in the CEC'23 workshop from various countries and backgrounds.

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[6] https://cec23.github.io

- The peer-reviewed accepted papers are being processed to appear in the IEEE Xplore proceedings. The paper titles and authors can be found in the Program section of the workshop web page[7].

4.5.3 Planned Workshop: Cloud-Edge Continuum Workshop 2024

As we mentioned in Section 4.5.2, the organization of the Cloud-Edge Continuum Workshop 2023 was a success for the project in multiple ways. For this reason, we have applied to IEEE ICNP'24[8] for a new edition of the CloudSkin workshop (M24 open workshop as planned in CloudSkin Deliverable *D6.1* [1]) in this year's edition of the conference. Our proposal has been accepted and we are now starting to organize Cloud-Edge Continuum Workshop 2024[9], which will take place in Charleroi, Belgium on October 28-31, 2024.

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[7]`https://cec23.github.io/index.html#program`
[8]`https://icnp24.cs.ucr.edu/`
[9]`https://cec24.github.io/`

5   Community building

Community building involves providing stakeholders with a deeper insight into project outcomes and engaging interested parties to become project stakeholders. The WP6 team, in collaboration with the entire consortium, has actively worked on identifying and expanding the CloudSkin community. Efforts were made to foster synergies and collaborations with broader European communities in AI, Data, industry and academia, among others.

While the initial phase from Month 1 to Month 17 has served as an introductory period to engage with intersecting communities and gain insights into their needs and preferences, the subsequent phase from Month 18 to Month 36 will focus on nurturing enduring relationships.

5.1   The European Cloud, Edge and IoT Continuum Initiative

Concerning the community involvement activities, and as set in **D6.1 Communication Plan**, the project is collaborating with other RIA/CSA within the framework of the call HORIZON-CL4-2022-DATA-01-02. CloudSkin intends to share information with other projects under the same theme to share results, capitalize on synergies, and optimize impacts, yet coordinating dissemination activities across the swarm project portfolio.

The CloudSkin project has engaged in several events organized by the European Cloud, Edge and IoT Continuum Initiative (EUCloudEdgeIoT). Participation in these events provided valuable insights into ongoing projects and facilitated the identification of potential intersections.

To facilitate these responsibilities, the CloudSkin project has formally become a member of the Cognitive Cloud working projects within the EUCloudEdgeIoT.eu community[10]. This initiative aims to realise a pathway for a better understanding and development of the Cloud, Edge and IoT Continuum by promoting cooperation between a wide range of research projects, developers and suppliers, business users and potential adopters of this new technological paradigm.

A proof of that is that CloudSkin attended the webinar called **"Transforming Wind Turbine Maintenance: AI-SPRINT's Predictive Insights and Edge-Cloud Integration"** that took place on 11 July, 2023. AI-SPRINT project[11] organised this event to present the main objectives, challenges and practical applications of the Maintenance & Inspection use case.

CloudSkin was also in attendance at **EUCloudEdgeIoT.eu RIA Showcase "Next-generation IoT insights"**[12] that took place on February 8, 2024. This webinar gave insights into the future of IoT, exploring the projects that are redefining the landscape of IoT technologies. From open, decentralised reference architectures to smart networking and data management solutions, witness the transformative potential of these initiatives across sectors such as agriculture, healthcare, and energy.

Another valuable contribution from CloudSkin was the generation of the **"Use case catalogue of cognitive cloud cluster** [13], initiative that was running under the umbrella of Task Force 5 of EU-CloudEdgeIoT.eu.

The project was presented in the **webinar on "Future-proof solutions for cognition-enabled cloud computing"**[14] by Marc Sanchez, the coordinator as the Figure 19 illustrates. This online event was organized by EUCloudEdgeIoT.eu on April 18, 2024. Europe's research funding aims to create breakthroughs in AI enabled cloud computing, allowing self-configuration, self-adjustment, and self-management systems that will enable better performance, lower costs, higher security while facilitating digital sovereignty. This webinar dives into the solutions and frameworks that these projects are creating and on top of that it will look at the next wave of research required to bring Europe into the top-3 of innovative contributors of provider-agnostic, open source, cloud infrastructures.

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[10] https://eucloudedgeiot.eu/

[11] https://ai-sprint-project.eu/

[12] https://eucloudedgeiot.eu/event/next-generation-iot-insights/

[13] https://docs.google.com/presentation/d/1VEkKWD_YW4pnroUxVgTNZzs-IgwufW1_Q1zTnztByec/edit?usp=sharing

[14] https://eucloudedgeiot.eu/event/future-proof-solutions-for-cognition-enabled-cloud-computing/
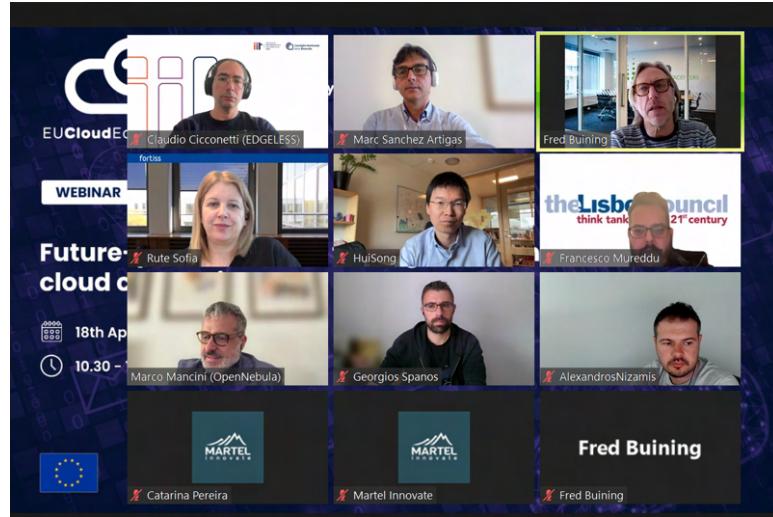
Figure 19: The project coordinator in the EUCloudEdgeIoT.eu webinar

CloudSkin was invited to the EUCEI's Open Continuum Final Conference[15], taking place on 18 June 2024, in Brussels. The Open Continuum Final Conference focused on the value of the EUCloudEdgeIoT.eu (EUCEI) community research for the industry, highlighting the latest advancements and results of the Open Continuum CSA and the more than 50 research and innovation actions that it has supported. Attendees had the opportunity to participate in engaging panel discussions, hear about the transition to the Nexus Forum CSA, and learn about the current status of the Unlock CEI CSA use cases. The conference also feature an awards ceremony recognising the most promising projects within our community. Figure 20 shows some pictures of this event.
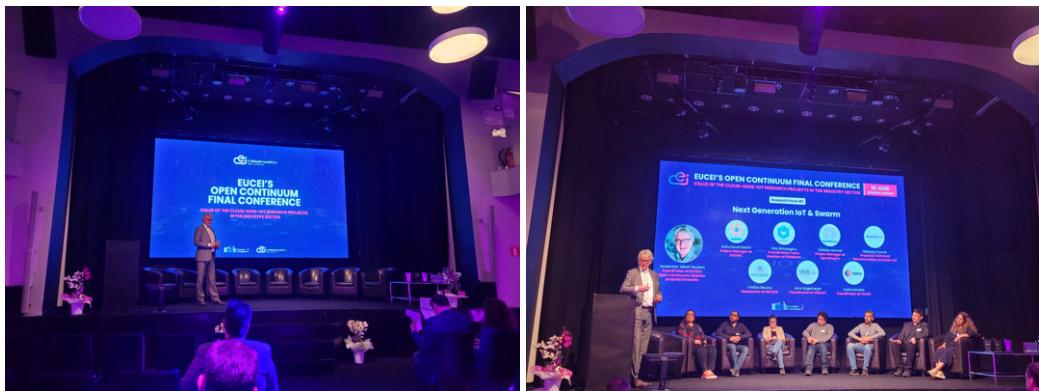
Figure 20: Pictures EUCEI's Open Continuum Final Conference (June 2024).

In the coming months, the project is expected to continue working on some of the six individual task forces, offered by the EUCloudEdgeIoT.eu initiative, such as the task force in communication, namely, TF6 Communication.

To increase the visibility of the project results, as well as to engage other related projects of the Cognitive Cloud, the project will prepare **quarterly newsletters** using attractive content. Newsletters will give the project an opportunity to gear the conversation and keep the European Cloud, Edge and IoT (CEI) communities in the loop about what is happening within the project. The plan is to prepare between three to five short articles per newsletter about the views and outcomes of the project. We will gently invite the beneficiaries of the research and innovation action grants from Horizon Europe on CEI topics to join our stakeholder community. Starting at **Month 21**, we will make available crucial

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[15]https://eucloudedgeiot.eu/event/euceis-open-continuum-final-conference-registration-now-open/

information on our innovative concept of cognitive continuum enabled by AI/ML, virtualization and infrastructure, and exchange knowledge connecting with the rest of projects in this domain. This will be an extremely valuable addition to our collaborative efforts.

As ultimate objective, we seek to build a community that can be a powerful lever for: 1. Scientific discussions; 2. Sharing of technological know-how; and 3. Building professional connections.

5.2 Contacts with some related projects

Furthermore, efforts have been made to collaborate with other projects within the HORIZON-CL4-2002 DATA-01-02 cluster to amplify CloudSkin's messages and explore common challenges that could be leveraged to expand each other's networks.

As an example of that was the organization of **CEC'23 workshop** co-located with IEEE ICNP'23 (The 31st IEEE International Conference on Network Protocols) that was held at Reykjavik last year, and included a poster session with the following invited projects:

- **NearData**: Extreme Near-Data Processing Platform;

- **INTEND**: Intent-Based Data Operation In The Computing Continuum;

- **CLEVER**: Collaborative edge-cLoud continuum and Embedded AI for a Visionary industry of thE futuRe;

- **GLACIATION**: Green responsibLe privACy preservIng dAta operaTIONs;

- **CloudSkin**: Adaptive virtualization for AI-enabled Cloud-edge Continuum;

- **SmartEdge**: Semantic Low-code Programming Tools for Edge Intelligence;

- **CAMEO**: Creating an Architecture for Manipulating Earth Observation data; and

- **AI for Edge**: The Future of Orchestration in the Computing Continuum.

This year we are organizing the second edition of this workshop, **CEC'24**, again co-located with IEEE ICNP'24. In addition to the poster session, the new edition of the workshop will include an **online EU event**, open to the beneficiaries of the research and innovation action grants from Horizon Europe on CEI topics. In this event, it is expected that project coordinators '**pitch**' their projects with a five to fifteen minute talk, providing a summary of their major outcomes.

5.3 BeOpen Project

Collaboration with the BeOpen Project of the Cartagena City Council, carrying out a collaboration to obtain sensor information for T5.7 Use Case: Agriculture IoT & GeoSpatial Data

6 Open source contributions

CloudSkin consortium is committed with the goal of increasing cooperation and transparency in all research stages. This embraces sharing research data, publications, tools and results as early and open as possible. Consequently, more robust scientific results, more efficient research and faster access to scientific results for everyone are achieved, which eventually leads to greater societal and economic impact

   In relation to the research activities, the project expects that many of the developed solutions will be open source. CloudSkin intends to publish mature software releases of some of its components, tools and use cases to the open source communities to promote and contribute to the open source domain. Gitlab and Github are being used as a community-based software code sharing platform, in particular a dedicated CloudSkin Github has been created were some partners included their work:

> https://github.com/cloudskin-eu

   At this stage, the outcomes leading to open source solutions that the CloudSkin project has released, together with the main involved partners, are listed below:

1. Agricultural dataspace source files (ALT), `https://github.com/developerAlternatecno/cloudskin`

2. AI4DL: Deep-Learning Containter Auto-Scaling framework (BSC), `https://github.com/BSC-IBM/AI4DL`

3. ThetaScan: Tools for smart container pipeline management (BSC), `https://github.com/BSC-IBM/ThetaScan`

4. Scanflow-Kubernetes: An MLOps Platform (BSC), `https://github.com/bsc-scanflow/scanflow`

5. ServerlessCluster: Tools for VM/Serverless deployments on private and supercomputing clusters, `https://github.com/HiEST/serverless-cluster`

6. Pravega: an open source distributed storage service implementing Streams (DELL), `https://github.com/pravega/pravega`

7. Pravega GStreamer: plugins to read and write Pravega streams using GStreamer[16] (DELL), `https://github.com/pravega/gstreamer-pravega`

8. NCT demos repository (DELL), `https://gitlab.com/nct_tso_public/cloudskin/`

9. Faasm: High-performance serverless runtime with WebAssembly (IMP), `https://github.com/faasm/faasm`

10. Faabric: Messaging and state layer for distributed applications (IMP), `https://github.com/faasm/faabric`

11. Faasm-CPP: Tools for building C/C++ to WebAssembly for Faasm (IMP), `https://github.com/faasm/cpp`

12. WAMR-CR: Prototype of Checkpoint-Restore for WebAssembly modules, (IMP), `https://github.com/csegarragonz/wamr-cr`

13. FaasmCTL: CLI to deploy, manage, and interact with a Faasm deployment (IMP), `https://github.com/faasm/faasmctl`

14. Faasm Planner: Centralised Scheduler with Migration (IMP), `https://github.com/faasm/faabric/tree/main/src/planner`

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[16] `https://gstreamer.freedesktop.org/`

15. Nearby blocks for the mobility use case (NRB), `https://github.com/cloudskin-eu/Mobility-use-case/`

16. Scone Secure Confidential Document Application example (TUD), `https://github.com/scontain/SecureDocumentApp`

17. Scone tutorial on how to build confidential policies using a mesh (TUD), `https://github.com/scontain/scone_mesh_tutorial`

18. Scone sample application showcasing how to use shielding for redis/flask application and their composition (TUD), `https://github.com/scontain/scone_flask_redis_tutorial`

19. Faasm Cloud-C-Cells prototype (TUD), `https://github.com/ardhipoetra/faasm`

20. Lithops: Serverless Data Analytics Platform (URV), `https://github.com/lithops-cloud/lithops`

21. MLLess: Serverless ML training on IBM Cloud Functions (URV), `https://github.com/pablogs98/MLLess`

22. Seer: A shuffle manager for serverless data analytics (URV), `https://github.com/GEizaguirre/seercloud`

23. Glider: Serverless In-Storage Ephemeral Stateful Computation (URV), `https://github.com/CLOUDLAB-URV/glider-store`

24. Dataplug: Unstructured Data Management for Computing in the Cloud (URV), `https://github.com/CLOUDLAB-URV/dataplug`

25. GEDS: A Generic Ephemeral Data Store (ZRL), `https://github.com/IBM/GEDS`

26. Hadoop Filesystem Implementation for GEDS (ZRL), `https://github.com/IBM/GEDS-HDFS`

27. Disaggregated Shuffle plugin for Spark, used for GEDS/Spark integration (ZRL), `https://github.com/IBM/spark-s3-shuffle/`

In addition to the open source software solutions, CloudSkin project wants to enable open access and reuse of the research data following the FAIR (Findable, Accessible, Interoperable, and Reusable) principles in all research practices. CloudSkin deliverable D2.4 "Data Management Plan, 2nd version" offers an overview of the existing and generated datasets known to be utilized to validate the results of the project. In particular, for the agriculture use case, the data space is being made public in the following ad-hot website:

`https://cloudskin.alternatecno.es/`

7 Exploitation and standardization

This section presents the status of exploitation activities of the CloudSkin project from M12 to M18. It reports on the status of the initial exploitation plan, which is essential part of task T6.3. Exploitation & standardization.

Exploitation activities may range from the use of project results in research activities that extend beyond its scope, such as in the creation derived from it, as well as the creation and commercialization of products or processes, or the provision of services, among others.

The main objective of the exploitation plan must be the use of the results for social, scientific, financial benefits or other purposes of interest. As expected, the exploitation of the project results is the responsibility of its partners, either independently or by facilitating exploitation by third parties, for example, by making the results accessible and usable under open licenses. Among the processes that can promote exploitation, we highlight innovation management actions, copyright management, data management plans and not less important, the participation of interested parties and users.

The tools related to exploitation are many such as: 1. Patent applications and publications; 2. Establishment of spin-off or start-up companies; 3.- Licensing practices (open or copyleft), as well as the use of results for academic purposes (doctorate, postdoctoral, follow-up projects).

7.1 Exploitation contact points

The first step for the use and commercialization of the results of the CloudSkin project involves the establishment of **Exploitation Contact Points** discriminated according to the type of exploitation, in addition to the identification and centralized detail of the related Intellectual Property Rights (IPR).

The role of the **Exploitation Contact Points** serve as a public communication interface between the project consortium and external stakeholders, being able to leverage or license the CloudSkin technological advances, thereby taking advantage of the companies' geographic proximity to every Exploitation Contact Point, in order to weave an international collaborative network.

This strategic initiative aims to protect and promote the intellectual assets achieved as a result of the project. The identification of intellectual property rights ranges from patentable technologies, optimized algorithms and proprietary methodologies that arise from research efforts.

This **proactive approach** ensures the protection of intellectual property, in addition to facilitating opportunities for collaboration between stakeholders and project partners, promoting the emergence of a dynamic productive ecosystem around the innovative solutions resulting from this project.

The operating contacts of the consortium partners can be extracted from the following table.

Partner	Contact	Comment
URV	Àngels Luque <angels.luque@fundacio.urv.cat> Marc Sanchez-Artigas <marc.sanchez@urv.cat>	Àngels Luque is responsible for managing IPR, funding, spin-offs, etc. Marc Sanchez-Artigas is responsible for project-related questions, such as specific KERs
BSC	Peini Liu <peini.liu@bsc.es> Josep Lluís Berral Garcia <josep.berral@bsc.es>	Peini Liu is responsible for smart management related questions Josep Lluis Berral Garcia can be contacted as a scientific supervisor of specific learning methods
IBM	Bernard Metzler, bmt@zurich.ibm.com	Bernard leads infrastructure WP3 and is IBM Research representative to the project
TUD	André Martin <andre.martin@tu-dresden.de>	André Martin acts as the main point of contact from TUD's side to the project.
NRB	Angelos Antonopoulos - aantonopoulos@nearbycomputing.com	R&I Director, responsible for future collaborations in the context of innovation projects
ALT	Jose Miguel Garcia <jm.garcia@alternatecno.es>	Responsible of agricultural dataspace related questions
KIO	Daniel Ramirez - proyectos_europeos@kionetworks.es	CTO - KIO Networks
NCT	Reuben Docea <reuben.docea@nct-dresden.de> Stefanie Speidel <stefanie.speidel@nct-dresden.de>	Reuben Doceais responsible for communication of Know-how & Surgical Data Stefanie Speidel is responsible for collaborations and scientific transfer
TRD	Javier Santaella Sanchez <javier.santaella@cellnextelecom.com>	Javier Santaella Sanchez is responsible for future collaborations in the context of innovation projects
DELL	Ger Hallissey <ger.hallissey@dell.com>	Ger is the leader of Dell OCTO in Europe and he is responsible for ongoing and future EU Research projects at Dell and BU interactions.
IMP	Carlos Segarra <cs1620@ic.ac.uk> Peter Pietzuch <prp@imperial.ac.uk>	Carlos Segarra is responsible for C-Cell related questions. Peter Pietzuch is Imperial's lead and the WP4 leader.

7.2   Preliminary Key Exploitable Results (KERs) Identification Steps

To maximize the impact and earned value of the CloudSkin project, the systematic identification of **Key Exploitable Results** (KER) is considered essential. These KERs represent tangible results and innovations that have significant potential for commercialization and exploitation of the results. The process of identifying these results requires a thorough examination of the project's achievements, advances and technological advances acquired both individually by each partner, and jointly through synergies and joint use cases.

This project must promote improved **Cloud-edge continuum solutions**, novel AI and massive information processing frameworks, both at the edge and cloud, including AI-enabled orchestration mechanisms and innovative storage and virtualization technologies developed within CloudSkin.

Through the identification of KERs, the project aims to both showcase its technological distinction and pave the way for strategic commercialization efforts, which can be aligned with more ambitious objectives such as their application to the current compute continuum technology challenges.

Table 4 presents the KERs defined at M18. It is necessary to point out that the KERs below mean an expectation at the present moment of the project, taking into account current environmental and market factors. However, we assume that as the project matures, stakeholder needs or even market

conditions evolve, which will in turn dynamically impact the evolution of the planned KERs.

Table 4: CloudSkin KERs at M18.

Partner	KER Name	KER type	estimated TRL	TRL at the end	MRL at the end
URV	Lithops Serve	Software	TRL5	TRL7	-
BSC	Data-connector	Software	TRL2	TRL5	-
IBM	GEDS	Software	TRL3	TRL5	MRL7
TUD	ConfidentialQuark	Software	TRL3	TRL4	-
NRB	NearbyOne v2.0	Software	TRL3	TRL5	MRLZ
ALT	Agricultural Dataspace	Software	TRL3	TRL5	MRL4
KIO	Attestation	Infrastructure	TRL4	TRL7	MRL5
NCT	Surgical Navigation	Software	TRL4	TRL4/5	-
TRD	Mobility Lab Castellolí	Infrastructure	TRL4	TRL6/7	MRL4
DELL	Pravega (SDP)	Software	TRL8	TRL8	-
IMP	C-Cells	Software	TRL8	TRL8	-

> The **URV** CloudLab actively collaborates with various global companies and research centers, fostering technology exploitation. As coordinators of the CloudStars open-source mobility network and collaborating with industrial clusters and innovation hubs, URV has strong ties in bioinformatics with entities such as the UK-Health Security Agency and the European Molecular Biology Laboratory (EMBL). URV plans to leverage this extensive network for exploitation targets.

Having gained Spanish National funding to create a startup on serverless analytics technologies, URV anticipates benefiting from and exploiting CloudSkin results across diverse domains, including bioinformatics. In managing IPRs, URV emphasizes open-source software development, intending to protect it with widely recognized licenses such as Apache 2, enabling commercial exploitation. Internally, URV plans to utilize the results for academic purposes, license them as open-source, and consider the possibility of establishing a spin-off or startup based on the outcomes.

> **BSC** is actively collaborates with scientific and industrial partners. In Cloudskin project, BSC is advancing research of bringing AI technology to the smart management of the continuum. Further, it handles the use case on mobility to explore intelligent application placement and migration across the cloud-edge continuum. On the one hand, we advance in research, sharing high-quality publications and conference dissemination; on the other hand, we open-source software data-connector as an agent framework for smart and autonomous management.

> **TUD** is actively advancing research on enabling confidential computing en-masse by utilizing SOTA technology such as Intel SGX as one of the most popular Trusted Execution Environment (TEE). Involvement with the CloudSkin project could further advance the implementation of trusted computing to multiple use cases and architectures. Specifically, equipping prominent fields such as Artificial Intelligence and serverless computing with a confidential approach would be essential for various use cases in the future. To support that, TUD will share the research result as a high-quality scientific publication and workshop dissemination.

> **NRB** is a start-up in the area of end-to-end (e2e) network and service orchestration, focusing on the challenges at the edge. NRB is providing their NearbyOne platform, which carries intra- and inter-domain orchestration capabilities and addresses the problem of xNF (CNF, VNF, etc.), as well as application orchestration in the cloud continuum. NRB will exploit the achievements of the project to

improve their flagship product in a multifaceted manner: 1) the AI-oriented interfaces that are developed in Cloudskin are expected to enhance the orchestration capabilities and place NearbyOne in an advantageous position in the market of zero-touch service and network management; 2) the project-specific use cases will open new directions and foster new collaborations and partnerships with 5G stakeholders (e.g., telecom operators) and vertical industries (e.g., automotive); and 3) the upgrade of the product is expected to facilitate the participation of the company in future research projects on 6G networks, where the AI-enabled network self-organization will be inherent by design. To that end, progress and results of this project will be shared with the development team and discussed with interested stakeholders and potential customers in innovation venues.

> **ALT** actively participates in the development of a data space for agriculture, which is capable of attracting data providers, to whom it offers mechanisms of reliability and use of information, capable of starting the generation around this platform, of a ecosystem of services related to agricultural and environmental information.

This platform pursues to eliminate technological differences related to the capture of information from sensors, and its availability for effective exploitation by third parties, using mechanisms such as data dictionaries and solutions for information sharing.

> **KIO** is a company that operates edge TIER IV data centers in Spain. As part of the CloudSkin project, KIO has provided IaaS (**Infrastructure as a Service**) resources and the necessary capabilities to create testbeds that each partner has required for their research work. In this sense, confidential computing capabilities have been made available to the SCONE project, which is being crucial for developing functionalities that CloudSkin project aspires to.

KIO will benefit from the technologies developed in CloudSkin to create new innovative services for our clients. Specifically, we are considering attestation as a confidential stack for our container offering. This project also opens interesting opportunities to offer our infrastructure for ephemeral compute-intensive workloads in serverless settings.

> **NCT** is actively advancing research in computer-assisted surgery (CAS) by developing artificial intelligence to support surgeons, leading to faster patient recovery and improved surgical outcomes. A key research area is surgical navigation, where segmentation, 3D mapping, and other extracted features are combined with pre-operative models to provide visual guidance. This helps surgeons approach tumor tissue precisely while avoiding critical structures such as nerves, blood vessels, and arteries. Leveraging CloudSkin's frameworks, the NCT ensures secure execution of machine learning (ML) models and streaming technologies.

> **IBM** is actively advancing research in the efficient handling of temporary data as it is being created, exchanged and consumed by compute tasks or serverless functions of complex, potentially multi-staged computational workloads. The corresponding Generic Ephemeral Data Store (GEDS), which is being developed in the CloudSkin project, implements the efficient caching and exchange of ephemeral data using the load/store semantics of an object store. It seamlessly integrates with any persistent object store using the S3 interface. Open-source GEDS is provided to the project as a core infrastructure element.

> **TRD** is advancing research in the continuous improvement and evolution of its Mobility Lab ParcMotor Circuit in the north-west of Barcelona. In a nutshell, it is an automotive test track rented by OEMs (Original Equipment Manufacturers) for stress tests of vehicles. It features one private 5G SA network operated by Cellnex and edge services, and its premises host both the test 5G network and the datacenter where most of the services are running. Castellolí small-scale test site provides a reliable testing environment that enables partners to refine and improve their services before their real-world deployment, providing edge solutions, cloud, and video analytics.

> **DELL** is the main maintainer and developer of the open-source CNCF Pravega project[17]. Pravega is a tiered storage system for data streams that is at the core of Dell Streaming Data Platform (SDP) product[18]. SDP is a platform for ingesting, storing and analyzing continuously streaming data in real-time. Moreover, SDP is one of the software offerings that are part of Dell NativeEdge product[19], which is an automated, secure, multicloud edge operations software platform to help businesses centrally manage and securely scale their edge applications across multiple locations.

The work we are carrying out within CloudSkin could benefit real projects and software products within Dell's ecosystem in multiple ways. First, we are sharing our interactions and outcomes from the CAS use case related work we do with NCT. The internal presentations and demos we are giving within Dell are eye-opening to multiple internal communities (*e.g*, sales, pre-sales, architects). Also, we are in contact with internal BUs and we share our insights and outcomes with engineering teams. This opens up the possibility for considering CloudSkin-related outcomes in the future roadmap of Dell products.

> **IMP** is advancing research in lightweight and universal virtual execution environments with WebAssembly. As part of its work, it maintains the Faasm[20] serverless runtime with almost 1k stars on GitHub. Under the scope of the Faasm ecosystem, for CloudSkin we have developed scheduling and orchestration policies and live migration of C-Cells in Faabric[21], our reference message passing and snapshot implementation.

7.3   Preliminary Exploration of Tools for Exploitation of KERs

As the outcomes of CloudSkin are gleaned, the importance of exploitation and commercialization becomes more present, and strategic collaboration with financing and exploitation agencies both at the EU level and in other countries can be a critical success factor.

To maximize the possibilities of external financing, it is essential that the project tries to align its exploitation objectives with the priorities and initiatives of the funding agencies, both within the European Union and the countries involved in the project. Through the process of identifying these agencies, and establishing contact links with them, CloudSkin seeks to take advantage of potential funding opportunities, through adaptation to existing related programs, along with the necessary establishment of partnerships that support the widespread deployment and use of the innovative solutions resulting from this protection.

This integrated approach of objectives and definition of links with financing networks defines the essence of an external financing strategy, which allows CloudSkin to be part of the sometimes complex scheme of financing and exploitation opportunities, achieving with the fulfillment of this objective, maximize the impact of exploitation at both a national and international level.

European Union:

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[17]https://github.com/pravega/pravega

[18]https://www.dell.com/en-us/dt/storage/streaming-data-platform.htm

[19]https://infohub.delltechnologies.com/en-us/t/dell-nativeedge-3/

[20]https://github.com/faasm/faasm

[21]https://github.com/faasm/faabric

Name	Description
Eurostars	Eurostars is the largest international funding program that supports research and development projects led by small and medium-sized enterprises (SMEs). The grant scheme focuses on promoting international collaboration among partners/SMEs from different Eurostars participating countries to develop innovative products, processes, or services with high market potential.
EIC Accelerator	It supports startups and high-risk and high-potential SMEs which are willing to develop and commercialise new products, services, and business models that drive economic growth and shape new markets or disrupt existing ones in Europe and worldwide. EIC Accelerator is open to innovations in any field of technology and supports the later stages of technology development (>TRL5) as well as scale-up. Grant funding of up to €2.5 million and equity investment of up to €15 million are available to support the development and scaling-up of European high-risk innovations!
EIC Pathfinder	The overall objective of the EIC Pathfinder for advanced research is to develop the scientific basis to underpin breakthrough technologies. It provides support for the earliest stages of scientific, technological, or deep-tech research and development. EIC Pathfinder supports early-stage development of future technologies like activities at low Technology Readiness Levels 1-4 and up to proof of concept. Pathfinder projects can also receive additional funding for testing the innovation potential of their research outputs.
EIC Transition	EIC Transition Open is an open funding scheme for projects in any field of science or technology as well as challenge-driven funding on specific strategic fields. The majority of funding will be granted through open calls with no predefined thematic priorities. EIC Transition projects should address both technology and market/business development, possibly including iterative learning processes based on early customer or user feedback. Grants of up to EUR 2.5 million are available to validate and demonstrate technology in application-relevant environments and develop market readiness. Who can apply ranges far - SMEs, spin-offs, start-ups, research organizations, and universities) or small consortia (two partners) or consortia of three to five different independent legal entities established in at least three different eligible countries.

Spain:

Name	Description

Ayudas para Redes de I+D+i	What is of interest is not the call itself, but the networks created in these calls, which aim to promote collaborations between research groups and private entities by providing them with mechanisms for technology transfer and knowledge valorisation.
MERCAT-PoC	Combines a financing operation in the form of a convertible equity loan or equity granted by Financial Instruments for Innovative Enterprises (IFEM) and aid in the form of a guarantee granted by the Department of Research and Universities.
ACCIÓ - Programa Indústria del Coneixement, Modalitat C. Innovadors	The purpose of the grants is to finance projects for the recruitment of a person with an entrepreneurial profile who will carry out the activities necessary for the transfer to the productive sector of technologies or knowledge generated in the public research system, through the creation of a spin-off or the exploitation of any form of intellectual or industrial property with licensing or co-development agreements.
ENISA	Loans are designed to boost Spanish small and medium-sized enterprises with viable and innovative projects.
CDTI Proyectos de innovación: Línea Directa de Expansión (LICA)	Loan to promote innovation in certain Spanish regions that are more disadvantaged and/or experiencing particular economic difficulties, through the improvement of the capacities of companies that propose technologically innovative investment projects that facilitate their growth.
CDTI Proyectos de R+D	Lending to RD projects developed by companies and aimed at the creation and significant improvement of production processes, products, or services. They may include both industrial research and experimental development activities. There is no restriction as to the sector or technology to be developed.
CDTI Proyectos de innovación: Línea Directa de Innovación (LIC)	Aid to support projects of an applied nature, very close to the market, with medium/low technological risk and short payback periods, which improve the competitiveness of the company through the incorporation of emerging technologies in the sector.
CDTI - EUROSTARS	Eurostars is aimed at generating RD projects carried out by small consortia and led by innovative SMEs. These projects must represent a break with the technical state of the art and a commercial challenge that will allow these companies to make a significant qualitative leap in their market position.
ICF - Venture Tech	ICF Venture Tech is a venture capital fund aimed at investing in technology and/or innovation projects with high growth potential in their early stages.

ELKARTEK	Non-refundable grants to support the implementation of Collaborative Research, carried out by the Research, Development, and Innovation Entities integrated in the Basque Science, Technology, and Innovation Network of the Basque Country, in the areas of specialization framed in the Science, Technology, and Innovation Plan Euskadi 2030.
HAZITEK COMPETITIVO / HAZITEK ESTRATÉGICO	The Hazitek program, regulated by the Department of Economic Development, Sustainability and Environment (SPRI) is composed of non-refundable grants, to provide the necessary resources for Industrial Research or Experimental Development. This program has been designed to promote Research and Development projects for SMEs, large companies, and associations in the Basque region.
Knowledge Industry grants for 2024. Modality B. Producte Grants. Agency for Management of University and Research Grants	The grants are intended for innovation projects that have completed the conceptualization of a transfer plan and have identified a candidate for a product or service to be developed. They should have a proposal for value generation based on the proposed technology and/or knowledge, following the validations carried out.
Knowledge Industry grants for 2024. Modality C. Innovadors. Agency for Management of University and Research Grants	The purpose of the grants is to fund projects for hiring individuals with an entrepreneurial profile who will carry out the necessary activities for transferring technologies or knowledge generated within the public research system to the productive sector. This can be done through the creation of a spin-off or the exploitation of any form of intellectual or industrial property through licensing or co-development agreements.
The Collider: deep tech venture builder	Mobile World Capital Barcelona's dedicated tech transfer program that supports scientific and innovative projects in their transition from the lab to the market. Through its multiple initiatives, The Collider works with ecosystem agents to strengthen technology transfer mechanisms in Catalonia, Spain, and Europe, facilitating the consolidation of scientific-technological startups.
Prueba de Concepto del Ministerio	its purpose is to promote and accelerate the transfer of knowledge and results generated in research projects of the State Plan, through the modalities of "Excellence" or "Knowledge Generation" R+D projects, of "Research Challenges" R+D projects and of oriented fundamental research projects.
CDTI (for companies)	Public business entity, dependent on the Ministry of Science, Innovation and Universities, that promotes innovation and technological development of Spanish companies. It is the entity that channels requests for help and support for R+D+I projects of Spanish companies at the national and international levels. Consist on loans partially repayable.

ACCIÓ-START-UP CAPITAL (for companies)	Startup Capital is a direct grant of up to €100,000 for recently created technological startups. This grant is aimed at startups that must be constituted at the time of publication of the call in the DOGC and must have a maximum of 18 months of life at the moment of request. The grant is a non-repayable public award and does not require a guarantee.
ACCIÓ-NUCLIS (for companies) Business enterprise R+D nuclis	Through these grants you can receive up to 250,000 euros in non-returnable funds to develop a different project and tackle the challenges of the technology and green transformation.

Throughout the M12 to M36 schedule, each project partner will dedicate their efforts to identify financing instruments and the analysis of the alignment of their objectives with those of the project's exploitation.

This international collaborative action brings together global opportunities that may be of interest both for CloudSkin and for the partial exploitation of its results.

Of course, the result of the market analysis work and financing opportunities will be documented and shared, and through the associated deliverable, it may serve as a basis for participation in future individual or joint exploitation and commercialization initiatives, serving as an essential tool for the analysis of the strategy efforts for CloudSkin exploitation, which will be carried out in the last stages of the project.

7.4   Preliminary Market Understanding and Innovation Gap Analysis

The construction of the CloudSkin architecture, as well as the definition of methodologies in it, allows extracting knowledge from the continuum components and interacting with the complete software stack for decision making and system optimization.

Needless to say, the increasing complexity of data and information management from cloud-edge infrastructures establishes heavy layers that affect not only performance, but also the capacity of the platforms and the energy consumption of countries. CloudSkin addresses the analysis and reduction of said complexity by addressing the following market challenges:

- The investigation and optimization of lightweight learning methods to model infrastructure, workloads and applications, as well as storage, in a comprehensive and dynamic way.

- The design of new provisioning and management policies using the learned models, helping to make computing, communication and storage decisions in the continuum.

- The standardization and integration of the Learning Plane mechanisms, connecting them to the full stack of the management architecture.

- Validation of the mechanisms of the Learning Plane through a real cloud-edge use case scenario on the provision of data analysis services.

Putting aside the AI market, the project also contributes valuable software such as C-Cells built on WebAssembly. There is huge interest in the market for lightweight virtualization technology. Just to illustrate, companies like Microsoft and Fermyon are capitalizing on WebAssembly SFI as a server-side replacement for containers and virtual machines. In spite of this growing interest, WebAssembly has not been widely adopted in production already, and this year it is expected that WebAssembly will start making its way into production spurred by server-side web frameworks such as Leptos and Razor. However, we see a large innovation gap in the continuum, where WebAssembly can allow the seamless execution of the same very code across the edge and cloud.

A similar situation occurs to TEEs, which have been started to be included as offerings in public cloud providers such as Azure in the last few years. For instance, Azure confidential computing has two offerings: one for enclave-based workloads and one for lift and shift workloads:

The enclave-based offering uses Intel SGX to create a protected memory region called Encrypted Protected Cache (EPC) within a VM. This allows users to run sensitive workloads with strong data protection and privacy guarantees. Azure confidential computing launched the first enclave-based offering in 2020.

The lift and shift offering uses AMD SEV-SNP (GA) or Intel TDX (preview) to encrypt the entire memory of a VM. This allows customers to migrate their existing workloads to Azure confidential compute without any code changes or performance degradation.

All in all, we see a large innovation gap between the needs of the market and the technologies available in the Cloud-edge continuum. The technologies developed with CloudSkin will be useful to narrow this gap.

7.4.1 Suggested New Products

CloudSkin is made up of the design and implementation of the Learning Blueprint, as a framework based on AI/ML towards an intelligent and holistic orchestration of the continuum. As one of the results of CloudSkin, an integrated framework capable of producing insights and predictions for resource and workload management will be defined, with the aim of optimizing service quality and resource consumption in a dynamic and adaptive way.

This also includes the need to provide new tools to serve and train new models such as Lithops Serve, which is good at offline batch inference. Offline batch inference is a critical workload for many AI products, in particular, with the growing usage of pre-trained foundation models. At its core, it turns out to be a simple problem: given a trained model and a dataset, get model predictions for each data point.

Nevertheless, there are many hallenges to doing this at scale such as managing compute edge infrastructures and cloud clusters, especially when needing to use heterogeneous clusters, consisting of different instance types to maximize throughput. Or parallelizing data processing by utilizing all resources (CPUs & GPUs) in the cluster at any given point in time.

Of course, AI model training and inference may be protected with enclaves. And WebAssembly fast startup times mean AI inference may be done on demand without waiting for a virtual machine or container to come online. That, in turn, would mean saving money (via efficiency) on costly GPU resources.

To wrap up, new AI products for the continuum with enhanced security paired with lightweight virtualization may cover the needs of smart orchestration and execution of tasks across the highly heterogeneous compute continuum.

7.4.2 Potential Need for the Suggested New Products

Among the possible applications derived from CloudSkin products, we can highlight:

- **Adaptive design:** This application covers the need to adapt the learning of decision support systems, considering the individual profiles of the interested parties, incorporating AI/ML to dynamically adjust the assessment parameters.

- **Real-time performance analysis of AI/ML implementation:** Allowing the solid progress of the technological ecosystem to be measured, identifying areas of strength and weaknesses, in addition to allowing the preparation of recommendations for optimization, as a result. Here KERs such as Lithop Serve and the Learning Plane abstraction developed by BSC can be very valuable.

- **Adaptive medical use environments:** Through the creation of flexible learning environments, capable of adjusting in real time, based on interactions and analysis, as well as optimizing the

effectiveness of surgical performance through this process. This facet of AI is very relevant for NCT, which is working intensively in computer-assisted surgery (CAS) infrastructures.

- **Cross-domain knowledge integration:** usage of AI/ML able to close gaps between different knowledge domains that leverage the continuum, facilitating interdisciplinary learning and promoting a holistic understanding of complex concepts.

- **Integration of ethical and inclusive AI:** Seeking the maximum possible guarantees so that the AI and ML algorithms used within the Learning Plane are **ethically** designed and **inclusive**, avoiding bias and promoting diversity in learning experiences.

- **Predictive learning paths:** Exploiting the benefits of AI/ML to forecast future learning needs and create proactive paths dynamically, thus anticipating the necessary skills and information requirements. This property is very important in CloudSkin as the needs of **AI-enabled QoS-based task placement** and **resource provisioning** may evolve after the early implementations of AI/ML solutions, e.g., with new metrics to optimize such as energy.

- **Content curation and recommendation:** A little less relevant in the project, the use of AI and ML algorithms to filter relevant information from a wide set of content, guaranteeing that the systems generate content appropriate to the defined business indicators is important in many settings such as the medical ones.

7.4.3 Competitors analysis

Competitor analysis is a fundamental aspect for creating a realistic exploitation plan, therefore an analysis of competitors in the continuous computing market will be carried out to better understand the market in which CloudSkin results are presented. This analysis has already started. However, the computing continuum is a new notion shaped by the recent rise of IoT devices and systems. The idea is more in a **research phase**. And therefore, competition is very low at the time of analysis (March 2024).

There is a myriad of standard technologies for training and model inference in the market, mostly for cloud environments. For instance:

- **Batch Services:** Cloud providers such as Amazon Web Services, Google Cloud, and Microsoft Azure provide batch services to manage compute infrastructure for you. Some newer products like Modal Labs provide a user experience layer around cloud providers to abstract away even more complexity. Regardless of which service you choose, the process is the same: you provide your code, and the service runs your code on each node in a cluster. These services have **the main limitation that they are not available at the edge**, which makes them suitable only for experienced cloud users who can write their own optimized batch inference code.

- **Online Inference solutions:** Solutions like Bento ML or Ray Serve provide APIs to make it easy to write performant inference code and can abstract away infrastructure complexities. But they have been designed for online inference and do not perform well in the offline case, which is required for the metabolomics use case in the project, leading inference service providers like Bento ML to integrating with Apache Spark for offline inference.

- **Distributed data systems:** These solutions are designed to handle large amounts of data and are better suited to cloud environments. They break large datasets into reasonable batches for processing and can map a given function over the dataset efficiently, effectively handling the challenges of data curation at scale. Examples include Apache Spark and Ray Data. However, these systems are so heavyweight that cannot be run on weak devices at the edge, being part of the cloud part of the continuum.

Currently, however, **there is no a defined or mature market for the edge-to-cloud continuum AI products**, nor is it thus possible to identify clear direct or immediate competitors for the products resulting from CloudSkin. The few potential competitors identified appear to be indirect, since they develop technologies that technologically support the IT continuum as shown above.

This means that the market analysis will need to be updated periodically, due to the foreseeable appearance of new agents in the market with new commercial or industrial application orientations, not contemplated yet.

7.4.4   Product advantages

One of the major advantages of the new product will be the use of WebAssembly-based virtualization and execution that will provide us with the execution environment necessary to run AI computations across the full range of the continuum.

This goal requires virtualization of resource accesses and extremely short instantiation times for AI processes, which in combination go beyond the characteristics of current academic and industrial technologies. AI enhanced continuum portability with WebAssembly will need to be paired with the needed orchestration, scaling, migration and observability mechanisms that allow for extremely low-latency elasticity support. Besides, the confidential computing capabilities of the platform will open the door not only to multi-tenancy at the untrustworthy edge, but also to the confidential execution of code. In terms of AI, there are three key reasons why this new approach is an ideal match with AI workloads:

- WebAssembly platform neutrality, which extends to GPUs, makes it portable across hardware. A developer can build AI applications locally using slow (but cheap) CPU or GPU inference, and then deploy onto a cloud system that has massive (and expensive) AI-grade GPUs.

- WebAssembly portability and small binary sizes, which mean that AI applications can be moved as close to the data and GPU as possible, or be migrated to the cloud and the edge, depending on the computation needs.

- Confidential exeuction of WebAssembly AI code within secure enclaves that will protect the access to the data captured by and stored inside edge devices itself before streaming it to the cloud.

Either way, the integration of the Learning Plane with an edge orchestrator in production such as NearbyOne, that can operate in all tiers of global service deployment, from the edge up until the corporate data centers and even up to the public cloud, will derive into a new product with smart orchestration capabilities.

The main competitive advantage of the platform is its uniqueness, as so far no direct competitors have been identified for this new type of product. For instance, Azure IoT Edge supports confidential applications that execute within secure enclaves on an Internet of Things (IoT) device. But it does not permit live task migrations, or it seamless execution on the cloud and edge thanks to WebAssembly virtualization. Our preliminary analysis does not find a similar product in the market.

7.4.5   Potential customers

Overall, the cognitive platform developed within the CloudSkin project will help European SMEs, farmers and governments, transition to a computing continuum with strong edge capabilities in both a reliable and energy-efficient way.

The results developed in CloudSkin are aligned with container-like technologies currently on the market, so once the stage of understanding the usefulness of the technologies has been overcome, rapid adoption is expected among companies that currently manage applications with containers.

This preliminary analysis makes us expect the productive application of the results in at least three clients before the end of the project.

7.4.6 Stakeholders

Stakeholders include cloud/edge providers, cloud resellers, 5G vertical industries like automotive, scientific communities, SMEs and administrations. Some application domains and examples include smart agriculture, healthcare as an example, metabolomics data spaces such as METASPACE2020.eu and hospitals.

7.4.7 Market segmentation

The number of devices and applications has grown exponentially in recent years. A transformative revolution begins in 2024 with the continued growth of IoT devices and applications. With 15 billion active IoT devices connected in 2023 and the foreseeable implementation of technologies such as 5G, the IoT sector continues to grow in 2024 both in number of devices and in application sectors.

Among the critical growing markets with application of CloudSkin results, the following stand out:

- **Integration of AI and machine learning with IoT.** Through predictive analysis of data and patterns, it will favor the emergence of integrated intelligent IoT systems capable of adapting and evolving.

- **Growth of edge computing.** Due to the cost of the cloud, cloud resource optimization will be complemented by moving to the edge for the execution of certain processes. Optimization in this sense is one of the key points of the CloudSkin project.

- **Advanced image technology.** The proliferation of virtual assistance (e.g., in surgeries), and the real-time analysis and generation of video, represents a technological challenge for the edge, for which solutions are also provided in part in this project.

- **Incorporation of IoT in healthcare.** The increase in subsidies to promote the integration of IoT in healthcare opens a specific market niche in the sector with a planned investment of 1,000 million euros.

7.5 Upcoming Exploitation Plan for M12-M36

7.5.1 Months M12-M18: Technical Asset Identification and Integration

- Finalizing individual technical assets and Key Exploitable Results (KERs).

- Develop plans to integrate the existing tools listed into exploitable solutions.

- Conduct a preliminary assessment of the Technology Readiness Level (TRL) of each identified asset.

7.5.2 Months M19-M21: Market Understanding and Innovation Gap Analysis

- Deepen the understanding of the project's potential market and exploitation horizon.

- Carry out a detailed analysis of the market to identify possible market niches and opportunities for innovation and investment.

7.5.3 Months M22-M24: Training Activities and Community Building

- Promote the insertion of the solution into the market by designing training and dissemination activities.

- Encourage the development of the innovative technology achieved in the project, promoting a scientific and technological community, tackling into dissemination resources such as webinars, conferences, workshops and collaborations.

7.5.4 Months M25-M27: Exploitation Plan Finalization

- Finalize the exploitation plans for technical and KER assets by each partner.

- Validate legal and information management compliance.

- Establish key indicators of strategic alignment of project results with market interests.

7.5.5 Months M28-M30: IPR Management and Business Modeling

- Collaborate with organizations and experts in intellectual property rights and commercial patent legislation, to guarantee strict compliance.

- Develop strategies and processes necessary for the management of Intellectual Property Rights (IPR) affected by the project.

- Adjust the business model, merging the identified market needs with the exploitable results of the CloudSkin project.

7.5.6 Months M31-M33: Market Penetration and Collaboration

- Identify viable business models for the exploitation and development of CloudSkin.

- Design and preliminary execution plans for business development in the technological and scientific market.

- Promote collaboration between consortium members, to promote both individual and joint exploitation of commercial and scientific results and opportunities.

7.5.7 Months M34-M36: Sustainability Planning and Final Evaluation

- Develop a long-term technological evolution program for CloudSkin technology.

- Collaborate with public and private organizations to influence the definition of standards and establishment of technological horizons, in order to shape the technology for the present with which future needs will be covered.

- A continuous improvement and feedback mechanism will be established, enriching the project with the experience of users and interested parties.

- Adaptation of CloudSkin to the market based on information collected from the market and first users.

- Drafting of the final exploitation and marketing report.

- Writing the report on successes and dissemination of the project, both in the short term and future impact estimates.

- Adaptation of company processes and definition of recommended investments based upon the results of the project, with the aim of maintaining the commercialization of products and services beyond the project life cycle.

7.6 Objectives and achievements at standardization

Standardization in the context of CloudSkin involves the establishment of a general framework for the definition of standards, through the creation of a set of protocols, interfaces and APIs to guarantee interoperability, compatibility and secure access between different platforms and implementations, defining the format and level. of the technical documentation necessary to make contributions to the standards in a clear and coherent manner.

Among the main standardization objectives and achievements of the project, we identify:

- **Through Interoperability.** With the aim that different components and systems can interact properly.

- **In search of compatibility**. Define mechanisms that allow software from different suppliers to work together.

- **Quality assurance.** Ideally, through the proposal of standards and good practices to guarantee the reliability, security and performance of the solutions.

- **Make scalability viable.** Design scalable systems capable of adapting to different workloads and user demands.

- **Optimization.** Ensure the minimization of the usage of resources related to virtualization and execution mechanisms.

Among the consequences of standardization, the promotion of innovation in virtualization and execution mechanisms to improve scalability stands out, as well as the growth of an open ecosystem for technological development. The success of the standardization processes will allow the growth of systems in an adaptive way to dynamic environments, with changing workloads and evolving technologies, in a safe way, both by evolution and adaptability to security considerations, and by variation in terms of the management of resources and underlying technologies.

8 Evaluation of activities and impact results

8.1 Impact items and KPIs

This section presents an evaluation of project key performance indicator (KPIs) and impact items defined as expected economic, technological and societal outcomes of the CloudSkin project.

Improved European leadership in the global data economy:

- European leadership in three European dataspaces (Health, Agriculture, 5GAutomotive). With METASPACE as reference space in metabolomics led by EMBL, also consolidates an additional federated dataspace in Surgery (NCT). We expect 3+ new institutions joining these dataspaces by the end of the project.

> **KPI nº 1.** 3+ new institutions joining european dataspaces

- Key alliance between European SMEs (KIO, SCONTAIN: Dresden's startup), URV's startup, Nearby Computing BSC's startup, Alterna and major open source leaders (IBM, DELL) should offer advance AI-enabled management of the virtualized Cloud-edge continuum. We expect sustained economic growth as well as consolidation of at least two startups by the end of the project.

> **KPI nº 2.** Economic growth and consolidation of at least two startups

Maximised social and economic benefits from the wider and more effective use of data:

- The wider use of healthcare data thanks to confidential computing technologies and open dataspaces will boost computational capabilities of hospitals and research laboratories. A vast amount of health data (e.g., surgical laparoscopic videos) is collected daily, but is virtually inaccessible to machine learning due to privacy concerns and data sovereignty. CloudSkin computing technologies will open those massive data sets for analysis, thus gaining useful insights in medical treatments and surgery. NCT will help to demonstrate secure healthcare data processing by the end of the project.

> **KPI nº 3.** Demonstrate secure healthcare data processing

- The AI models developed within CloudSkin will enhance the orchestration capabilities and place the NearbyOne platform by NRB in an advantageous position in the market of zero-touch service and network management. The product upgrade will promote the participation of the company in future research projects on 6G networks, where the AI-enabled network self-organization will be inherent by design. Specifically, we foresee 3+ new customers by the end of the project.

> **KPI nº 4.** 3+ new customers (NRB)

- Another decisive impact of this project is portability. The novel portable virtualization technologies (C-Cells) combined with standard CNCF technologies such as the CNCF Pravega project from DELL, will clearly benefit European Cloud providers such as KIO Networks, OVH-Cloud, Scaleway, and Kubermatic, etc. Edge-cloud datacenter companies such as KIO will be

able to leverage different cloud providers and optimize deployments for industries exploiting Cloud-edge resources. Companies focused on the public sector (ALT) will be able to leverage different cloud providers and simplify the use of remote resources. This can create a vibrant ecosystem in Europe with novel contributions in the software layer, while using infrastructure as a true utility in an open market. The alliance with open source companies such as IBM and DELL may also increase the global adoption of these technologies.

- The data sharing technologies from agricultural and environmental sensors developed in the project will influence the elimination of offline data niches, and the promotion of cloud services for the analysis and processing of information.

- These new services will be able to apply analysis and machine learning algorithms, or the inter-relation of data from other sources, including satellites, which will result in the effective expansion of the capacity for analysis and knowledge of the environment, as well as the automation of agricultural processes.

- Surgery data technologies developed in the project will entail relevant improvements in accuracy but also in the detection of complications during surgical interventions. Through active learning and semisupervised algorithms, unlabeled data will become accessible to machine-learning. Computer-assisted Surgery (CAS) using multicentric data with high variance will create generalized machine-learning models that will aid surgeons during surgery, e.g., to avoid post-operative complications. NCT will demonstrate such advances in their use case.

- A European single market on health and agriculture data will help transform the health and agriculture sectors with precise medicine and automated irrigation solutions, resp.

Reinforced Europe's ability to manage urgent societal challenges (e.g. data for crisis management, digital for clean energy):

- The project is reinforcing Europe's ability to deal with clean energy. The project will help reduce energy consumption of both cloud and edge infrastructures derived from resource utilization (e.g., when moving 9/10 of load from the cloud to the edge). An efficient use of energy is fundamental for the European data ecosystem, as evidenced by the steep increase in fossil fuel prices due to the recent Russian invasion of Ukraine.

- The use case about water management in agriculture is a showcase for some of the project contributions to society. Collected irrigation data is private and difficult to share, not only for the abusive use of information by competitors, but also by suppliers and distributors, preventing the public sector and stakeholders to take advantage of the collected data from sensors, e.g., to perform optimal water management projections. CloudSkin can help here by leveraging its capability to distribute the workload between the cloud and the edge to keep sensitive data computations within the organization boundaries, exfiltrating to the cloud only those tasks with no confidential requirements. The results from all these computations can then be used to alleviate the climate crisis. The effective implementation of an agricultural dataspace will imply, in the long term, compliance with the following key aspects:

  – Less pollution. Through the optimization of resources, the analysis of information will improve the efficiency of irrigation, allowing farmers to optimize the use of scarce or polluting resources, such as water and the use of fertilizers.

  – Adaptation to the environment. Having real-time data on local climatic conditions and the state of crops allows preventive measures to be taken against droughts, floods, hail or even pests.

  – Improvement in decision making. With the right information, farmers will be able to improve their decision-making capacity regarding which crops to plant or when and how to manage them (for example, when to harvest, optimal irrigation periods).

– Strategic capacity for climate action. The collaboration and creation of a global data sharing panel among interested entities (farmers, researchers, brokers, companies and governments) will allow addressing climate challenges, measuring the success of the established policies, and designing new strategies in a coordinated and transparent.

8.2 Summary

In the previous sections a description of all the communication, dissemination and exploitation activities was presented for the reported period M5-17. Moreover, deliverable D6.1 reported the activities of the first period of the project. All dissemination activities and tasks are being monitored through the metrics shown in Table 6, that summarizes the communication and dissemination results and the actual goals achieved for the period first phase of the project, i.e., from M1 to M17.

Table 6: Evaluation of activities (M1 to M17)

Activity	Metric	Target (by the end of the project)	Status (M1 to M17)
Corporate image	Logo and templates	1 logo, 1 PPTX, 1 Latex	Met
Promotional material	Poster and flyer	1 poster and 1 flyer	Met
Online promotional material	Video	As many	1
Communication channels	Website and social media	1 website, 1 Social Media	Met
Social media	Number of posts	As many	62
Social media	Number of Followers	As many	48
Press strategy	Number of press releases	As many	5
Scientific publications	Number of scientific publications	As many	14
Scientific publications	Number of citations in bioinformatics technologies	>100	15
Scientific publications	Number of citations in information technologies	>300	22
Industrial and scientific events	Number of exhibitions, presentations, posters	As many	30
Organisation of events	Number of events (workshops, seminars, training, poster sessions, webinars)	5	2
External interactions	Presentation to external entities like stakeholders or research institutions	As many	19
Science for society	Number of presentations, posters, publications to the general public	As many	7

9 Conclusions

This document presents the activities to promote the impact of the CloudSkin project. It describes a number of key activities that the partners are conducted, and will follow up in the next period, in order to guarantee broad visibility of the project work and results in the cloud, edge, IoT domain and beyond so as to engage target stakeholders and produce relevant and durable impact.

In first period of the project, the CloudSkin partners have been active in several ways and pursued various promotional activities, including:

- Creation of promotion material to help in efficiently, consistently, and accurately disseminate CloudSkin.

- Online promotion of the project through the website and social media channels.

- 30 presentation and demonstrations of the CloudSkin project at several conferences, exhibitions, workshops and events.

- 14 scientific publications in conferences, journals o magazines.

- 19 presentation of the CloudSkin project to external entities like potential stakeholders or research institutions.

- 7 presentation of the CloudSkin project to the general public.

- 2 CloudSkin workshops organized and one more planned.

- Contribution to foster synergies and collaborations with broader European communities in Cloud, Edge, AI, Data, industry and academia, among others.

- Releasing open source data, technologies, tools and results as early as possible.

- Evaluation of the use of the CloudSkin results for social, scientific, financial benefits or other purposes of interest.

The work of WP6 will continue to be intensive in the upcoming months as several efforts are planned in order to support the broad and effective promotion of various CloudSkin-driven activities.

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