Smart Networks and Services International and European Cooperation Ecosystem

D3.1 Vertical Engagement Tracker

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Legal Disclaimer

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Abbreviations List

Abbreviation / Term	Description
3GPP	3rd Generation Partnership Project
5G4SC	5G for Smart Communities
5GAA	5G Automotive Association
5G-ACIA	5G Alliance for Connected Industries and Automation
5G-MAG	5G Media Action Group
5G PPP	5G Public Private Partnership
6G-IA	6G Smart Networks and Services – Industry Association
AENEAS	Association for European NanoElectronics ActivitieS
AI	Artificial Intelligence
AIOTI	Alliance for IoT and Edge Computing Innovation
AR	Augmented Reality
ARTEMIS	Association for actors in Embedded Intelligent Systems
ATO	Automatic Train Operation
CCAM	Cooperative Connected and Automated Mobility
CEF	Connecting European Facility
CETIC	Centre of Excellence in Information and Communication Technology
DaaS	Desktop as a Service
DG CNECT	Directorate General for Communications Networks, Content and Technology
DIHs	Digital Innovation Hubs
EBU	European Broadcasting Union
ECC	European Consumer Centre
ECSO	European Cyber Security Organisation
eMBB	Enhanced Mobile Broadband
ERTICO	European Road Transport Telematics Implementation Co-ordination Organisation
ESA	European Space Agency
ETCS	European Train Control System
ETP SMR	European Technology Platform on Sustainable Mineral Resources
ETSI	European Telecommunications Standards Institute
EuCNC	European Conference on Networks and Communications
EUTC	European Utilities Telecom Council
FRMCS	Future Rail Mobile Communication System
IAFA	Impact Assessment and Facilitation Actions
ICT	Information and Communication Technologies
IoT	Internet of Things
ITS	Intelligent Transport System
ITU	International Telecommunications Union
JU	Joint Undertaking

MEC	Multi-Access Edge Computing
mMTC	Massive Machine-Type Communications
MoU	Memorandum of Understandings
NEM	New European Media Initiative
NGMN Alliance	Next Generation Mobile Networks Alliance
PSCE	Public Safety Communication Europe
PPDR	Public Protection and Disaster Relief
RIA	Research and Innovation Action
RIS3	Regional Smart Specialisation
SCoDIHNet	Smart Connectivity Digital Innovation Hub Network
SEO	Search Engine Optimisation
SNS	Smart Networks and Services
TaHiL	Tactile Internet with Human in the Loop
THz	Terahertz
TIM	Traffic Incident Management
UX	User Experience
VR	Virtual reality
URLLC	Ultra-Reliable and Low Latency Communications
WG	Working Group
xR	Extended reality

Executive Summary

Launched in January 2023, the SNS ICE project aims to establish a collaborative environment for European and global stakeholders involved in developing 6G smart networks and services. It serves as a platform to showcase, leverage, and position the achievements of SNS JU in major European and global forums. The project actively engages with regions where 6G activities are planned or ongoing, including vertical industries, through established associations to understand their requirements and promote SNS JU solutions, enabling the development of tailored 6G solutions for early adoption.

As a Coordination and Support Action (CSA) project, SNS ICE's practical actions include supporting and representing the SNS JU Research and Innovation Action (RIA) projects in their technological developments. In this context, SNS ICE particularly seeks to cooperate with Phase 1 projects, divided into four Streams (A, B, C and D) [1].

Deliverable D3.1 of WP 3 — *Verticals Engagement* — outlines a first working scenario for the project's vertical engagement tasks. This effort responds to the project's main aim to enhance vertical sector engagement through stakeholder support, workshops, presentations, identification of new use cases, support for SNS project presentations at international forums, facilitation of European participation in Global 6G events, adaptation of key messages for vertical promotion, and fostering synergies with key stakeholders and the SNS Operational CSA.

In particular, it showcases the first steps taken in mapping the use cases provided by each project and engaging with relevant vertical associations, initiatives and events to leverage the portfolio of partnerships of different consortium members to consolidate the 5G/6G vertical ecosystem, also including new sectors enabled by new technological applications.

Furthermore, the document outlines the main infrastructure of the Vertical Engagement Tracker online tool that will be launched by the fall of 2023 and populated in the following months adding relevant information on projects' use cases (a more detailed project survey will be created and circulated among projects in the early months of 2024) and new partnerships which will arise from SNS oriented events on verticals resulting from events such as EuCNC and 5G Techritory.

Finally, the document outlines the next steps, which will involve assessing use cases and emerging vertical needs, translating them into requirements for future research activities and actively working to align 6G capabilities with the identified vertical needs. The results will eventually be fed into a position paper leveraging the analysis of vertical trends and incorporating key outcomes from projects.

1 Introduction

Vertical Engagement activities have been established under 5GPPP by the 5GIA Board several years ago to establish a collaboration framework with key European industrial sectors. The objective was to promote 5G technologies to future adopters while collecting their needs in terms of requirements and use cases. Key activities included industry influencing, partnerships with key industry associations, project cartographies and whitepaper dissemination.

Continuing the trajectory established by the 5GPPP, the ongoing 6G activities described in this document build upon the foundation of Vertical Engagement activities initiated by 5GIA. More precisely, this deliverable provides a preliminary analysis of 6G vertical use cases, laying the ground for the online platform Vertical Tracker which will be launched in the following months as the main feature of SNS ICE WP3's effort on vertical engagement concerning SNS JU RIAs' use cases.

This online Verticals cartography continues the work initiated with 5GPPP Coordination and Support Action projects Global5G.org, and later on, 6GStart.eu, still ongoing until 2024 [2].

This document is structured as follows. Section 1.1 describes the background and context of the document. Section 1.2 defines the blueprint of the new verticals cartography and 1.3 outlines the envisioned work plan. Sections 2 focuses on the project portfolio, providing details on the coverage of industry verticals, previous cartographies, vertical clustering and related statistics. Section 3 describes the new vertical tracker online tool, providing updates in relation to the previous versions, further technical details, information on the use cases and the sectors, and the vertical association. Section 4 provides details on the WP3's engagement strategy to engage different vertical industries showcasing relevant partnerships (e.g., Maps with Verticals Fora and MoU Agreements), listing relevant national/international initiatives to engage verticals, as well as relevant vertical engagement events that the WP will organise and join. Finally, section 5 concludes the deliverable, providing info on the WP's envisioned impacts and next steps, with samples of website pages, and future developments, especially the drafting of a whitepaper.

1.1 Background and Context

The Verticals Cartography was originally triggered by the 5G PPP Technical Board (TB) in the context of Global5G.org with a view to collect a set of data points that would help classify and analyse use-case experiments targeting industry verticals, starting with phase 2 projects and progressing towards the integration of phase 3.

In contrast, the version to be developed by SNS-ICE will focus on Phase 1 of Research and Innovation Action (RIA) projects of the SNS Joint Undertaking (Streams A, B, C and D). This deliverable aims to outline the initial stages of use cases clustering and describe the criteria used to construct a vertical cartography mapping the projects' use cases and to bring these related to relevant verticals associations.

In this context, a first step is the development of a blueprint to define main characteristics and commonalities across SNS JU RIAs and cluster the projects' use cases together according to the targeted vertical sectors.

1.2 Cartography Blueprint

The Cartography Blueprint is a spreadsheet that collects data for analysis on the following:

Vertical clustering: The targeted industry vertical. References are harmonised as much as possible with terminology at the programme and 5G standardisation levels, integrated with new 6G verticals such as Industry 4.0 and Smart Energy.

Features: The International Telecommunication Union (ITU) has identified several key functionalities for 5G/6G networks. These functionalities aim to enhance the capabilities and performance of the network to meet the

requirements of future 6G communication systems. As some SNS JU RIAs, especially those included in Stream A, constitute a bridge between 5G and 6G features, both 5G ITU-defined and potential future 6G features must be considered. However, it is important to note that identifying specific 6G features at this stage is speculative, and their maturation will depend on specific experimentation and development trends as well as specific societal needs, which will allow certain features to ultimately mature and be employed in 6G networks [3].

Current 5G Features:

- **Enhanced Mobile Broadband (eMBB) service category**: significantly faster data speeds than previous generations, enabling high-quality streaming, immersive virtual reality experiences, and seamless multimedia content delivery.
- **Ultra-Reliable and Low Latency Communications (URLLC) service category**: extremely low latency and high reliability, crucial for applications requiring real-time interactions, such as autonomous vehicles, remote surgery, and industrial automation.
- **Massive Machine-Type Communications (mMTC) service category**: the connection of a massive number of Internet of Things (IoT) devices, enabling efficient communication between machines, smart cities, smart homes, and various IoT applications.
- **Multi-Access Edge Computing (MEC) functionality**: MEC brings computing resources closer to the network edge, reducing latency and enabling localised data processing. This functionality supports time-sensitive applications, such as augmented reality, autonomous vehicles, and smart city services, by allowing data to be processed closer to the point of generation [4].

Potential 6G Features:

- **Hyper-connectivity**: seamless communication between machines, objects, and the environment, involving ubiquitous connectivity across various domains, such as terrestrial, aerial, and underwater.
- **Terahertz (THz) Communication**: leveraging terahertz frequency bands, enabling extremely high data rates and ultra-low latency communication to support massive bandwidths and accommodate the growing demand for data-intensive applications.
- **Intelligent Network Architecture:** employ intelligent and self-organising network architectures to incorporate artificial intelligence (AI), machine learning (ML), and advanced algorithms, optimising network performance.
- **Holographic Communications:** advanced holographic technologies, enabling immersive and interactive communication experiences through virtual reality (VR) and augmented reality (AR) applications.
- **Green and Sustainable Networks:** smart application to reduce carbon footprint, optimise energy consumption, and design eco-friendly network infrastructure.
- **Quantum Communication and Computing:** incorporating quantum technologies to enhance security and cryptography in communications beyond the capabilities of classical computing.

Type of Experiment: Assesses maturity and roll-out levels based on the following definitions (agreed within the SNS JU initiative):

- Proof of Concept: The initial stage of development where a theoretical idea is put into practice to validate its viability.
- Prototype: A tangible embodiment of the proven concept integrated into a component or system.
- Demonstration: A fully functional system that can showcase specific scenarios or use cases, offering a comprehensive perspective.
- Trial: Carrying out tests outside the controlled environment to ensure the functionality of a system or its components, primarily focusing on accurate performance.
- Pilot: Conducting a trial that tests the system and demonstrates additional value for end users based on underlying business assumptions.
- Commercial Product: A system or technology that is commercially available to consumers.

Location: City and country. References to dedicated test tracks are also included wherever relevant, e.g., automotive; cross-border corridors.

Date of experiment: Expressed as "Q-Year", including multiple testing scenarios and targeted functionalities (as applicable).

Ecosystem: Summary of stakeholders involved across supply and demand, public and private organisations, helping to identify newcomers to SNS JU.

1.3 Work Plan

Below are the first and envisioned next steps in the work plan towards vertical engagement.

1.3.1 Current State of Play

The Vertical Engagement Tracker activities have been based upon the activities formerly conducted under Global5G.org, FULL5G and 6GStart projects, mapping a vast array of RIA projects' use cases within the large 5G domain. These are currently:

- First, information on verticals has been collected and analysed also thanks to SNS OPS WP1's survey conducted among SNS JU RIAs to map their main engaged verticals, adopted technologies and envisioned market outputs (see Appendix 1).
- A list of key vertical associations to engage has been drafted during a first internal workshop among WP 3's task leaders (see Appendix 2). These will be linked on the vertical engagement online tool through a common filter (see section 3.1).
- Several vertical engagement panel discussions featuring experts have been attended by WP 3 leaders at 6G-related conferences, such as ITS Europe (22-24 May 2023) and EuCNC (June 6-9, 2023), to understand the current vertical landscape.
- New verticals-related fields have been added in the present cartography to fully represent the new potential use cases allowed by 6G technologies, such as Extended Reality and Satellite for Verticals, while also maintaining relevant 5G verticals, such as Automotive, Transport & Logistics, Health, Public Safety.

1.3.2 Envisioned Future Steps

Envisioned future steps will mostly lie in enhancing knowledge of vertical sectors and organising events involving SNS JU RIAs and relevant associations to generate synergies and open up exchange opportunities. The main future activities include:

- Run a survey among SNS JU RIA projects to better assess their use cases' vertical engagement with specific blueprint information as of 1.2.
- Assess the result of the vertical engagement mapping through the activities of the Trials WG.
- Create the vertical engagement tracker online tool (see section 3.1).
- Populate the tracker after running a survey among projects.
- Create infographics about the first vertical engagement mapping and present them at relevant events.
- Monitor updates among the SNS JU RIA community by attending related events and further engaging SNS JU RIAs in targeted events.
- Feed the events' results into a gap analysis which will result in a position Whitepaper (D3.4).

The activities for the period M07-M27 (July 2023-April 2025) will be reported in D3.2, D3.3 and D3.4, which will be published in M13, M24 and M27, respectively. These will contain updates on the WP verticals engagement actions, measure impact creation, assess relevant gaps and outline a roadmap for future 6G developments.

2 Project Portfolio

2.1 Coverage of Industry Verticals

Partnerships through Memorandum of Understandings (MoUs) were established with key industry associations selected as representatives of vertical sectors. Under 5GPPP, partnerships agreements were signed by 5GIA with key associations such as 5GAA (Automotive), 5GACIA (Smart Manufacturing), ECSO (Cybersecurity), PSCE (Public Safety), ESA (Space), ERTICO (Transportation), NEM (Media). Negotiations are undergoing with other sector representatives such as EUTC (Energy) and EBU (Broadcasting) through its 5G MAG (5G Action Group). Most of these became 6G-IA associate members (PSCE is also a Board Member of 6G-IA), strengthening the ties with SNS JU.

Under SNS JU, 6G Health Institute also became a member representing the health sector. New sectors have been addressed, such as Agriculture, thanks to the Alliance for IoT and Edge Computing Innovation (AIOTI). Other sectors are under investigation.

2.2 Previous Cartographies

The vertical engagement task will continue to engage different vertical sectors, which will be associated with SNS JU RIAs' main use cases.

The SNS cartography draws from vertical clustering activities carried out for the Global5G.eu and 6GStart project, where the results of 5G research projects were mapped and published first on 5G-PPP.eu's website and later rebranded with the 6GStart logo and published in a new domain[1].

The analysis aimed to gain a bird's eye view of the selected vertical distribution, including use cases targeting more than one vertical and new scenarios emerging outside the core set of verticals. The results emerged from mapping over a hundred projects funded under the 5GPPP programme. In contrast, the SNS vertical cartography will map and monitor SNS JU RIAs use cases, linking them to relevant vertical sectors. The first version, planned for release by September 2023, will contain results of Phase 1 projects (Streams A, B, C and D) and could be updated in the next phases of SNS JU.

However, while previous in cartographies industry verticals were associated with one or more industry-related icons as the baseline for the vertical clustering and the delineation of relevant use cases, the current version aims to create a direct connection between vertical use cases with relevant associations/initiatives to facilitate possible dialogues and collaborations (see Tool description at Section 3).

2.3 Methodology for the Clustering of Verticals

The process of vertical clustering will primarily arise from the aggregation of diverse datasets, as illustrated below. The initial categorisation, known as industry verticals, will be established using colour-coded criteria that differentiate among various main industry sectors. Additionally, these criteria will combine multiple categories to create new scenarios under the "others" category.

Each industry vertical is associated with one or more icons on the cartography, serving as a baseline for the vertical clustering process, as demonstrated in Figure 1.

[1] https://verticals-cartography.5g-ppp.eu/

Figure 1. Icons associated with vertical sectors in old online verticals cartography

The clustering activity has already commenced through the SNS OPS WP1 survey to SNS JU RIA projects, facilitating the creation of the initial broad vertical clustering process (refer to Appendix 1). However, more specific details, including use cases targeting new verticals, may emerge as updates and monitoring of use cases progress. Furthermore, a more tailored survey among projects is planned for M12 (January 2024) to gather more detailed information about their use cases and targeted vertical sectors.

2.3.1 Preliminary Analysis and Statistical Overview

Projects target an average number of three verticals each. Based on the number of use cases of SNS OPS WP1's internal survey, an ordered list of the targeted verticals from the largest to the smallest has been drafted following a clustering methodology already used in several publications targeting project use cases [5].

- Industry 4.0/Manufacturing (20)
- Media/xR (17)
- Smart Health (14)
- Smart City (13)
- Automotive/Transport/Logistics (12)
- Tourism & Culture (11)
- Security/PPDR (11)
- Smart Agriculture (7)
- Smart Energy (5)
- Education (1)

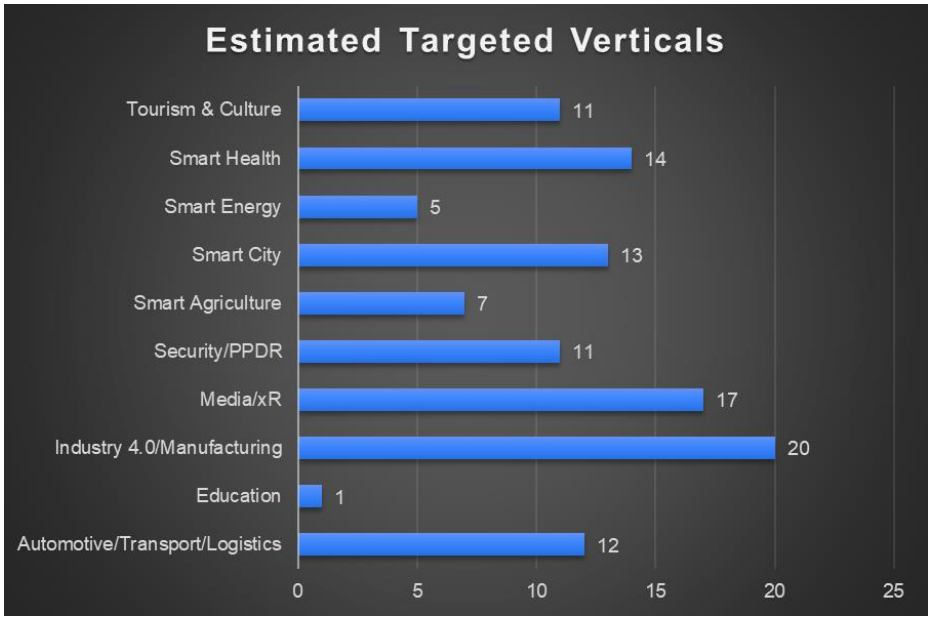

Figure 2. Estimated targeted verticals by project's use cases.

Figure 2 depicts the analysis regarding the addressed use cases per vertical sector. The leading sector, Industry 4.0/Manufacturing, focuses on 20 use cases, revolutionising manufacturing processes with automation, predictive maintenance, and efficient supply chain management. Media/xR follows closely with 17 use cases, redefining media consumption through immersive content and real-time interactive experiences. Smart Health targets improved healthcare with 14 projects, while Smart City integrates advanced technologies in 13 projects for urban living, sustainability, and efficient services. Automotive/Transport/Logistics enhances road safety and enables autonomous vehicles in 12 cases. Tourism & Culture leverages 6G for enhanced tourism experiences in 11 use cases, while security/PPDR ensures public safety and critical infrastructure protection in 11 projects. Smart Agriculture addresses sustainable farming and environmental monitoring in seven projects. Smart Energy focuses on renewable energy and grid management in five projects. Lastly, education explores XR and holographic applications in one project.

In summary, the analysis highlights the significance of Industry 4.0/Manufacturing and Media/xR as the most targeted verticals while also acknowledging the attention given to other sectors such as automotive/transport/logistics, smart city, smart health, and security/PPDR.

2.4 Use Cases and Sectors

The clustering will also gather information on different use cases of SNS JU projects. According to the result of a first internal survey carried out as part of SNS OPS' WP1 tasks, a total of 178 use cases spread across various sectors are targeted by SNS JU RIA projects. These demonstrate the potential of 6G technology to revolutionise industries and enable innovative applications, ranging from manufacturing and healthcare to transportation, security, and communication.

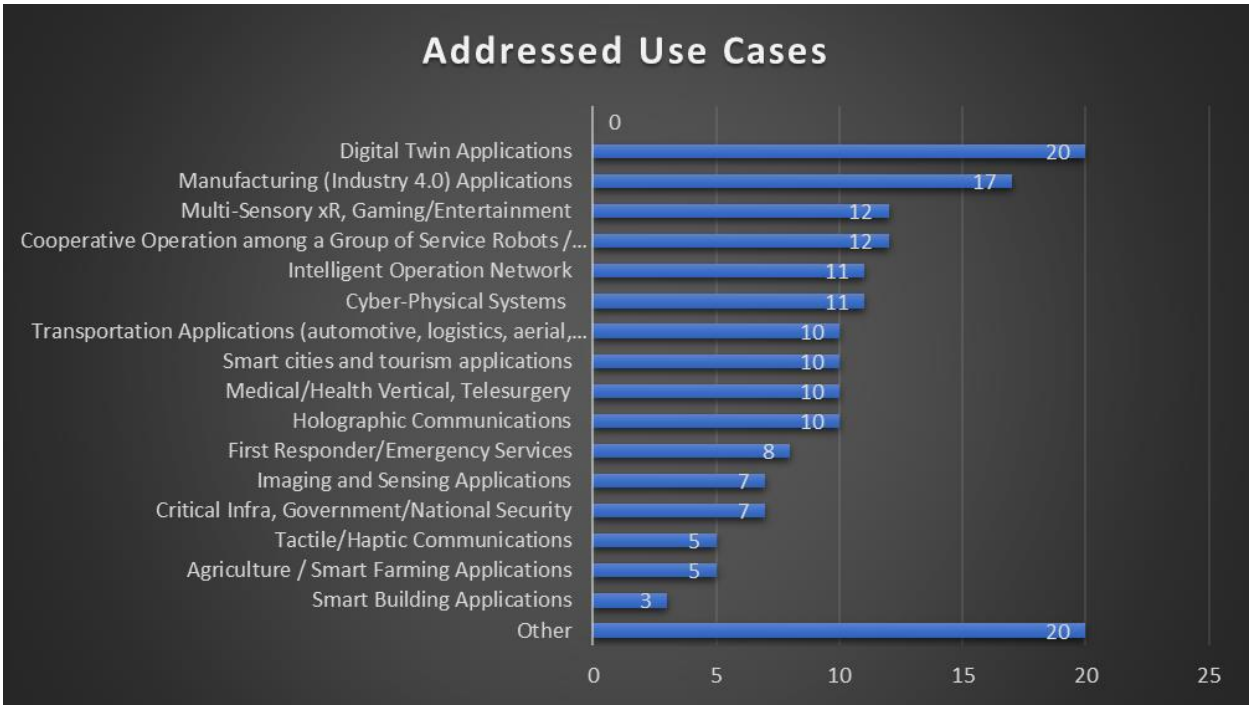

Figure 3. Addressed use cases.

As shown in Figure 3, 20 projects showcase Digital Twin Applications, utilising 6G networks to simulate, monitor, and optimise physical assets or systems. Manufacturing (Industry 4.0) Applications encompass 17 use cases, revolutionising industrial processes with automation, predictive maintenance, and smart supply chain management. Cooperative Operation among a Group of Service Robots/Drones is presented in 12 projects, enabling seamless communication and collaboration. Cyber-Physical Systems and Intelligent Operation Networks have 11 use cases, integrating physical systems and managing network resources intelligently. Holographic Communications, Medical/Health Vertical (Telesurgery), Smart Cities and tourism applications, and Transportation Applications have four use cases targeted by ten projects. Critical Infra, Government/National Security and Imaging and Sensing Applications have seven projects, while Tactile/Haptic Communications and Agriculture/Smart Farming Applications have five projects. Lastly, Smart Building Applications encompass three use cases for energy efficiency and automation through 6G networks.

Twenty extra use cases have emerged aside from the categories provided in the survey. These encompass various applications, as shown in Figure 4.

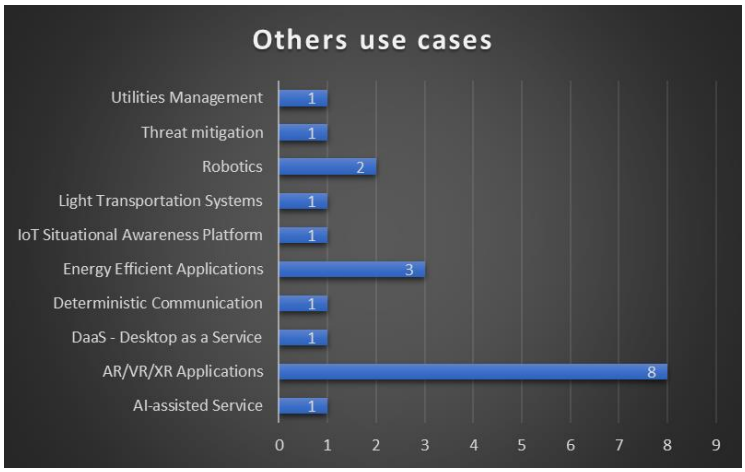

Figure 4. “Others” use cases.

Overall, eight use cases are focused on AR/VR/XR applications, three on energy efficient applications, two on robotics, and one use case each for AI-assisted service, DaaS - Desktop as a Service, deterministic communication, IoT situational awareness platform, light transportation systems, threat mitigation, and utility management.

2.5 Relevant Associations

Relevant associations in key European sectors have also been selected to feature in the Vertical Engagement Tracker to represent their industries at best. Links and logos can be provided for the following associations:

- **5G Automotive Association** (5GAA) is representing the **Automotive** sector. 5GAA[2] is a global, cross-industry organisation of companies from the automotive, technology and telecommunications industries (ICT) working together to develop end-to-end solutions for future mobility and transportation services.
- **European Road Transport Telematics Implementation Coordination** (ERTICO - ITS Europe) is an "intelligent transportation system" (ITS) organisation promoting research and defining ITS industry standards. It connects public authorities, industry, infrastructure operators, users, national ITS associations and other organisations.
- PSCE, the **Public Safety Communications Europe Forum,** is an independent forum where representatives of public safety user organisations, industry, and research institutes discuss and exchange ideas and best practices, develop roadmaps and improve the future of public safety communications.
- The **European Cyber Security Organisation** (ECSO) is a fully independent non-profit organisation aiming to develop a competitive European cybersecurity ecosystem providing trusted cybersecurity solutions.
- The **European Space Agency** (ESA) is Europe's gateway to space. Its mission is to shape the development of Europe's space capability and ensure that investment in space continues to benefit the citizens of Europe and the world.
- The **6G Health Institute** is a privately and publicly funded research institute focused on the interface between communications electronics and medical technology. Its focus is on developing, testing and applying new technologies in healthcare.
- **NEM Initiative / New European Media Initiative** is leading the European Network for Media and Creative Industries. It promotes interaction between Media, Content, Creative industries, Social Media, Broadcasting and Telecom sectors, and Consumer electronics.

Given the 6G potential to create connections with other verticals such as IoT applications or metaverse, further relevant associations (e.g., AIOTI, IoT4SMEs, ARTEMIS) could be added following the evolution of SNS RIAs use cases, or simply industry connections could be added. More details on already-established partnerships are provided in section 4.1.

[2] https://5gaa.org/

3 The Online Tool

The online tool will gather information on the SNS JU RIAs' use-case experiments and vertical sectors addressed. Through a user-friendly interface, it aims to facilitate access to verticals-related use cases by providing easily digestible information to people in the outside world, providing information on how the industry verticals will benefit from R&I advances in the coming years and vice-versa.

3.1 Chronology of Previous Tools

As already mentioned in section 2.2, this online tool draws from previous versions resulting from vertical clustering activities carried out for the Global5G.eu and 6GStart project, where the results of 5G research projects were mapped and published first on 5G-PPP.eu's website and later rebranded with the 6GStart logo and published in a new domain[3].

A complete chronology of versions published thus far is included below:

1. The first online Verticals Cartography (release 1.0) was launched in mid-September 2018 as part of Global5G.org.
2. A second version, or release 2.0, was launched in April 2019, entailing a revamp of the content and layout of the use cases and integrating inputs received from projects (Global5G.org).
3. The third version — release 3.0 — started towards the end of Global5G.org and included the first round of new entries for the integration of phase 3 projects and continuous updates since October 2019 with the inclusion of inputs for the first 5G PPP Trials and Pilots Brochure (FULL5G).
4. Release 4.0 coincided with the competition to select the top ten trials and pilots organised by the Trials WG, also featured in the 5G PPP Brochure 2020 on Trials and Pilots.
5. A final release (5.0) was carried out between December 2022 and January 2023, as the cartography migrated from the Global5G to the 5GPPP website. It was also re-branded with the 6GStart logo, and new surveyed use cases from Phase 3 5G projects were included. More will be added in the following months as the project reaches an end.

3.2 The New Platform

Compared to the previous versions of the Verticals Cartography described above, the Verticals Engagement Tracker will host a dedicated area including an online tool of R&I Results and Services, to enable stakeholders to easily access information on relevant vertical sectors and interact with vertical-related associations. This will allow a big-picture vision, connecting research results with demand and supply in the 5G/6G expanding industry.

Thus, under this new format, the Vertical Engagement Tracker will help mitigate fragmentation risks in the European 5G/6G community by providing a single access point where all SNS JU projects and relevant associations can find a singular engagement channel and interface with each other, both at synergy level and commercial level developing new research partnership and business opportunities.

The platform is envisaged to be an engagement and communication tool for the whole ecosystem. This will be reached through a progressive continuous improvement of the features and services offered, following UX principles and with carefully designed content.

[3] https://verticals-cartography.5g-ppp.eu/

3.2.1 Technical Details

The Vertical Engagement Tracker has been conceived as a continuously updated user-centric platform featuring different search functionalities to enhance the user experience. The platform design and realisation process will be carried out by consortium members Trust-IT and COMMpla, following a structured approach, ensuring optimal outcomes, as depicted in Figure 5. The marketing team initiates the process by creating an initial platform structure and appearance aligned with the project's primary objectives and UX design principles. The graphics team then utilises their expertise to develop an aesthetically appealing mockup, while the technical team contributes to the subsequent implementation and testing stages. Throughout this process, the marketing team provides feedback, and the collaborative Figma software tool for UX/UI design facilitates interactions between the teams during the mockup phases.

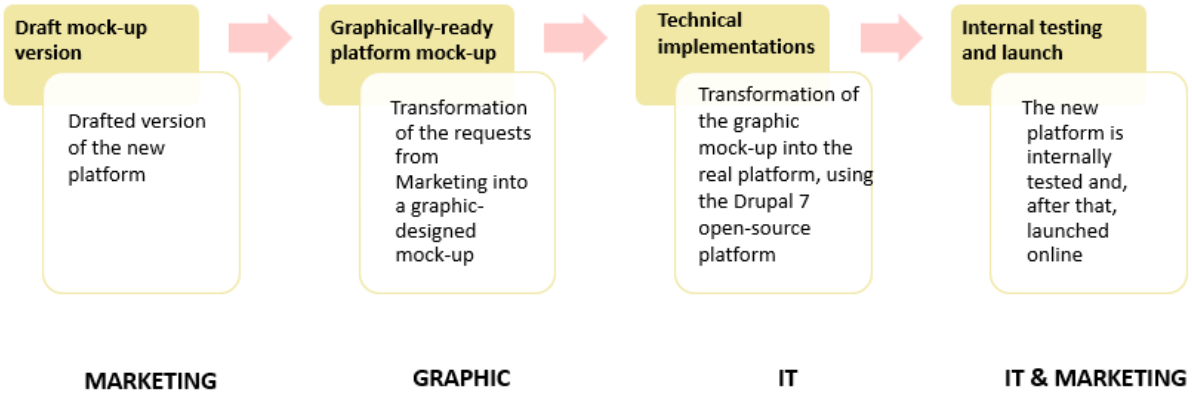

Figure 5. Platform creation internal process.

3.2.2 Wireframes and Mockups

During the design and development process of the new platform, numerous layouts of webpages (or wireframes) have been created, some of which are depicted in the following figures. As part of the platform development, the initial requirements have been transformed into essential concepts to be showcased on the site. The platform's entry page is crucial in conveying the project's assets, goals, and main accomplishments through various means. Once the concept has undergone multiple iterations and received validation and revisions, a mockup will be generated to translate the key message from the wireframe into a user interface (UI). At present, a mockup is being drafted, and simultaneously the online structure is programmed as shown in the images below.

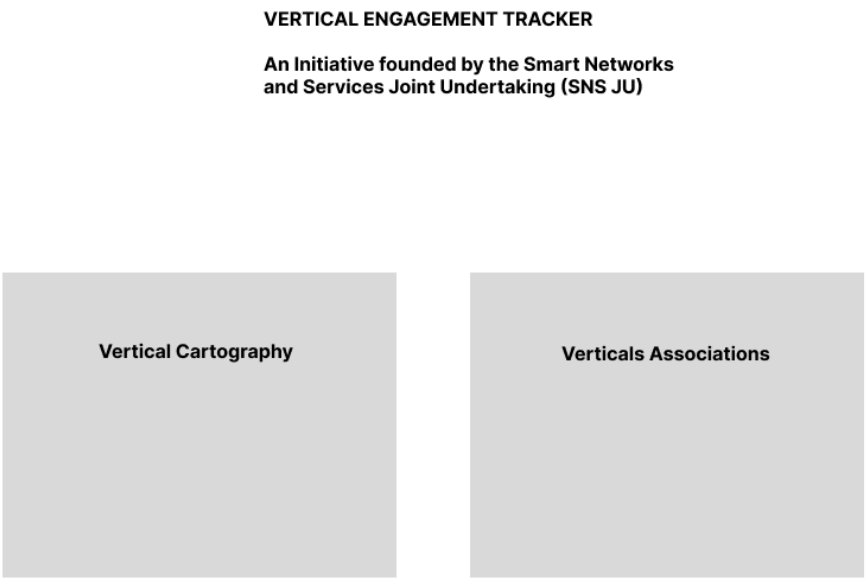

Figure 6. Vertical Engagement Tracker initial page wireframe.

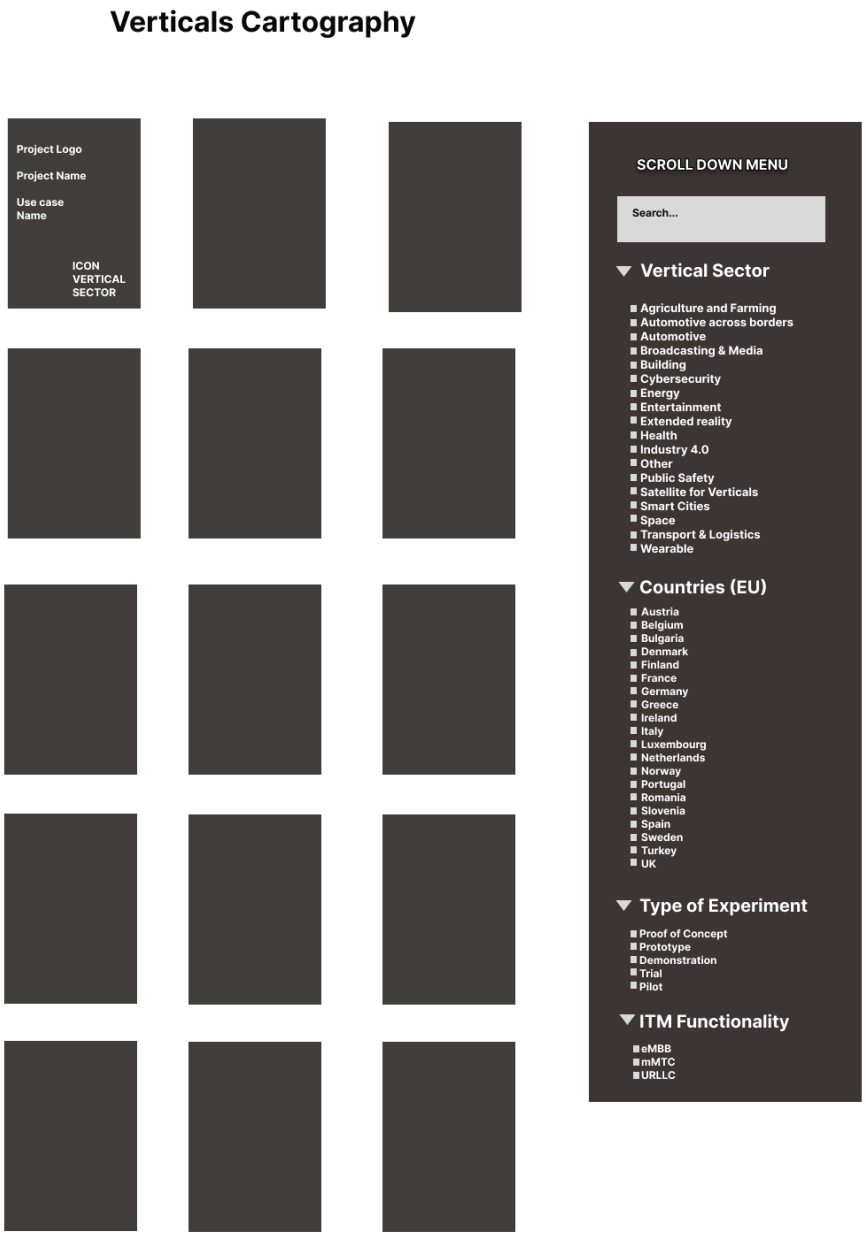

Figure 7. Vertical Engagement Tracker - Verticals Cartography main page wireframe.

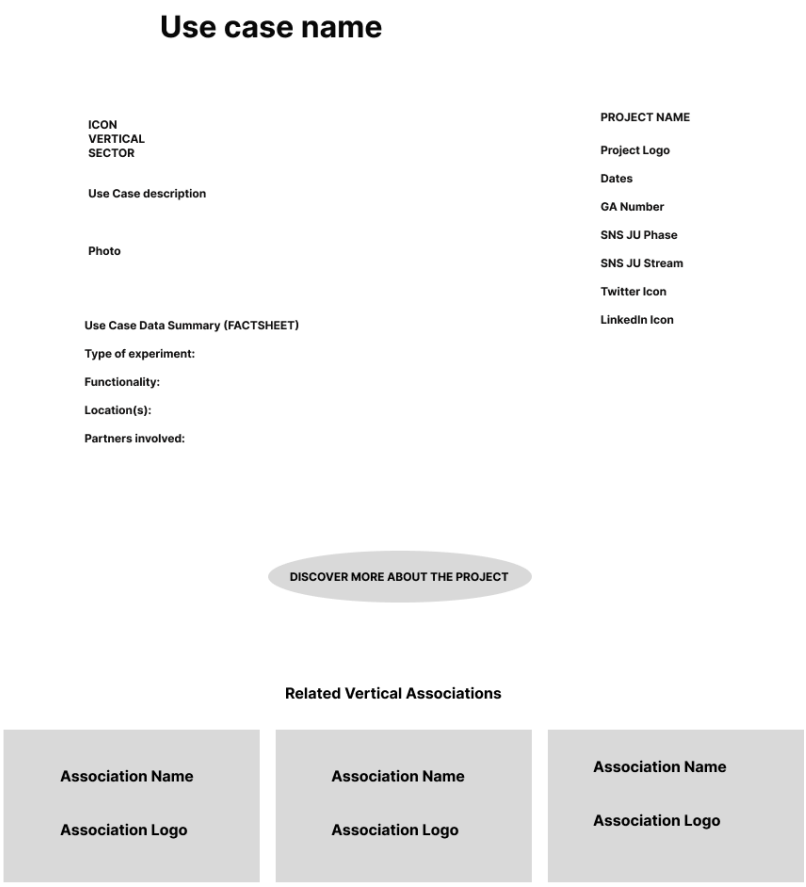

Figure 8. Vertical Engagement Tracker - Verticals Cartography single project details wireframe.

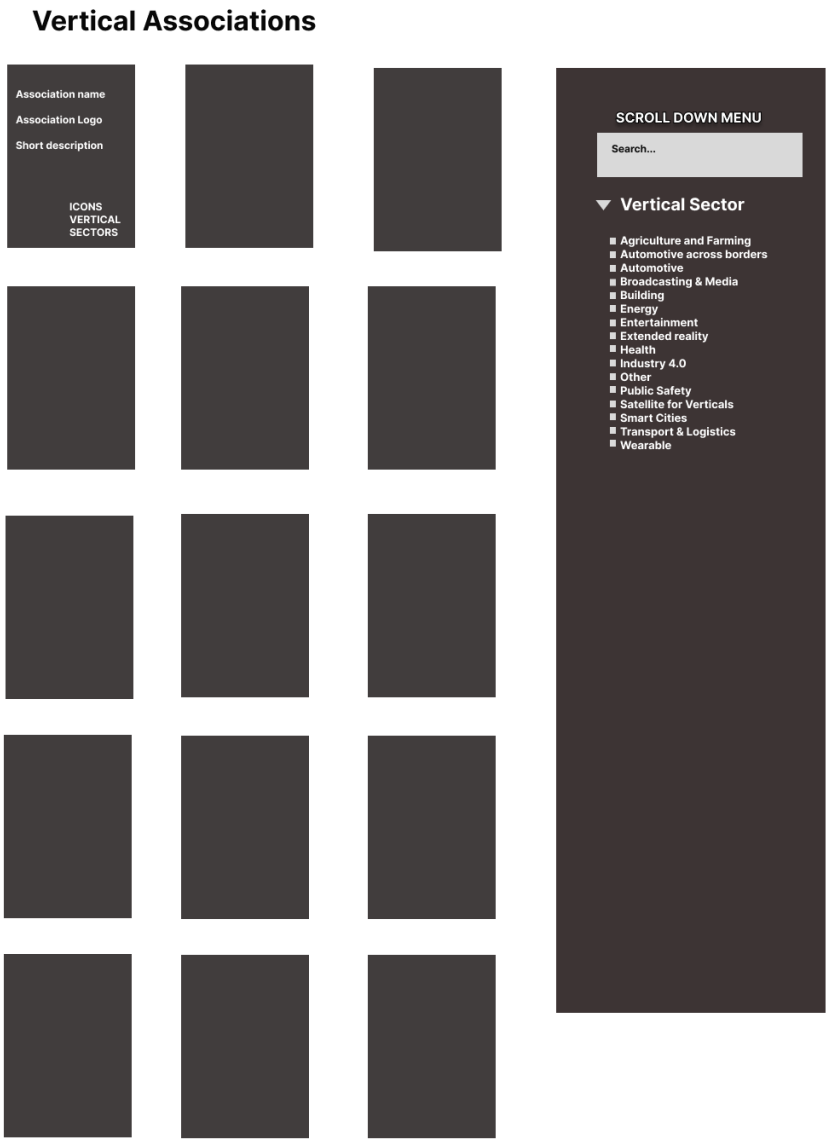

Figure 9. Vertical Engagement Tracker - Vertical Associations main page wireframe.

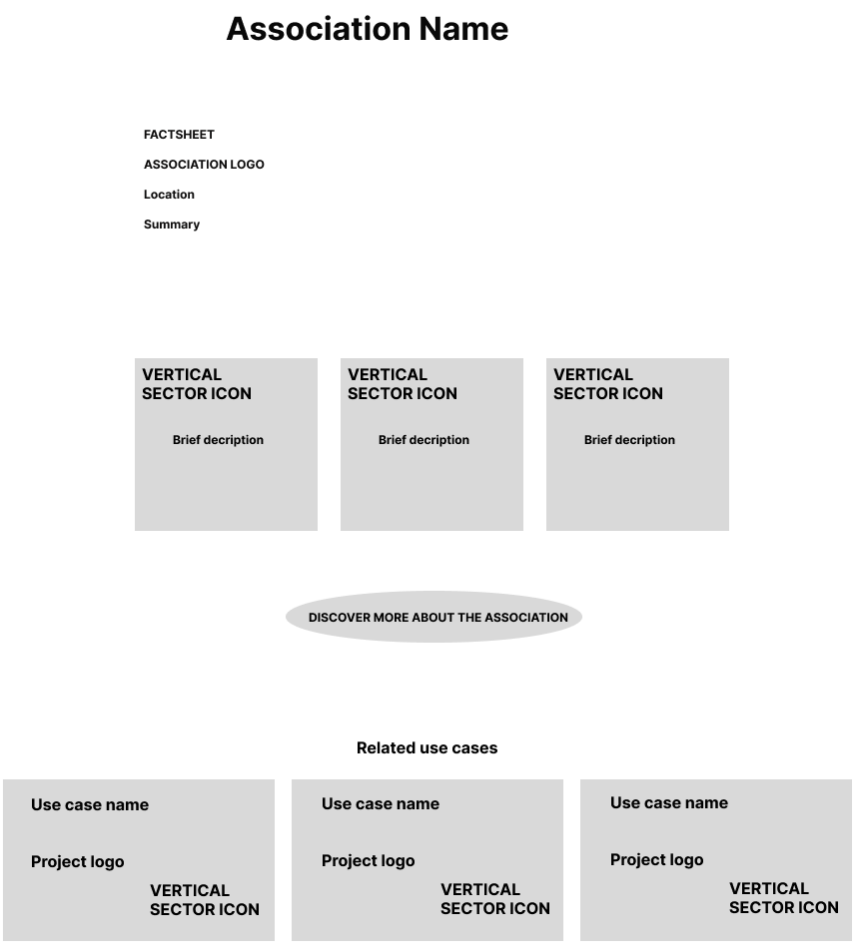

Figure 10. Vertical Engagement Tracker - Vertical Associations single profile detail wireframe.

As shown in the figures above, a first page (Figure 6) will allow platform users to access the use cases' vertical clustering cartography or the list of related vertical associations. Subsequently, users will be redirected to a first catalogue containing details of vertical-related use cases or vertical associations (Figure 7 and Figure 9). A drop-down menu containing different filters will allow users to filter content according to chosen vertical sector or other criteria such as country, experiment type and functionality. By clicking on a specific information card, users will be redirected to a more detailed info page (Figure 8 and Figure 10) containing a fact sheet of the specific use case or association. A content carousel at the bottom of each page will redirect users to related associations or use cases.

3.2.3 Platform Framework

The Vertical Engagement Tracker platform will be built using the open-source content management framework Drupal specifically Drupal 9, the latest version provided [6]. The decision to utilise Drupal was based on its extensive range of functionalities supported by a large and skilled community of developers. This choice was particularly advantageous as it accommodated different user types, provided robust security features, shared selected content by exposing API endpoints, and enabled content reuse and display beyond the website itself.

3.2.4 Platform Tracking

The platform's development will adhere to SEO-driven principles. Monthly tracking of website analytics using Google Analytics will provide detailed statistics on platform visitors and users. Monitoring will be implemented

to ensure platform performance and promptly identify any potential issues, allowing for the implementation of necessary corrective actions. A Matomo profile will be established to track initial data on visitor engagement, including clicks on calls to action and conversions. Following the platform's publication and population, the primary data will be disclosed in forthcoming deliverables and project update reports. Also, the web analytic tool Hotjar will be used to gain valuable insights into user behaviour and interaction on the platform, utilising features such as heatmaps, session recordings, and surveys to optimise the user experience and make informed decisions for improvements [7].

Both Matomo and Hotjar are transparent data tracking tools that prioritise user privacy and adhere to the principles outlined in the General Data Protection Regulation (GDPR). These platforms are based within the EU borders, which enables them to operate in compliance with the strict data protection laws and regulations set by the European Union. By choosing these tools, transparent and responsible user data collection and processing will be ensured, safeguarding website visitors' and customers' privacy and rights.

3.2.5 Platform Maintenance and Administration

The website is maintained and administered by the Trust-IT + COMMpla tech team. They routinely perform the following tasks:

- Hosting management;
- Technical maintenance;
- Monitoring;
- Administrating the root password of the web platform and being in charge of all technical tasks, including updating the security patches of the platform.

The maintenance team is also responsible for designing and implementing all further evolutions of the web platform, adding new functionalities and/or sections upon punctual request and discussion by the SNS ICE consortium and other members of the larger SNS JU community.

3.2.6 Platform Monitoring

The SNS JU Vertical Engagement Tracker's platform instance and database instance are automatically monitored using Uptime Robot, a free service that checks the website's availability and other endpoints [8]. If a failure occurs, the system sends an email notification to alert the Technical team at Trust-IT. Additionally, the notification is distributed through other channels, including the Internal Technical Communication Channel and the personal smartphones of key technical employees at Trust-IT, leveraging third-party webhooks.

3.2.7 Platform Hosting

Trust-IT will host the platform on its virtual servers in AWS (Amazon Web Services). AWS guarantees the servers to be in the Ireland region to maintain all the data in the European Union. The sub-domain will be linked to EURESCOM's hosted domain www,.sns-ju.eu. The Verticals Engagement Tracker sub-domain name is yet to be defined. Two tentative names are https://verticals-tracker.sns-ju.eu and https://verticals-cartography.sns-ju.eu.

3.2.8 Platform Disclaimer

The SNS ICE consortium will not be responsible for the quality of each piece of information published in the Vertical Engagement Tracker, for which each use case retains all rights and obligations towards the end-users.

The Vertical Engagement Tracker is committed to maintaining its users' privacy and data protection, safeguarding personal information, and adhering to applicable data protection regulations, including the European General Data Protection Regulation (GDPR) and other relevant EU standards.

In the interest of transparency and compliance, a dedicated privacy policy page will be created to provide detailed information on how user data is collected, used, stored, and protected. This privacy policy will be specifically tailored to meet the requirements of the GDPR and align with EU standards. The privacy policy will outline the specific data collection practices, purposes, and user rights related to the Vertical Engagement Tracker.

The collected data will be kept for a period not exceeding the achievement of the purposes for which they are processed ("conservation limitation principle", art.5, GDPR) and/or for the time necessary for the obligations of law and EC-funded projects Rules. The verification of the obsolescence of the data stored concerning the purposes for which it was collected is carried out periodically, and obsolete data are erased permanently from the website database.

4 Engagement Strategy

To achieve an effective vertical engagement strategy, relevant partnerships with vertical fora are being established while actively collaborating with national and international vertical initiatives. These strategic alliances enable cultivating productive vertical relationships, creating a detailed mapping of SNS JU initiatives and harnessing the expertise of industry leaders in specific vertical sectors. Aside from partnerships, vertical initiatives are being engaged and vertical events co-organised. These endeavours ultimately aim to facilitate substantive interactions and constructive discussions among key stakeholders, foster meaningful dialogue, ascertain industry requirements, and explore opportunities for innovation and collaboration. By actively engaging with vertical forums and initiatives, it will be possible to create a dynamic environment for knowledge-sharing, align efforts with industry priorities and needs, and ultimately drive the success of the vertical engagement strategy within the SNS JU Programme.

4.1 Partnerships

The partnership strategies with relevant associations are a fundamental component of our approach in the Vertical Engagement Tracker. Each association is carefully selected based on expertise and representation within their respective industries. By collaborating with these associations, meaningful connections and engagements can be established with key stakeholders across various sectors in Europe. This collaboration effectively promotes the SNS JU Programme and its objectives within these industries, raising awareness and fostering a deeper understanding of the program's potential benefits and opportunities. Furthermore, these partnerships provide valuable insights and perspectives from industry experts, enabling the alignment of SNS ICE's vertical engagement initiatives and activities with the specific needs and challenges faced by each sector. Through ongoing collaboration and mutual support, innovation and advancement in the targeted industries can be driven to contribute to the overall success of the SNS JU Programme.

4.1.1 Partnership Map with Verticals Fora

Partnerships with vertical fora were established during 5GPPP and continued under SNS JU. The strategic objective was establishing a two-direction link with verticals to promote 5G and gather unsatisfied needs for 5G and 6G.

Some MoU partners also joined (e.g., 5GAA, ERTICO) while PSCE was elected 6G IA Board Member. The partnership map which is depicted in Figure 11 is constantly evolving and will be upgraded with new partnerships.

Figure 11. Partnership map with vertical fora.

4.1.2 Actions to Implement MoU Agreements

MoU agreements are collaboration frameworks to implement concrete actions. In this context, key events have been identified with vertical partners where 6G-IA high-level speakers have been invited to panels, promoting 5G while gathering unsatisfied vertical needs. Whitepapers and brochures have been edited on vertical use cases and promoted during relevant events such as EUCNC or Mobile World Congress. Partners representatives have been invited to 5GIA (now 6G-IA) Working Groups to foster the exchange of key know-how on its vertical sector. Finally, cross-promotion of key events and whitepapers have occurred on their respective websites and social media accounts for wider dissemination of results and common deliverables.

The current list of MoU partners is listed in Figure 11, while new MoUs are on the radar.

4.2 National/International Vertical Initiatives

As part of the vertical engagement strategy, a significant focus will be placed on mapping and reaching out to national and international initiatives. This approach will enable identifying existing vertical initiatives that align with the goals of the SNS JU Programme and establish collaborations. Actively mapping and engaging with these initiatives will allow them to leverage their expertise, resources, and networks to drive innovation and accelerate the adoption of 6G technologies across various vertical sectors. This proactive outreach will foster stronger connections and capitalise on synergies with vertical initiatives, creating a collaborative ecosystem that amplifies the impact of collective efforts. A more comprehensive list of relevant national and international vertical initiatives is provided in Appendix 3 and Appendix 4, respectively. In the following subsections, detailed examples of some national vertical initiatives are delivered.

4.2.1 Examples of National Vertical Initiatives

4.2.1.1 France

In the context of the France Relance initiative [9], the French Ministry of Economy has launched a set of calls with funding capacities to support the acceleration of 5G development. The French National Initiative is integral to the 'France 2030' recovery plan, which revolves around three core themes: ecology, competitiveness, and cohesion. To transform crucial economic sectors such as energy, automotive, aeronautics, and space, the government recognises the significance of 5G and future telecommunications network technologies as key drivers of competitiveness. This initiative, which started in 2021 under the auspices of the French Ministry of Economy, Finances, and Industrial and Digital Sovereignty, is centrally coordinated by the Directorate-General for Enterprise/Ministry of Economy and Finance in collaboration with other relevant ministries, government agencies, and the national telecoms regulatory authority (ARCEP). Overall, 21 projects of 5G experimental platforms are supported by the program, as shown in Table 1.

Table 1. 5G Projects supported by the program.

Project	Location	Use case
PCN 5G	Romagny-Fontenay	Industry 4.0
Living Labs 5G	Rennes	Industry 4.0, Rail
Smart Water Network	Lannion	Water management
Engage 5G & Beyond	Cesson-Sévigné	Health and Energy
5G4Agri	Angers	Agriculture
5GREEN Mobilité	Angers	Air quality
Dev5G Industrie (HAROPA)	Le Havre	Industry 4.0
5G Calais 4.0	Calais	Industry 4.0
5G Steel	Florange Dunkerque	Industry 4.0
CRIIoT	Paris	Aerospace and rail
PI5G	Gif-sur-Yvette	Industry 4.0
5G-mMTC	Le Pecq	Sport, Energy, Industry
5G Event Lab	Chatillon	Entertainment
5G InnovLab	Nozay	all sectors
5G Vehicules Autonomes	Lyon	Mobility
Batlab 5G	Lyon	Connected building
Agir 5mart	Grenoble	Lightning, waste management
Vertical ISS	Toulouse	Health
5G@CAF	Toulouse	Car manufacture
Perf5GMaritime	Aix en Provence	Maritime

They mainly address the following verticals: Industry 4.0, Rail, Water management, Air Quality, Agriculture, Energy, Sport, Entertainment, Waste Management, Health, Car, Maritime, Public Safety, Mobility, Buildings, and Lightning.

4.2.1.2 The Netherlands

The Netherlands is actively pursuing advancements in 6G through the Future Network Services (FNS) program, which is part of the National Growth Fund. With a proposed budget of €315 million, the FNS program aims to establish a leading position in 6G technology, contributing to the country's long-term economic growth. The core values of digital autonomy, reliability, and sustainability serve as key drivers for the program. The FNS program

focuses on specific areas within 6G, including intelligent radio components and antennas, intelligent networks, and leading applications in key vertical sectors.

To support these objectives, the program is organised into four program lines: Intelligent Components, Intelligent Networks, Leading Applications, and Strengthening the Ecosystem. Each program line has distinct work packages that address various aspects of 6G development, such as transmitters, communication technology, testing, AI-assisted networking, and application demonstrators in vertical sectors like transportation, healthcare, energy, and gaming. Additionally, the program emphasises the importance of ecosystem development through establishing a national 6G testbed, collaboration with policy and regulation, support for startups and SMEs, and international standardisation efforts. The FNS program is expected to begin in the first quarter of 2024 and continue until the fourth quarter of 2029, pending funding approval.

Within the program line 3, focusing on Leading Applications, the FNS program aims to build 6G vertical applications and serve the Dutch market. The main focus areas for this program line are as follows:

- Transport Hubs: will focus on ground-assisted flight control by building programmed heavy payload drones from a centralised location at scale.
- Remote Surgery: will focus on building therapy-assisted modules and collaborative surgery techniques to increase innovation and lifespan.
- Smart Grids: will focus on predictive balancing demand & supply in the access grid to increase power quality and reduce congestion.
- Wireless Detection: will focus on wireless detection of traffic participants to improve mobility and safety.
- 6G Wireless Factory: will focus on hyper digitisation of machines to accelerate innovation & increase the lifecycle of complex machines.
- E-commerce Platform: will focus on monetisation of 6G micro-services channels & sales.
- Digital Sport/XR Gaming: will focus on exercise and gaming for the masses through optical tracking & rendering from 6G edge in combination with slicing.

Several programmes also exist at the regional level, which serve the Dutch verticals in several domains. A few of them are below:

- Innovation Center Connected Solutions (ICSS): The mission of ICSS is to, together with its partners, develop solutions for mobility, energy transition, agriculture, and care from a rural region, using the latest communication technology, to sustainably stimulate quality of life and broad prosperity in the Netherlands.
- Do IOT Fieldlab: Do IOT fieldlab drives the acceleration of innovation in the field of the Internet of Things. The high reliability, fast connections and short response times of 5G make it possible to bring new applications to the market in areas of mobility, logistics, agriculture, health and safety.
- 5G Hub: The 5G Hub is a joint innovation centre of the High Tech Campus, Brainport Development, VodafoneZiggo and Ericsson. The 5G Hub works on possibilities of new technologies, not only in the area of 5G but also in artificial intelligence, virtual reality, augmented reality, blockchain and photonics.

4.2.1.3 Spain

The Spanish national initiative on 6G forms part of the broader Digital Spain 2026 initiative, initiated by the Ministry for Economic Affairs and Digital Transformation as a crucial component of Spain's digital transformation roadmap. Aligned with EU strategies and programs, these initiatives aim to propel the country's digital development at the national, regional, and local levels. Under the updated “España Digital 2026” framework, a budget of up to €31.8 billion has been allocated for 2021-2026, covering diverse digital areas such as research and innovation, technology adoption, deployment, skills, regulation, and other investments. Within this context, this report focuses primarily on national developments related to research and innovation in 6G and selected expansions of 5G technology.

Within the comprehensive framework, the “Boosting 5G Technology” axis, part of the “España Digital 2026” initiative, includes several measures specifically targeted towards 5G and 6G, encompassing research and development efforts. This program aims to achieve digital sovereignty for Europe, support a minimum of 200 R&D&I projects to advance 5G and 6G ecosystems, and position Spain as a centre of excellence in 5G and 6G research and development.

The UNICO R&D 5G Advanced and 6G Program is vital in funding research and innovation projects by public research foundations, Spanish public universities, and private organisations. Its objective is to establish a thriving 5G+6G R&D&I ecosystem that attracts investment, stimulates the emergence of startups, and fosters innovative research and certification companies specialising in in-depth security assessments, audits, and testing of 5G services and equipment. So far, three Calls for Proposals have been launched under the umbrella of the UNICO program. In the 2021 call, 95.2 M€ were invested in 54 projects. Those projects, which build on the results of 5G-PPP calls, are fully aligned with the contents of the SNS R&I Work programmes and the Strategic Research Agenda of NetworldEurope. The target TRL levels are in the 2-4 range, and, because of that, many of them are strongly technology-oriented. However, it is also the aim of this programme to contribute towards the definition of use cases, on the one hand, and the definition and assessment of both general and sectoral or vertical-oriented KPIs (e.g., manufacturing, railroad transport, immersive) on the other. Table 2 below indicates which verticals are addressed by several selected projects funded in the first call of the UNICO R&D 5G Advanced and 6G Program.

Table 2. Mapping of UNICO R&D projects on verticals.

Vertical	Projects
Connected and autonomous mobility (CAM)	SUCCESS-6G, 6GTWINROAD
Smart Manufacturing and Industrial Automation	6GSMART, 6G-EDGEDT, 6G-DATADRIVEN, CHRONOS, MIMBRES, TIMING SP
Metaverse and extended reality	6G-OpenVerso
Digital Twins	6G-EDGEDT, 6GTWINROAD, B5GEMiNI-AIUC
Emergency services	6G-DATADRIVEN
Smart Campus	HEFESTO
Railway	MIMBRES
Media production	DIS-RADIO
Holographic communications and telepresence	Avanzando-5G

The 2022 call, with a total budget allocation of 116 Meuro, comprises two distinctive sub-programmes aimed at (i) Strengthening Research Infrastructures and Scientific Equipment (23 Meuro); and (ii) Research Project in Beyond 5G networks (93 Meuro). The former is mainly targeted at acquiring lab and experimental infrastructure, whereas the latter aims to further consolidate the R&I ecosystem in 6G, along the lines of the 2021 call. Projects in the 3-15 Meuro range were expected, with TRLs in the range of 5-6 (vs. 2-4 in the 2021 call). The projects were awarded in Q2/2023 and are now in their ramp-up phase. As for Call 3, the budget allocation is 62 Meuro (12.9

Meuro for research infrastructures, plus 44.6 Meuro for the R&I ecosystem). Project proposals are currently under evaluation.

In addition, the Spanish Government has awarded two large projects to foster the deployment of 5G networks and services in selected vertical sectors. This includes one project on 5G services and communications for emergency management and civil protection where local/regional public agencies from the city of Madrid and the Extremadura and Valencia regions participate (Royal Decree November 2022; 15 M€), plus another action towards 5G network deployment in logistic areas of the Spanish rail infrastructure manager ADIF (January 2023; 20.5 M€).

4.2.1.4 Italy

Italy's national initiative, known as RESTART: RESearch and innovation on future Telecommunications systems and networks to make Italy smarter, is designed to enhance the country's technological landscape. This program is scheduled to run from 2023 to 2026, with a funding allocation of €118 million and a consortium comprising 25 partners.

The RESTART partnership brings together universities, research centres, companies, and public administrations to undertake various research projects collaboratively. The program encompasses a range of activities, including fundamental and applied research, technology transfer, exploitation of research outcomes, dissemination efforts, support for establishing and growing start-ups and spin-offs, incubation and venture capital initiatives, and targeted training programs. These initiatives address the skills gap between universities and enterprises, particularly emphasising small and medium-sized enterprises (SMEs).

The primary focus of the RESTART initiative is to drive structural improvements in research and development, specifically in leveraging telecommunications in diverse vertical sectors such as agriculture, trade, energy, finance, industry, media, health, security, and transportation. The aim is to strengthen the connection between scientific excellence and business, fostering innovation and practical applications of advanced telecommunications technologies throughout the Italian ecosystem.

According to the initiative’s website, the main verticals the RESTART initiative addresses include: Media/xR, Smart Healthcare, Transport/Logistics, Smart Energy, Smart Agriculture, and Smart Manufacturing/Industry 4.0 [10].

4.2.1.5 Germany

The German national initiative on 6G, the 'Platform for Future Communication Technologies and 6G (6G Platform),' strongly emphasises targeting specific industrial vertical sectors. Its primary goals are to contribute scientifically to the design of 6G and provide scientific-organisational support for implementing the German-European 6G program.

The 6G Platform serves as an umbrella organisation and networking platform for 6G, promoting collaboration with international 6G programs to avoid duplication of work. It fosters matchmaking with other initiatives, harmonises concepts and results for joint dissemination, and builds an innovation network involving SMEs and start-ups. The initiative also focuses on creating a skilled workforce, ensuring acceptance of 6G concepts through bidirectional science communication, and aligning German contributions with UN Sustainable Development Goals.

Within the context of the German initiative, some specific projects focus on verticals. For example, 6G Health mainly focuses on eHealth, 6G-ICAS4Mobility on mobility, 6G-Campus and 6G-CampusSens on campus / private networks for industry. However, there are also the clusters 6GEM, 6G-RIC, Open6GHub and 6G-life which tackle a wider spectrum of things around defined testbeds. These include Media x/R, Smart Manufacturing/Industry 4.0, Smart Energy, and Smart Healthcare.

4.2.1.6 Finland

Within the Finnish research and development landscape, two major initiatives are currently underway: the 6G Bridge and the 6G Flagship.

The 6G Bridge program has the vision to position Finland as a global leader in utilising 5G Advanced and 6G technologies to create value in sustainable industries and societies, such as smart cities, smart energy, smart ports, and smart factories, by collaborating with various ecosystem players. The stakeholders involved in the 6G Bridge initiative include 190 organisations, primarily from the ICT industry, including companies like Nokia and Ericsson, as well as other Finnish initiatives such as 6G Finland, 6G Flagship, 5G Momentum, Allied ICT Finland, Academy of Finland, and Technology Industries of Finland. The program is scheduled to run from January 2023 until the end of 2026, with a planned budget of EUR 130 million for innovation funding.

Similarly, the 6G Flagship initiative is an integral part of the Finnish government's national research spearhead program, which began in 2018 and is set to continue until 2026. The primary objective of this initiative is to develop the essential technological components, tools, and equipment necessary for constructing a 6G Test Network. Additionally, by focusing on verticals such as health, energy, automotive, and industry, the program seeks to gain a deeper understanding of the requirements and integration of these applications within the 6G ecosystem.

According to a preliminary analysis by SNS ICE WP2, the main verticals addressed by these initiatives include Transport/Logistics, Media/xR, Smart Healthcare, Smart Energy, and Smart Manufacturing/Industry 4.0.

4.2.2 Connecting European Facility

The European Commission has supported this program to help the development and deployment of 5G infrastructures in 2 main areas:

- 5G for Smart Communities: CEF Digital supports the early deployment of 5G-based systems that enable use cases for public administrations, healthcare centres, schools and other education and training institutions, so-called socioeconomic drivers.
- 5G Corridors: CEF Digital funds projects providing 5G coverage along major transport paths such as roads, railways and waterways to establish a pan-European transport network of 5G corridors by 2027. These 5G infrastructures will, in turn, enable the roll-out of connected and automated mobility.

In the first call, seven projects were selected for the Smart community domain; they target the following verticals: Education and training, Health, Agriculture, PPDR, Energy, Traffic management, and Smart city.

Moreover, seven deployment projects for the 5G Corridors domain and seven inception studies are covering several use cases targeting rail, road and waterways. They are planning to develop the following services to end users: Intelligent Transport Systems (ITS), Future Rail Mobile Communication System (FRMCS), Critical automatic train control systems and applications (ETCS and/or ATO), Cooperative, Connected and Automated Mobility (CCAM), River Information Service, Multiservice/multi-application 5G Passenger services, Traffic Incident Management (TIM), Road Safety, Traffic efficiency, Driving comfort.

SNS ICE project is working closely with the 5G for Smart Communities (5G4SC) and the GUIDE(Supporting the Strategic Deployment Agendas for the EU Corridors) coordination and support actions which are supporting these projects to capture potential problems or weaknesses that partners will face to fix them in the next 6G network [11].

4.2.3 Digital Innovation Hubs

In the context of the Digital Europe program, Digital Innovation Hubs (DIHs) aim to facilitate the digitalisation of the European Industry in varied sectors. The Smart Connectivity Digital Innovation Hub Network (SCoDIHNet) initiative contributing to the European industry digitalisation through the use of connectivity technologies is supporting DIHs offering smart connectivity technologies to end users covering a number of vertical sectors. The Digital Europe Program has funded one DIH per European region (NUTS2), which has to cover the domains declared by the region at the RIS3 exercise.

SCoDIHNet has conducted a survey among the 93 members in order to get a vision of the domains supported by DIHs. The result is depicted in Table 3.

Table 3. SCoDIHNet survey results.

Application areas (sectors)	Photonics	Nanotechnology and micro/nano electronics	Sensory systems	Additive manufacturing	CPS and IoT	Communication networks	Robotics	Artificial intelligence	Cyber security	HPC and cloud computing	Big data, data analytics, data handling	Virtual, augmented and extended reality	Simulation, modelling and digital twins	Gamification	Software systems	Green ICT	Distributed Ledger Technology	Industrial biotech	
Agriculture and food	3	4	10	6	10	9	5	11	8	9	10	8	9	6	8	7	5	4	132
Maritime and fishery	2	1	4	1	4	4	1	5	5	5	5	4	5	3	5	3	2	2	61
Energy and utilities	3	1	7	3	6	5	3	6	5	5	5	4	4	3	5	5	1	0	71
Construction	0	5	6	6	6	5	4	7	5	5	6	6	7	4	7	6	4	2	91
Wholesale and retail	0	2	6	3	7	5	3	6	5	5	7	6	5	5	4	5	3	2	79
Tourism (incl. restaurants and hospitality)	0	2	6	3	7	4	3	7	5	6	7	5	5	5	4	4	3	2	78
Transport and logistics	1	4	6	4	6	6	3	7	5	6	7	5	5	4	5	4	3	2	83
Financial service sector	0	2	3	2	4	5	3	5	5	4	4	3	4	4	4	3	3	2	60
Public administration	1	3	5	3	9	7	3	9	6	6	9	6	6	5	7	6	3	2	96
Education	2	5	6	7	8	8	5	8	7	6	8	8	6	6	6	7	4	3	110
Life sciences and healthcare	4	5	8	5	8	8	3	10	8	7	10	6	8	4	9	5	4	6	118
Manufacturing consumer products	1	6	9	6	8	8	6	8	6	7	8	6	8	5	7	5	4	3	111
Manufacturing basic materials	2	2	5	3	4	3	3	4	4	4	4	3	4	3	3	3	2	1	57
Manufacturing machinery and equipment	1	5	7	7	8	7	6	8	6	7	8	7	7	5	6	7	4	3	109
Culture and Creative industries	1	3	6	5	7	6	2	6	5	6	7	7	5	4	4	6	4	2	86
Science and research	4	5	9	7	9	8	6	12	8	7	10	7	8	6	8	8	6	3	131
Defence and security	2	1	4	0	3	3	1	4	3	3	4	3	4	2	4	2	1	0	44
Telecommunication and ICT	1	3	6	4	6	7	3	7	6	6	7	7	6	4	6	7	3	2	91
Aeronautics and aerospace	1	2	2	2	2	2	1	3	2	2	3	3	2	2	2	1	1	0	33
	29	61	115	77	122	110	64	133	104	106	129	104	108	80	104	94	60	41	
Number of answers	18																		

Following this survey, this heat map shows that SCoDIHNet members have mainly high competencies in Communication networks, Sensory systems, CPS&IoT, Artificial intelligence and Big Data. SCoDIHNet also covers most verticals to develop digital services needing smart connectivity technologies. In this context, a strong focus is placed on Agriculture, Education, Manufacturing and Science&Research, among others.

4.3 Vertical Engagement Events

SNS ICE WP3 will organise informative workshops dedicated to vertical sectors, focusing on SNS research and standardisation topics as part of the vertical engagement strategy. The aim is to prepare for two upcoming events, Techritory and other relevant conferences such as EuCNC and IAFAs, by promoting SNS-oriented sessions specifically tailored for verticals. Additionally, this task will coordinate the participation of the SNS ICE project in the IAFAs organised by the other CSA project — SNS OPS. This will foster meaningful discussions and exchanges between the SNS community and the vertical industries.

4.3.1 List of Past Events

Following the launch of the 1st call of the SNS JU programme in January 2022, a series of events were organised to present the programme and promote SNS research and pre-standardisation actions across different vertical sectors. First, a public information day was co-organized by 6G-IA, DG-CNECT, and the SNS JU Office, with 462 participants (SMEs, industries, etc.) covering multiple vertical sectors, including Energy, Health, Industry 4.0, Smart Cities, etc. Additionally, the publicly accessible SNS Brokerage platform was established. The SNS JU, as one of the European Partnerships, focused on R&I activities in the ICT domain, establishing partnerships and engagement channels with public and private sectors to position itself in the global 6G research activities by creating contact channels with vertical industries, enhancing mutual beneficial synergies and engagement.

In this context, various events (e.g., presentations, webinars, and keynote speeches) were delivered, and agreements were signed at European and international events to promote SNS JU. A complete list of these events is provided in SNS ICE D4.1. Among these, some featured vertical participation, including:

- Engagement with Horizon Europe National Contact Points, presenting SNS JU opportunities.
- Signing of Memoranda of Understanding (MoUs) with organisations and associations such as IMT-2020 (5G) Promotion Group, Beyond 5G Promotion Consortium - Japan, IMT-2030 (6G) Promotion Group - China, Next G Alliance - North America, and vertical representatives like 5GAA, ERTICO, ECSO, PSCE, NEM, and 5G-ACIA.
- Collaborative agreements with associations/partnerships, including NetworldEurope ETP, AIOTI, ESA, ECC, ETSI, NGMN Alliance, CETIC-NEXT, and AENEAS.

These activities aimed to raise awareness of the SNS JU, foster collaborations, and position Europe as a leading player in defining, providing, and exploiting 6G solutions.

4.3.2 List of Future Events

Regarding future vertical engagement events, the SNS ICE partners have devised an ambitious plan to widely disseminate the SNS JU goals, structure, projects, and outcomes to the European and International communities, focusing on promoting cross-sectoral vertical engagement for the SNS JU Programme. Through active participation and organisation of future events, the partners aim to maximise the impact of the SNS JU project results and gather feedback and trends from diverse stakeholders.

A full list of targeted events initially published in SNS ICE Deliverable D4.1 is available in Appendix 5. However, this initial list of targeted events within the SNS-ICE project will be continuously updated to ensure comprehensive coverage and facilitate meaningful engagement with academia, industry, and various verticals. Specifically, the 5G Techritory forum in 2023 and 2024 and side event organisation will serve as key platforms for promotion and communication activities aligned with the forum's communication plan, including organic marketing, media publications, PR campaigns, and multi-channel event promotion. A detailed communication plan dedicated to the 5G Techritory forum and its related activities will be developed in the year's second quarter.

5 Envisioned Impacts and Next Steps

During the initial analysis conducted from M01-M06, 178 use cases were identified and categorised into 11 distinct vertical sectors. A new online tool called the Vertical Engagement Tracker has been meticulously planned to further refine the mapping and vertical clustering of the SNS JU RIA's (Specific Grant Agreement Joint Undertaking Research and Innovation Actions) use cases. This tool aims to provide a more precise and comprehensive overview of the use cases within their respective vertical categories.

In addition to the improved mapping capabilities, the latest version of the tool will include direct associations with relevant verticals and establishing official partnerships with pertinent associations (refer to Appendix 2) where applicable. The list of associations is expected to expand as national initiatives come into play, alongside engagement events scheduled for the upcoming months, including dedicated workshops at EuCNC 2023 and Techritory 2023.

Following the online launch of the Vertical Engagement Tracker, a detailed survey will be distributed among SNS JU RIA projects. This survey will gather in-depth information about their specific use cases and the vertical sectors they address, enabling a more comprehensive analysis and mapping of the results and impacts stemming from the SNS JU RIA's use case experiments.

Furthermore, the annual competition organised by the 6G-IA Trials Working Group will continue to play a vital role in disseminating the results of the SNS JU RIAs. This ongoing initiative will enhance awareness and understanding of the outcomes achieved.

Finally, another important aspect of our future vertical engagement strategy will be continuously establishing partnerships and organising vertical engagement initiatives and events. These efforts will foster collaboration, exchange knowledge, and identify new opportunities within the vertical sectors. While partnerships with relevant associations have already been established, more will follow to strengthen our connections with key industry sectors. Furthermore, dedicated workshops at EuCNC 2023, Techritory 2023 and other events have promoted and will keep promoting vertical engagement in the next months to promote 6G solutions across industrial sectors. These initiatives and events will enhance awareness, facilitate collaboration, and expand our reach within the vertical communities. In this context, the upcoming launch of the Vertical Engagement Tracker will reinforce engagement, providing a comprehensive overview.

Together, these actions will enable the comprehensive mapping of the societal, economic, and environmental impacts generated by the RIAs' use cases while also facilitating the identification of potential business opportunities. The collected and relevant results will feed into a gap analysis, providing valuable insights into new vertical sectors that innovative 6G applications can target. Additionally, this process will enrich the taxonomy of the Vertical Engagement Tracker, ensuring its continuous development and effectiveness in capturing the evolving landscape of vertical engagements.

6 References

[1] See the SNS JU website here https://smart-networks.europa.eu

[2] See https://verticals-cartography.5g-ppp.eu/ and https://global5g.5g-ppp.eu/cartography.

[3] For future scenarios posed by 6G applications, see 5G-PPP Architecture WG Whitepaper "The 6G Architecture Landscape European Perspective", 2023.

[4] About 5G functionalities see ITU-R M.2083, "IMT Vision - Framework and overall objectives of the future development of IMT for 2020 and beyond," 2015 and ITU-R M.2410, "Minimum requirements related to technical performance for IMT-2020 radio interface(s)", 2017.

[5] See the latest iteration in the 5G-PPP TMV WG White paper "5G PPP Trials Results 2022 Key Performance Indicators measured in advanced 5G Trial Sites", 2023.

[6] Learn more about Drupal Open-Source CMS at https://www.drupal.org/.

[7] Learn more about this service at https://www.hotjar.com/.

[8] Learn more about this service at https://uptimerobot.com/.

[9] Learn more about this initiative at https://www.diplomatie.gouv.fr/en/french-foreign-policy/economic-diplomacy-foreign-trade/promoting-france-s-attractiveness/france-relance-recovery-plan-building-the-france-of-2030/

[10] Learn more about the RESTART initiative at https://www.fondazione-restart.it/.

[11] Learn more about the GUIDE project at https://guide.5gcorridors.eu/.

Appendix 1

Table 4. SNS JU RIAs' use cases targeted vertical sectors.

Project	Vertical #1	Vertical #2	Vertical #3	Vertical #4	Vertical #5	Vertical #6	Vertical #7
BeGREEN	Smart Energy						
5G-STARDUST	Security/PPDR	Media/xR	Automotive/Transport/Logistics	Smart Health			
SEASON	Media/xR						
6Green	Security/PPDR	Industry 4.0/Manufacturing	Smart Health	Smart City	Tourism & Culture		
VERGE	Automotive/Transport/Logistics	Media/xR					
NANCY	Media/xR	Industry 4.0/Manufacturing					
ACROSS	Smart Health	Industry 4.0/Manufacturing	Smart Agriculture	Security/PPDR	Media/xR	Smart Energy	
DETERMINISTIC6G	Industry 4.0/Manufacturing	Media/xR	Smart Agriculture				
ADROIT6G	Smart Health	Security/PPDR	Industry 4.0/Manufacturing	Media/xR	Automotive/Transport/Logistics		
DESIRE6G	Industry 4.0/Manufacturing	Media/xR					
PREDICT-6G	Smart Health	Security/PPDR	Industry 4.0/Manufacturing				
TERA6G							
TERRAMETA	Industry 4.0/Manufacturing	Smart City	Tourism & Culture				

Project	Vertical #1	Vertical #2	Vertical #3	Vertical #4	Vertical #5	Vertical #6	Vertical #7
6GTandem	Smart Health	Industry 4.0/Manufacturing	Media/xR	Automotive/Transport/Logistics	Smart City		
CENTRIC	Industry 4.0/Manufacturing	Media/xR					
TIMES	Industry 4.0/Manufacturing	Smart City	Automotive/Transport/Logistics	Smart Health			
FLEX-SCALE	Security/PPDR	Industry 4.0/Manufacturing					
ETHER	Automotive/Transport/Logistics	Smart Agriculture					
6G-NTN	Smart Health	Security/PPDR	Automotive/Transport/Logistics	Smart Agriculture	Smart City	Tourism & Culture	
SUPERIOT	Smart Health	Industry 4.0/Manufacturing	Smart City	Tourism & Culture	Smart Agriculture		
CONFIDENTIAL6G	Industry 4.0/Manufacturing	Automotive/Transport/Logistics					
RIGOUROUS	Security/PPDR	Smart Health	Smart City	Tourism & Culture			
HORSE	Media/xR	Smart City	Tourism & Culture				
PRIVATEER	Automotive/Transport/Logistics	Smart City	Tourism & Culture				
HEXA-X II	Smart Health	Industry 4.0/Manufacturing	Media/xR	Automotive/Transport/Logistics	Smart City	Smart Energy	Tourism & Culture
6G-SHINE	Industry 4.0/Manufacturing	Media/xR	Education				
6G-SANDBOX							

Project	Vertical #1	Vertical #2	Vertical #3	Vertical #4	Vertical #5	Vertical #6	Vertical #7
6G-BRICKS	Industry 4.0/Manufacturing						
6G-XR	Smart Energy						
TARGET-X	Industry 4.0/Manufacturing	Automotive/ Transport/Logistics	Smart City	Tourism & Culture	Smart Energy		
TrialsNet	Smart Health	Security/PPDR	Media/xR	Industry 4.0/Manufacturing	Automotive/ Transport/Logistics	Smart City	Tourism & Culture
FIDAL	Smart Health	Security/PPDR	Media/xR	Smart City	Tourism & Culture		
IMAGINE-B5G	Smart Health	Security/PPDR	Media/xR	Industry 4.0/Manufacturing	Smart Agriculture		

Appendix 2

Table 5. Vertical associations' targeted vertical sectors.

Association	Vertical Sector	Partnership status
MoUs/LoIs – ESA	Space	Established
PSCE	Public Safety	Established
ECSO	Cybersecurity	Established
NEM	Media	Established
5GAA	Automotive	Established
5G ACIA	Smart Manufacturing	Established
ERTICO	Transportation	Established
ECSO	Cybersecurity	Established
6G Health Institute	Health	Established
EBU/5G MAG	Media	Ongoing negotiations

Appendix 3

Table 6. Initial mapping of European national initiatives working to develop 6G-related use cases across multiple vertical sectors.

Initiative	Country
Future Network Services	Netherlands
España Digital 2026	Spain
6G Flagship	Finland
6G Bridge	Finland
6G Platform Germany	Germany
6GEM (6G research hub)	Germany
6G-RIC (6G research hub)	Germany
Open6GHub (6G research hub)	Germany
6G-life (6G research hub)	Germany
5G et réseaux du futur	France
Restart	Italy
CONNECT	Ireland

Appendix 4

Table 7. Initial mapping of international initiatives working to develop 6G-related use cases across multiple vertical sectors.

Initiative	Country
IMT-2020 (5G) Promotion Group	China
IMT-2030 (6G) Promotion Group	China
5G Forum	Korea
5G MF	Japan
5G Americas	Northern/South America
Telebrasil - Projeto “5G Brasil”	Brazil
ENCQOR	Canada
TSDSI	India
Beyond 5G Promotion Consortium	Japan
Next G Alliance	North America
TSDSI	India
Trade and Technology Council	EU-US
Industry Technology Research Institute (ITRI)	Taiwan

Appendix 5

Table 8. Past and future targeted events/activities involving verticals targeted by SNS ICE.

##	Targeted Event / Activity	Date / Location	Involved SNS-ICE partner	Target Audience
International Events				
1	IEEE International Conference on Communications	May 2023, Rome Italy	6G-IA	IETF, ITU, Vertical sectors, 5G Americas
2	5G Techritory	October 2023, Riga Latvia	VASES, 6G-IA, NSN	European National Initiatives, EUREKA, CEF, IMT-2020, NGMN
3	Global5G event (Global6G)	October 2023	NSN, 6G-IA	5G Americas, 5G Forum, IMT-2020 KDT. HPC
4	IEEE Globecom 2023	December 2023, Kuala Lumpur Malaysia	6G-IA, TIM, NSN	KDT, HPC, Photonics, CCAM, AI & Robotics
5	IEEE Wireless Communications and Networking Conference	April 2024, Dubai EAU	CTTC	5G Americas, 5G Brasil, 5G Forum, IMT-2020. TSDSI
European Events				
6	ETSI Research Conference	February 2023, Sophia-Antipolis France	6G-IA, TNO, NSN, TIM	ETSI, 3GPP, IETF, ITU, European National Initiatives
7	IEEE Wireless Communications and Networking Conference	March 2023, Glasgow Scotland	CTTC	5G Americas, 5G Brasil, 5G Forum, IMT-2020. TSDSI
8	INTERACT COST ACTION (on AI for 6G et al.)	May 2023, Barcelona Spain	CTT	AI for Robotics, Smart factories, Industry 4.0
9	EuCNC & 6G Summit 2023	June 2023, Gothenburg, Sweden	6G-IA, EURESCOM, NSN, TIM, TNO, CTTC	European National Initiatives, EUREKA, CEF, 5GAA, 5G-ACIA, ESA, NGMN, PSCE
10	German national initiative workshop	June 2023, Germany	TNO	European National Initiatives, EUREKA, ScoDIHNet
11	Fraunhofer FuSeCo forum	September 2023, Berlin Germany	TNO	KDT, HPC, CCAM, AI & Robotics, 3GPP, ETSI. Industry 4.0
Vertical Events				
12	PSC Europe Conference	May 2023, Athens Greece	TIM	PSCE, 3GPP

13	ITS Congress	May 2023, Lisbon Portugal	TIM	Automotive, Transport, 5GAA, CCAM
Other Relevant Activities				
14	Collaboration & Info Day with ESA 5G/6G Hub	March 2023, Online	6G-IA, TIM	ESA
15	MoU between 6G-IA and the 6G Platform Germany	June 2023 (@EuCNC)	6G-IA	European National Initiatives, EUREKA, ScoDIHNet
16	Where 5G leaders meet	May 2023	CTTC	Technology professionals, senior executives, vice presidents, directors, department heads, broadcasters and service providers.