Smart Networks and Services International and European Cooperation Ecosystem

D2.1 Identification of European 6G R&I stakeholders and trends

Document Summary Information

Start Date	01/01/2023	**Duration**	27 months
Project URL	https://smart-networks.europa.eu/csa-s/#SNS-ICE		
Deliverable	D2.1 Identification of European 6G R&I stakeholders and trends		
Related Work Package	WP2	**Related Task**	T2.1, T2.2, T2.3
Contractual due date	31/12/2023	**Actual submission date**	31/12/2023
Resubmission date	19/09/2024		
Type	Report	**Dissemination Level**	Public
Deliverable Editors	Toon Norp (TNO), Prachi Sachdeva (TNO), Kostas Trichias (6G-IA)		

This project has received funding from the Smart Networks and Services Joint Undertaking (SNS JU) under the European Union's Horizon Europe Research and Innovation programme under the Grant Agreement No 101095841

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Revision history (including peer reviewing & QA)

Version	Issue Date	% Complete	Changes	Contributor(s)
v0.1	17/10/2023	1%	Draft ToC to be discussed among partners	Toon Norp (TNO), Prachi Sachdeva (TNO)
v0.2	08/11/2023	40%	Input to Section 2, Section 3, Section 4	Toon Norp (TNO), Prachi Sachdeva (TNO)
v0.3	25/11/2023	60%	Input to Section 2, Section 4	Kostas Trichias (6G-IA)
v0.4	08/12/2023	80%	Review of photonics section, Section 2.8, addition of information on HiPEAC	Werner Mohr (6G-IA office)
V0.5	19/12/2023	90%	Review, edits, and comments	Mauro Renato Boldi (TIM), Carles Anton (CTTC)
V1.0	15/01/2024	100%	Incorporating feedback and finalizing draft	Toon Norp (TNO), Prachi Sachdeva (TNO)
V2.0	15/09/2024	100%	Incorporating feedback from Period 1 review	Toon Norp (TNO), Prachi Sachdeva (TNO), Maria Raftopoulou (TNO), Kostas Trichias (6G-IA), Claudio de Majo (Trust-IT)

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Table of Contents

List of Figures

List of Tables

Abbreviations List

Abbreviation / Term	Description
3GPP	3rd Generation Partnership Project
5G-PPP	5G Public Private Partnership
5GA	5G Advanced
6G-IA	6G Smart Networks and Services Industry Association
AI	Artificial Intelligence
B5G	Beyond 5G
CEF	Connecting Europe Facility
CFP	Call For Proposals
CSA	Coordination and Support Action
EM	Electro Magnetic
ERDF	European Regional Development Funds
EU	European Union
FNS	Future Network Services
ICE	International and European Cooperation Ecosystem
ICT	Information and Communication Technology
KPI	Key Performance Indicator
NI	National Initiative
NTN	Non-Terrestrial Networks
R&D	Research and Development
R&D&I	Research and Development and Innovation
R&I	Research and Innovation
RCoF	Research Council of Finland
RESTART	RESearch and innovation on future Telecommunications systems and networks, to make Italy more smART
SDG	Sustainable Development Goals
SME	Small and Medium Enterprise
SNS	Smart Networks and Services
SNS JU	Smart Networks and Services Joint Undertaking
STEM	Science, Technology, Engineering and Mathematics
TRL	Technology Readiness Level
UN	United Nations

1 Introduction

Within the Horizon Europe Smart Network and Services (SNS) programme, the SNS ICE project is a CSA that amongst others has the goal to establish collaboration within Europe between different national and European initiatives. To that aim, is a fluid exchange of information, plans and priorities to enable a better understanding of activities among the involved stakeholders and to potentially enable a better alignment of plans is needed. As a first step to establish such dialogues, the SNS ICE project has established contacts with several national and EU initiatives. As a second step, specific information was collected on seven large national initiatives in the EU member states, via desk research and structured interviews. As a third step, SNS ICE initiated discussions on ways to improve collaboration between (i) the SNS programme and the national initiatives, and (ii) among the different national initiatives themselves. This resulted in a set of three actionable collaboration lines that SNS ICE recommends being adopted.

In chapter 2, this report first gives an overview of the different activities that SNS ICE has done in 2023 to foster collaboration and exchange of information between different 6G initiatives in Europe. Subsequently in chapter 3, the report provides an overview of the seven large national initiatives in the European member states. Finally in chapter 4, the report provides an overview and recommendations of possible collaboration actions.

2 Establishing collaboration in Europe

2.1 Introduction

The Horizon Europe Smart Network and Services (SNS) R&I programme has an earmarked budget (900 MEuro of European funding over the period 2021-2027 with at least the same contribution from industry) dedicated to the development of 6G. In addition to the SNS R&I programme, in several countries in Europe large national 6G initiatives have also started with a combined funding budget of almost 2.5 BEuro. On top of that, there exist also other EU initiatives that focus on other areas but that are related to 6G. From the perspective of the SNS R&I Programme, which has the goal to facilitate and develop industrial leadership in Europe in 5G and 6G networks and services, it makes sense to investigate what these other initiatives are doing and what can be done to increase collaboration among them.

The SNS ICE project has carried out several activities in 2023 to foster collaboration between 6G related initiatives within Europe, by creating contacts, organizing sessions and panels on collaboration, attending events and meetings, etc. The remainder of this chapter gives an overview of what SNS ICE has done in 2023.

2.2 Creating a list of contacts

In order facilitate exchange of information and alignment of priorities, the SNS ICE project undertook the task of establishing contacts with the different national and EU initiatives. It was important to identify the key people within the initiatives and their specific roles so that it becomes easy to exchange information at the different levels. SNS ICE organized those contacts into four main categories based on of the roles they play within their respective initiatives, namely, – governmental contact, organizational contact, technical contact, and a liaison with the SNS. A governmental contact within the national initiative could be, for example, a representative of the Ministry that directly funds the initiative which is involved within the programme. An organizational contact is the person that is involved in the overall organization of the initiative, such as a programme manager. The technical contact person is one that can be contacted to understand the technical scope of the programme and different topics covered within, and this could be someone like a technical programme lead. Lastly, several key people within national and EU initiatives are also involved in SNS projects, such as the SNS ICE and the SNS Ops. These people are well connected to both sides and hence can act as ambassadors for the national initiatives within the SNS projects and ease the exchange of ideas and information. Such contacts have been categorized as liaisons with the SNS.

For each contact person, we collected their name, role in the programme, organization they represent, and their contact details such as phone number and email address. This information was collected with their explicit permission and they were asked to confirm that they had no concern about having this information shared with others too. The overall process resulted in a holistic overview of the key contacts within the national initiatives that are covered in this document and within other EU initiatives as well.

2.3 Organization of panel session on European collaboration at EUCNC'23

At the EuCNC & 6G Summit in Gothenburg, SNS ICE organised a panel session on collaboration with verticals and with European initiatives. Within the session two separate panel discussions were held. One of these was devoted to European collaboration, which included the panellists presented in Table 1.

Table 1: Panelists at panel session on European collaboration

Name	Topic
Nadje Rohrback	KDT Key Digital Technologies
Mohand Achouche	Photonics 21
Prof. Dr. Hans D. Schotten	German 6G program
Prof. Ari Pouttu	6G Flagship
Marc Jamet	French Acceleration Strategy on 5G/6G and Future Telecom Networks
Jos Berière	Future Network Services

Each panelist introduced the initiative he was representing and discussed their views on European collaboration on 6G. A snapshot of the session which was moderated by Toon Norp (TNO) from the SNS ICE project is depicted in Figure 1.

Figure 1: Panel on European initiatives.

2.4 SRG session at EUCNC

During the EUCNC held in Gothenburg in June 2023, SNS ICE organized a brainstorming session with the State Representative Group of the EU Member States as well as representatives from the national initiatives. The first part of the session included presentations from the speakers presented in Table 2, while a snapshot of the event is depicted in Figure 2.

Table 2: List of presenters at the SRG session at the EUCNC 2023

Name	Topic
Toon Norp	Objectives and goals of the session, Overview of National Initiatives
Marc Jamet	Perspective on collaboration from French National Initiative
Prof. Dr. Hans D. Schotten	Perspective on collaboration from German National Initiative
Kari Leino	Perspective on collaboration from the Finnish 6G Bridge

Figure 2: SRG session at the EUCNC 2023

The second part of the session comprised of two brainstorming sessions in small groups of 6-7 people. The discussion topic for the first brainstorm was the identification of goals that can be achieved through European collaboration. Since each group included representatives from different member states as well as different national initiatives, it resulted in a balanced discussion bringing forth several points of view. The results of the first brainstorming were used to structure the second one, and each group had to discuss potential ways in which the goals they had previously identified could be achieved. Each group was then asked to present the main results, and following to this, the overall key takeaways were identified.

This session was organized in such a way that it preceded a scheduled regular meeting of the State Representative Group. The key takeaways of this session were presented in the SRG meeting afterwards, and these have also been recorded in the annex of this document. The suggestions and action points from the session have been taken onboard and have been elaborated upon in the section 3 of this deliverable on European Collaboration.

2.5 Signing of a Memorandum of Understanding with the German national initiative

During the 2023 EUCNC & 6G Summit event which took place in Gothenburg, Sweden on June 6th - 8th, 2023, the SNS ICE partners organized a convened session entitled "*A European collaborative initiative with a strong vertical impact on a global level*". The purpose of this convened session was to present to the community the SNS strategy and the envisioned European and Global collaboration framework and kick off the discussion among a) activities taking place mainly at European level (i.e., national initiatives and related Horizon Europe Partnerships) and b) Vertical users.

In this session, a Memorandum of Understanding (MoU) was signed between the 6G Smart Networks and Services - Industry Association (6G-IA), coordinator of the SNS ICE project, and the German National Initiative on future communication technologies and 6G (6G Platform)[1]. The goal of the MoU is to strengthen the collaboration between the SNS JU and this national initiative and to jointly address the upcoming challenges of 6G R&D. The MoU was signed by the Chairman of the Board of the 6G-IA, Dr. Colin Willcock and by the 6G Platform Director Dr. Hans Schotten. Figure 3The moment in which the MoU was signed is portrayed in Figure 3.

Figure 3: Signing of the MoU between the 6G Platform (Germany) and the 6G-IA.

[1] https://www.6g-platform.com/

2.6 Organization of a co-creation event at 5G Techritory 2023

At 5G Techritory 2023, the SNS ICE project organized a co-creation event titled "*National Initiatives: discussion on different approaches to European collaboration for 6G research*". Its goal was to explore opportunities for collaboration among the various national initiatives working on 6G in Europe. The workshop was by-invitation only, with some 20 attendees from different national initiatives, the SNS Office, the SNS State Representative group, several SNS projects, and other organizations involved in European 6G collaboration. The workshop was a continuation of earlier SNS ICE activities aimed at establishing collaboration between different national initiatives, such as the event organized at EUCNC'23 and the preparation of an overview report of 7 large national initiatives in EU member states.

The workshop started with several presentations to give different perspectives on collaboration and provide suggestions on collaboration topics. Table 3 shows the list of presenters, their affiliation, as well as the title of their presentation:

Table 3: Presenters at the 5G Techritory co-creation workshop on European collaboration

Name	Affiliation	Title
Chiara Mazzone	Programme Officer, Smart Networks and Services JU	National Initiatives discussion on different approaches to European collaboration for 6G Research - An EU-wide perspective
Toon Norp	SNS ICE WP2 European Collaboration	National Initiatives: Report and lessons learned
Paul Wijngaard	FNS program board, Alliance Director	6G Future Network Services (Dutch National Initiative)
Pekka Rantala	Head of 6G Bridge Programme	FINLAND | 6G Bridge Programme Perspectives
Xavier Priem	CELTIC-NEXT Director	CELTIC-NEXT | contribution & offer
Kostas Trichias	6G-IA, SNS ICE Project Coordinator	SNS-ICE & National Initiatives
Carles Antón Haro	Member of the 6GIA Board – Chair SWG Member State Initiatives	Smaller member state initiatives

After the presentations, the workshop continued with discussions in small groups (see Figure 4). The moderator, Toon Norp from SNS ICE, provided an overview of the suggestions that were given in the presentations and/or in the report on national initiatives. A vote was conducted to select three proposals out of this list which attendees wanted to discuss in the small groups to make these suggestions more concrete. For each of the groups, the goal was to define actionable recommendations, with a clear *Who, What, When* (who will do what by when). A subset of the recommendations were selected for implementation. The results of these discussions, and other proposals that were identified but not selected, can be found in section 4.

Figure 4: Impression from group discussion during the national initiatives co-creation event @5G Techritory

2.7 Attendance at other European events

A number of other European events (not listed above) were of particular interest too for the establishment of R&I collaborations on 6G in Europe. The ones listed below were attended by SNS ICE representatives.

2.7.1 ETSI Research Conference

The ETSI Research Conference took place on the 6th to 8th February 2023 at the ETSI Headquarters in Sophia Antipolis, France. The event provided a great opportunity for the research community to come together with industry representatives and standardization experts to discuss future technology research and links to standardization developments. Several of the new SNS projects from the first call presented their standardization plans. Also a number of national initiatives (Germany, Finland, Spain, The Netherlands, UK, France) presented overviews of their programs (see Figure 5). This enabled the SNS ICE project to make contact with main representatives of these national initiatives. Other valuable insights gained from attending the workshop, next to establishing contacts, was to learn how these national initiatives were organized, what budgets had they allocated, what topics were they focusing on, etc. It is also good to note that for most national initiatives the information they presented at this conference was the first publicly available information about them.
Presentations from the conference are available via the conference website: https://www.etsi.org/events/2130-etsi-research-conference

Figure 5: Presentation by Paul Wijngaard (TNO) on the Dutch Future Network Services programme.

2.7.2 Annual networking event of the German 6G Program

In June 2023, the SNS ICE project attended the annual networking event of the German 6G Program. The event was organized by the 6G Platform project and a snapshot is provided in Figure 6. Several national initiatives (e.g. France, Finland, The Netherlands, and of course Germany) and European initiatives (SNS, Hexa-X / Hexa-X-II) presented their programmes and there was an additional session specifically dedicated to national programmes in Europe. It is also interesting to note that this event was co-located with the 2nd Germany - Japan Beyond 5G/6G Research Workshop. Other valuable insights gained from this event were on topics and internal organization of the national initiatives, especially for the German national initiative. The German national initiative has many individual projects within the programme and it was valuable to learn more about what these projects were doing.

Figure 6: Session on EU 6G initiatives at annual networking event of the German 6G Program.

2.7.3 France – Ireland collaboration

On the 8th of November, an online session was organized to investigate possibilities for 6G R&I collaboration between France and Ireland. The French Ministry of Economy, Finances & Industrial and Digital Sovereignty presented the French Acceleration Strategy for 5G/6G & Future Networks Technologies. Also, organizations and companies from France pitched their work in 5G/6G R&I. From the Irish side there were presentations from the CONNECT Centre for Future Networks & Communications, the national regulator ComReg, and several Irish universities. The event provided insights into the practical collaborations being established on collaborative research between national initiatives.
The session was followed, on 15th of November, by another event to discuss France-Ireland collaboration possibilities in the context of the SNS JU 2024 call. This second event was restricted to French and Irish organizations with an interest in initiating cooperations.

2.8 Collaboration with other EU Initiatives & their status

Since its inception, the SNS JU has identified the following partnerships for potential collaboration: KDT/Chips JU (Joint Undertaking), Photonics Europe, AI Data and Robotics, High-Performance Computing, and Mobility and Safety for Automated Road Transport. The SNS JU Office and the 6G-IA have established communication links with all five partnerships. They are in a stage where input to their related Strategic Research and Innovation Agendas (SRIAs) and/or R&I Work programmes has been delivered or is planned to be delivered. This is described next.

2.8.1 Chips JU (formerly known as Key Digital Technologies - KDT)

SNS has established a very close collaboration framework with Chips JU (www.chips-ju.europa.eu/). Following up on the 6G-IA and AENEAS MoU in 2021, SNS and Chips JUs have planned for coordinated actions and focused topics in their respective Work Programmes for 2023 and 2024.

Moreover, the 6G-IA, the SNS JU Office, and DG-CNECT have formed a task force with key European stakeholders in microelectronics for connectivity. This task force is preparing a roadmap for possible future activities (notably joint activities starting under the next Work Programmes 2025 for the two initiatives) that will be submitted for consideration by the SNS and the Chips governing boards and subsequently announced for further public consultation with all interested parties. Such synergies remove the silos among partnerships and enable Europe to achieve positive multiplier effects in critical areas such as communication networks.

The Chips JU (CJU) hosted a Launch event on November 30th to December 1st, 2023. An overview of the most important aspects is presented below.

The CJU is part of the Chip Act (CA) which is a bold public private initiative framing the microelectronic sector in Europe, with 43 Bn€ of investments committed.

- The CJU represents the first pillar of the CA, with a budget of 11 Bn€ until 2030, funded from multiple sources: Horizon Europe for about 4.2 Bn€, a similar amount from Member States (MS), Digital Europe Programme additional financing, and some extra investments expected from private industrial sources.
- The second CA pillar is focused on industrial resilience. It is not about closing Europe but rather about creating industrial capabilities and ecosystems. It covers state aid support to Opex and Capex, to stimulate EU competitiveness. It has already stimulated 100 Bn€ investments in Europe for the sector and manufacturing capabilities, e.g. in megafabs.
- The third pillar covers international cooperation and a strategy to engage in partnerships. It requires 3 conditions to be credible with non-EU partners: less dependency; security of supply chains; security of EU's own production. The CA includes a semiconductor board to monitor and advise on possible adverse evolutions of the sector worldwide. It is backed by an Alliance on Processors and Semiconductor Technologies[2], to inform the work of this board.

One of the key CA objectives is to develop capabilities in domains where Europe is not so good, such that Europe can have a stronger voice in global supply chains. Below 10% of global markets is considered as a non-credible position vis a vis international players and the objective is to reach 20% for highly critical semiconductors (including processing capabilities). This view is not necessarily shared by all industrial players and this is where public support and steering is expected. Most industrialists accept the idea that Europe has to be stronger on the manufacturing/design sides, primarily from a resilience perspective. But this is not seen as necessarily optimum from an economic point of view, hence the need for public private partnerships;

Skills is another topic of focus. The structure of the JU has been designed in that respect to enable access to pilot lines and design facilities to large communities, including SME's, in an open manner. Opportunities in that respect also focus on green aspects, where the sector is to be fully developed and skills have to emerge. Multiple players indicated the need to go back to materials, chemistry, and physics as key disciplines; all domains where Europe has talents but those talents are not necessarily going for jobs in the microelectronics/engineering sector.

Compared to its KDT predecessor, the CJU intends to cover a complete chain, from R&I to stimulation of lead markets. The overall budget is distributed over two parts:

- An "initiative" part, with focus on the missing bits to move R&I closer to exploitation and EU value creation. This part is the high priority part from a policy perspective;
- A "non-initiative" part, which basically continues the work of KDT, and support industry driven R&I for most promising techs and domains.

[2] https://digital-strategy.ec.europa.eu/en/policies/alliance-processors-and-semiconductor-technologies

Both parts are now addressed in the CHIPS JU SRIA [1], which is complemented as appropriate to reflect the initiative part. The structure and some calls of the initiative part were announced as follows:

- New advanced pilot lines: preferential access to pilot lines to open EU foundries. 4 pilot lines are targeted by the current call:
  - Advanced sub 2nm, for 700 M€. It covers production of IP nodes at 2nm, a level of integration only available from Taiwan or Korea today.
  - Advanced FDSOI with 7nm target for 420 M€. It covers SOI, prototyping for SOI tech with smart combinations/integration, down scaling at 7nm;
  - Advanced packaging for 370 M€. It covers packaging, for advanced coms with the intention of capturing higher value in connectivity markets, advanced IoT applications.
  - Advanced semiconductors based on wide bandgap materials for 180 M€. Telecom applications are also possible in this domain.
- Quantum Chips: The creation of a Q chips Program Line is envisaged as a follow up initiative beyond the 4 already decided. It piggybacks on the Quantum flagship, which covers a full value chain from R&I to creation of lead markets.
  - Quantum flagship includes multiple activities and funding: e.g. 300 M€ IRIS², 700M€ euroQCI; euro HPC 400M€; Skills 25M€.
- Competence center: As per the EuroHPC JU, the CJU supports a "Competence Center". The Competence Center (CC) is where users can go to access design platforms and then pilot lines, with the idea of "stacking" them on top of each other. CCs support industry or public sector (e.g. for "policy driven designs"). They provide access to design facilities and then PL's, provide trainings and upskilling facilities. The EU supports one CC per Member State, with Member States or regions co-investing into it. This way the CC operates as a network of national (regional) CC's, with the idea that Member States know the stakeholders better and can organize better access to CC's actors. CC may cover specialized areas, tech or application, help technology transfer, promote chip funds and access to Venture Capital, raise awareness and promote success stories.
- Funding: The CA comes with additional funding tools to support capital intensive industry like microelectronics. EU is behind China and the US for Start Ups in the field, but investment is raising. There is no dedicated Venture Capital fund, which limits SME growth in the field. Those with more mature technology are at risk of being acquired. The CA hence includes a Chip fund with two facilities:
  - The EIC accelerator which provides equity + grants to high potential Start Ups to validate their tech and transform it into innovation;
  - The InvestEU, funded by Digital EU and implemented by the European Investment Fund is targeted at SMEs. Also, for loans, InvestEU targets higher maturity technologies and domains.
- Design Facilities: Europe's share of design of components is very low. The Chips JU includes the development of design tools and platforms whose access is to be facilitated by the CC's. A call for design platforms opens July 2024.

Chips JU & Connectivity

Connectivity has a special place within the Chips JU SRIA, addressing its criticality, wide applicability and importance for Europe's digital future. Cellular technologies receive special focus, as it is recognized within the Chips JU SRIA that it is the only connectivity technology addressing all the key applications nominated by the Electronic Components and Systems (ECS) Strategic Research and Innovation Agenda (ECS-SRIA), as depicted in Figure 7.

PHYSICAL LAYER CONNECTIVITY	ECS KEY APPLICATIONS					
	MOBILITY	ENERGY	DIGITAL INDUSTRY	HEALTH AND WELLBEING	AGRIFOOD AND NATURAL RESOURCES	DIGITAL SOCIETY
	3.1	3.2	3.3	3.4	3.5	3.6
Cellular	X	X	X	X	X	X
Low power wide area		X	X	X	X	X
Low power short range	X		X	X		X
High speed	X	X	X			X

Figure 7: ECS/CHIPS JU Key Technologies enabling connectivity [1]

The CHIPS JU SRIA recognizes that connectivity permeates all aspects of digitalization and that the development of HW and SW technologies needs to go hand in hand with developments in the telecommunications section. Several key application breakthroughs are highlighted, that can be expected by improvements in connectivity which will impact ECS application areas, while the strategic advantages for Europe from the synergy of connectivity and ECS developments are also highlighted.

The CHIPS JU also identifies five major challenges in the connectivity domain, from their perspective which are:

- **Major Challenge 1**: Strengthening the EU connectivity technology portfolio to maintain leadership, secure sovereignty and offer an independent supply chain.
- **Major Challenge 2**: Investigate innovative connectivity technology (new spectrum or medium) and new approaches to improving existing connectivity technology to maintain the EU's long-term leadership.
- **Major Challenge 3**: Autonomous interoperability translation for communication protocol, data encoding, compression, security and information semantics
- **Major Challenge 4**: Architectures and reference implementations of interoperable, secure, scalable, smart and evolvable IoT and SoS connectivity.
- **Major Challenge 5**: Network virtualisation enabling run-time and evolvable integration, deployment and management of edge and cloud network architectures.

Each of these challenges are analyzed in depth offering their distinct vision and expected outcome, the key focus areas, the topics to be addressed in each of them as well as a timeline of necessary actions (short, medium and long term).

Based on their analysis, links between the proposed SRIA on connectivity and "innovation accelerators" being currently set up in the frame of the European Chips Act, are proposed, following the below potential synergies.

- Heterogeneous Integration and Advanced Packaging Pilot Line: this initiative should support the R&I efforts in the following key focus areas:

- Enable a European ecosystem that can support heterogeneous integration (multi-die system-in-a-package, advanced assembly capability, advanced substrate manufacturing, etc.) to help European players capture higher value in the connectivity market.
- Enable the development of innovative antenna-in-package solutions at mm-wave and THz frequencies.
- Enable a sovereign European packaging ecosystem to secure the supply chain of European semiconductor players (especially in key areas such as space were required manufacturing scale limits the possibility to have access to Asian Outsourced Semiconductor Assembly and Testing)

- FD-SOI Pilot Line: this initiative should support the R&I efforts in the following key focus areas:
  - Enable the development of power efficient connectivity solution leveraging European based semiconductor technology.
  - Enable the development of innovative connectivity solution at mmW and THz frequencies.

Two years ago, a focus topic was selected about THz but there was no submission on that topic. This was unfortunate as in the SNS JU WP 2023, there was a plan for potential interactions between SNS and Chips JU. Currently, there is no focus topic in relation to connectivity and no specific plan for the Chips JU pilot lines. Consequently, it is up to chance if anyone will submit a proposal on connectivity challenges / issues, based on the open calls that is possible to address any topic in their huge SRIA. Table 4 below provides an overview of the CHIPS JU open (and closed) calls, which can be found in the main CHIPS JU webpage[3].

Table 4: CHIPS JU Calls overview

Call Type	Call ID	Call name	Call Status	Call Max Funding	Call Deadline
Europe Initiative Calls	Chips 2023-CPL-1	Pilot line on Advanced sub 2nm leading-edge system on chip technology	Closed	700 M€	29-Feb-2024
	Chips 2023-CPL-2	Pilot line on Advanced Fully Depleted Silicon On Insulator technologies targeting 7nm	Closed	370 M€	29-Feb-2024
	Chips 2023-CPL-3	Pilot line on Advanced Packaging and Heterogenous Integration	Closed	420 M€	29-Feb-2024
	Chips 2023-CPL-4	Pilot line on Advanced semiconductor devices based on Wide Bandgap materials	Closed	180 M€	29-Feb-2024
	Chips-2024-CPL-5	Pilot Line on Advanced Photonic Integrated Circuits	Open	180 M€	17-Sep-2024
	Chips-2024-CCC-1	Competence Centres	Open	116 M€	02-Oct-2024
	Chips-2024-CCC-2	Support to the European Network of Chips Competence Centres	Open	4 M€	02-Oct-2024
	Chips-2024-CDP-1	Design platform	Coming Soon	25 M€	10-Oct-2024

[3] https://www.chips-ju.europa.eu/callsinfo/

Non Initiative Calls	Chips 2024-3-RIA	Joint call with Korea on Heterogeneous integration and neuromorphic computing technologies for future semiconductor components and systems	Closed	N/A	N/A
	Chips 2024-2-RIAT1	Global RIA call according to SRIA 2024	Open	52 M€	17-Sep-2024
	Chips 2024-2-RIAT2	Sustainable and greener manufacturing	Open	15 M€	17-Sep-2024
	Chips 2024-2-RIAT3	Joint call with Korea on Heterogeneous integration and neuromorphic computing technologies for future semiconductor components and systems	Open	6 M€	17-Sep-2024
	Chips 2024-1-IA-T1	Global IA call according to SRIA 2024	Open	103 M€	17-Sep-2024
	Chips 2024-1-IA-T2	High Performance RISC-V Automotive Processors supporting SDV	Open	20 M€	17-Sep-2024
	Chips 2024-1-IA-T3	Service Oriented Framework for the Software Defined Vehicle of the future	Open	20 M€	17-Sep-2024

On October 16th 2023, a dedicated Workshop from experts from the Chips JU and the SNS JU took place in Brussels, focusing on microelectronics for 6G. a separate report has been drafted extracting and grouping the main messages of the workshop and proposing a way forward see micro-electronics report[4]). During this workshop, 24 topics were identified as promising in the area of microelectronics for 6G, and next steps for each of them are currently being discussed with all involved stakeholders. The report is to be used as a common reference for joint activities between the SNS and Chips JU, with the objective of stimulating strategic cooperation to develop core 6G enabling technologies, to be later reflected in the respective work programmes, 2025 being currently the target. The report suggests two domains of activities for future cooperation: i) Front End Modules (FEM) with challenging R&I issues such as integration of heterogeneous technologies, design, packaging, and multi band operations with potential to be applied both on the infrastructure side and on the device side; ii) computing technologies, with a first set of activities focusing on advanced accelerators for virtualized platforms. These topics have been endorsed by AENEAS (apart from 6G-IA) and presented in the Chips JU Board. 6G-IA has also presented the report to the Chips JU but there has been no response received yet.

2.8.2 Photonics Europe

In relation to Photonics Europe, 6G-IA along with supporting associations has been exchanging information related to the SNS priorities on photonics activities as well as information about selected related projects. Also, 6G-IA provided input and suggestions about the preparation of the Photonics 21 SRIA [2]. The idea is to establish a more coordinated approach about the organization of related research activities in both initiatives. 6G-IA has participated in a workshop organized by Photonics 21 on October 5, 2022 to present the SNS priorities. 6G-IA also participated in the Photonics 21 annual Meeting in Brussels on April 26 and 27, 2023, a workshop on June 27, 2023 and bilateral calls between 6G-IA and Photonics 21 were also organized.

Photonics 21 has released documentation regarding three different research areas on digital communication, which are summarized below:

[4] https://6g-ia.eu/wp-content/uploads/2024/02/6g-ia-position-paper_microelectronics-final.pdf

Photonic Research as a basis for a trustworthy optical digital infrastructure

- Technical content
  - This research area is related mainly to the backbone network as well as optical-based fronthaul systems.
  - The focus is on security and significant reduction of energy consumption.
  - There are also system aspects of interest for SNS.
  - In addition, optical communication from NTN systems and the associated security is addressed.
  - There are synergies with SNS topics.
  - Photonic integrated circuits are in scope, which will not be developed in SNS but could be used in systems and trials.
  - There is potential for cooperation.
- Intended Photonics 21 budget: around 20 M€ in this domain
- Intended timing: Photonics 21 Work Program 2025/26

Photonic technologies enabling a sustainable climate-change compatible digital infrastructure

- Technical content
  - Where possible electronics are replaced by photonics, which results in significant energy savings.
  - The focus is on energy savings and increased energy efficiency in optical systems.
  - This area is very much focused on the implementation of optical systems.
  - SNS could be a consumer of such results in trials.
  - There are no direct system aspects for SNS.
  - In this domain there are less synergies with SNS however cooperation possibilities for trials.
- Intended Photonics 21 budget: around 15 M€ for projects in this domain as short-term activity.
- Intended timing: Photonics 21 Work Program 2024

Photonics infrastructure to support the industrial metaverse

- Technical content
  - This approach is based on digital twins of the network for industrial applications and use cases and the associated huge amount of data, which need to be transmitted and processed.
  - Results can be applied in trial systems for the 6G backbone network, where huge data rates will appear.
  - There could be synergies for the 6G architecture especially in the backbone.
  - The convergence of optical and wireless networks is addressed.
  - Here are synergies with SNS for trials and on system architecture considerations.
- Intended Photonics 21 budget: around 20 M€ in this domain
- Intended timing: Photonics 21 Work Program 2025/26

Photonics 21 is still in the process to agree priorities and focus areas for the updated Photonics 21 work program, which will fit to the available funding budget. Results are not yet public and as a result **there is currently no open call available from Photonics 21**, as also highlighted in their webpage[5]. SNS is supporting the generation of the Photonics 2021 Work Programme 2025/26 by providing information on cooperation opportunities according to the SNS work program 2024 and the envisaged work program 2025.

It is considered very encouraging that the Photonics 21 SRIA recognizes the need for close collaboration with the SNS JU on connectivity issues as it is mentioned that the work carried out within the SNS JU "…*may derive important component and device requirements and also provide relevant test environments for prototype devices resulting from Phototonics21 developments. A close collaboration ensures that network, system, and component developments go hand-in-hand*". It is also highlighted that that the competitiveness of the European communication industry critically depends on the availability of commercial manufacturing,

[5] https://www.photonics21.org/ppp-services/european-calls.php

fabrication, packaging, and assembly partners on the electronic and photonic side, which creates hope about potential calls that will promote synergies between the Photonics 21 and the SNS JU.

From an architectural perspective the biggest potential synergies between the SNS JU and Photonics are with the first topic area and then the third. For the second topic SNS could be in the role of a user especially of components and devices in SNS trials.

2.8.3 HPC (High Performance Computing)

6G-IA participated at the ETP4HPC workshop on 08 March 2023 to present SNS JU priorities during the "Opportunity Radar" session. This was a first attempt to establish a communication link with the HPC community and identify potential opportunities for collaboration. After this workshop a bilateral call was organized followed by the participation of 6G-IA at the HiPEAC (https://www.hipeac.net/#/) meeting that took place on 21 September 2023 in Brussels with the target to participate in coordinating activities. HiPEAC invited many European initiatives and the EU Commission in the context of high-performance computing such as ADRA, AIOTI, BDVA, Chips/KDT JU, Destination Earth, ECSO, EPT4HPC, FIWARE Foundation, NESSI and SNS. It was the objective to exchange information on activities on high-performance computing in the different initiatives and to identify potential synergies for cooperation. AI was identified as a common denominator for most initiatives. However, the terminology on HPC should be aligned or explained, because there is a different understanding what HPC means. Sustainability should have a high priority with respect to climate change, energy prices, supply chains for materials etc. 6G-IA presented the SNS JU requirements and priorities including HPC related topics. 6G-IA has joined as HiPEAC member.

The EuroHPC Joint Undertaking aims to develop, deploy, and maintain a world-leading, secure, and hyper-connected supercomputing, quantum computing, service, and data infrastructure ecosystem within the EU. It seeks to support the development and adoption of innovative and competitive supercomputing systems driven by user demand and built on a robust supply chain, thereby minimising risks of disruptions. Additionally, it aims to broaden the use of this infrastructure across a wide range of public and private users while fostering the development of key HPC skills for European science and industry.

The EuroHPC Joint Undertaking is governed by three main bodies: the Governing Board, the Executive Director, and the Industrial and Scientific Advisory Board. The Governing Board, which includes EU and Participating States representatives, is responsible for setting policies and making funding decisions, including public procurement activities. The Executive Director acts as the legal representative and chief executive officer, managing daily operations in line with the Governing Board's decisions. The Industrial and Scientific Advisory Board, composed of members from academia and industry, provides independent advice on research, innovation, supercomputer operations, capability building, and international cooperation programs.

The EuroHPC Joint Undertaking comprises public and private members. Public members include the European Union, represented by the Commission, and Member States and Associated Countries that have opted to join, such as Austria, Belgium, France, Germany, Italy, Spain, and the United Kingdom, among others. Private members consist of representatives from the European Technology Platform for High-Performance Computing (ETP4HPC), the Big Data Value Association (BDVA), and the European Quantum Industry Consortium (QuIC). This diverse membership ensures a comprehensive approach to developing and maintaining Europe's supercomputing infrastructure.

Budget and Open Calls

The EuroHPC Joint Undertaking provides financial support through procurement or research and innovation grants following open and competitive calls. EuroHPC is jointly funded by its members with a budget of around EUR 7 billion for 2021-2027. Most of this funding comes from the current EU long-term budget, the Multiannual Financial Framework (MFF 2021-2027), with a contribution of EUR 3 billion. This includes EUR 1.9 billion from the Digital European Programme for infrastructure-related activities, EUR 900 million from Horizon Europe for research and innovation, and EUR 200 million from Connecting Europe Facility-2 (CEF-2) for improving interconnections. An equivalent amount from participating countries matches the EU contribution, and private members contribute an additional EUR 900 million.

The EuroHPC JU has launched several research and innovation activities to position Europe at the forefront of high-performance computing. These efforts align with strategic goals to enhance capabilities across various sectors, promote SME competitiveness, support training and education, and foster international cooperation. As a result, a series of open calls were launched from 2020 to 2024. These were mainly focused on the following topics:

HPC Applications: a significant focus was placed on developing HPC applications for exascale and post-exascale systems. The calls aimed to advance applications in various domains, such as weather forecasting, material science, and digital twins of the human body. These efforts were supported by the establishment of Centres of Excellence (CoEs) to gather HPC software development expertise and promote sector-specific advancements.

Key Initiatives:

- Establishment of multiple Centres of Excellence for HPC applications.
- Launch of projects like Inno4scale to develop algorithms addressing exascale challenges.

SMEs: improving SME access to HPC resources was a consistent priority. Calls aimed to develop tools, services, and training tailored to SME needs, thus enhancing their innovation capabilities. Specific projects focused on providing HPC resources to SMEs to help them tackle business challenges and remain competitive in the global market.

Key Initiatives:

- Calls targeting SME access to HPC.
- Support programs to enhance SME competitiveness and innovation.

HPC education and training: Initiatives included developing a European Master's program in HPC, training platforms, summer schools, and virtual academies. These programs aimed to build a robust skills base across Europe, ensuring a steady pipeline of HPC experts.

Key Initiatives:

- European Master's program in HPC.
- EuroHPC Training Platform and International HPC Summer School.
- EuroHPC Virtual Training Academy.

Quantum Computing: the development and integration of quantum computing within the HPC ecosystem were crucial. Open calls have focused on selecting organisations to host and operate quantum computers and

developing quantum computing applications. These initiatives aimed to leverage quantum mechanics principles to enhance computational capabilities significantly.

Key Initiatives:

- Hosting and operating quantum computers.
- Developing quantum computing applications.

International cooperation: In 2023, the importance of strengthening international cooperation, particularly with Japan, was highlighted. A specific call was launched to facilitate resource sharing and collaborative efforts in the field of HPC, aligning with the European Commission's Japan-EU Digital Partnership.

Key Initiatives:

- Calls to strengthen cooperation with Japan in HPC.

Interconnects: technological innovation was consistently targeted, particularly in low latency and high bandwidth interconnects and energy-efficient HPC software. Calls focused on developing innovative HPC inter-node interconnect technology and software to enhance supercomputing systems' performance and energy efficiency.

Key Initiatives:

- Development of low latency and high bandwidth interconnect technology.
- Energy-efficient HPC software tailored to exascale and post-exascale supercomputers.

AI support centre: A notable initiative in 2023 was the call to establish a European AI support centre. This centre aims to train and enable European AI communities to fully leverage HPC capabilities for advanced AI applications, facilitating the development of complex models with significant impact, such as generative AI.

Upcoming EuroHPC calls are listed in Table 5.

Table 5: EuroHPC Open Calls overview

Call Type	Call ID	Call Name	Call Status	Call Model	Call Deadline
EuroHPC Access Calls	N/A	EuroHPC JU Call for Proposals for Regular Access Mode	Open	Multiple cut-offs	25 Mar 2024 6 Sep 2024
	N/A	EuroHPC JU Call for Proposals for Extreme Scale Access Mode	Open	Multiple cut-offs	17 Apr 2024 4 Oct 2024
	N/A	EuroHPC JU Access Call for AI and Data-Intensive Applications	Open	Multiple cut-offs	15 Apr 2024 14 Jun 2024 13 Sep 2024 15 Nov 2024
	N/A	EuroHPC JU Call for Proposals for Development Access	Open	Multiple cut-offs	1 Jan 2024 1 Feb 2024 1 Mar 2024 1 Apr 2024 1 May 2024 1 Jun 2024 1 Jul 2024 1 Aug 2024 1 Sep 2024 1 Oct 2024 1 Nov 2024 1 Dec 2024
	N/A	EuroHPC JU Call for Proposals for Benchmark Access	Open	Multiple cut-offs	1 Jan 2024 1 Feb 2024 1 Mar 2024 1 Apr 2024 1 May 2024 1 Jun 2024 1 Jul 2024 1 Aug 2024 1 Sep 2024 1 Oct 2024 1 Nov 2024 1 Dec 2024
R&I Calls	HORIZON-EUROHPC-JU-2024-DARE-SGA-04	Specific Grant Agreement (SGA) for the development of a large-scale European initiative for HPC ecosystem based on RISC-V	Open	Single Stage	29 Aug 2024

2.8.4 AI Data and Robotics

In September 2023 6G-IA has established a communication link with Adra (AI, Data, and Robotics Association) and exchanged information about the key SNS activities in relation of AI/ML and how the two partnerships could establish a closer collaboration. Also, 6G-IA participated in an online event entitled “An AI Moonshot for Europe: Can it help Europe compete and accelerating sustainable growth and welfare?” discussing about the way forward in the Adra domain and possible collaborations with the SNS community.

Adra was established in 2021, by five European organisations: BDVA, CLAIRE, ELLIS, EurAI, and euRobotics. The mission of Adra is to drive innovation, acceptance, and the uptake of AI, data, and robotics technologies to deliver the greatest benefits to Europe. By fostering the development and deployment of trustworthy, safe, and robust technologies that align with EU values and regulations, Adra aims to bolster European sovereignty in these critical fields by 2030. This mission is rooted in the belief that those who control digital technologies significantly influence economic, societal, and political outcomes, making it imperative for Europe to lead in vision and robotics technologies.

Adra operates as the private side of the European Partnership on AI, Data, and Robotics, part of the Horizon Europe program under Cluster 4 (digital, industry, and space). The partnership was officially launched with the signing of a Memorandum of Understanding (MoU) with the European Commission on June 23, 2021. The governance structure of Adra is designed to integrate and connect the European research landscape, overcoming fragmentation by uniting various communities and disciplines across member states. This cohesive structure aims to enhance the effectiveness of European companies and research organisations, facilitating the translation of research into innovative solutions.

Adra boasts a diverse membership network that includes Research Organizations, Small and Medium Enterprises (SMEs), Large Enterprises, Startups, and Non-profit Organizations. With 140 members from 24 countries, Adra's collaborative network represents a global collective dedicated to advancing AI, data, and robotics technologies for societal betterment. This diverse membership base ensures various perspectives and expertise, fostering innovation and driving progress in these critical technological fields.

Significant investments support the partnership led by Adra to ensure the successful development and deployment of AI, data, and robotics technologies. This includes funding from the Horizon Europe program and contributions from various stakeholders within the partnership. The budget is allocated to support research and innovation, enhance the capacity for reskilling and upskilling the workforce, and develop advanced materials and processes. By addressing the skill mix in the economy and boosting the attractiveness of European innovation ecosystems, Adra aims to maximise productivity gains from new technologies and maintain competitiveness on a global scale.

Strategic orientations towards an AI, Data, and Robotics roadmap 2025-2027 (SRIDA)

Although ADRA does not have open calls, the Strategic Research Innovation and Deployment Agenda (SRIDA) is published to orient European Commission calls on robotics.[6] The SRIDA document provides a comprehensive overview of the strategic position of the AI, Data, and Robotics (ADR) Partnership from the perspective of Adra members, offering several recommendations for the upcoming European work programs. These recommendations are motivated by both global and specific challenges related to AI, data, and robotics, aiming to address Europe's future sustainable development and welfare amid recent world crises and global disruptions.

[6] Learn more at https://www.adr-association.eu/srida.

- **Strategic Plan 2025-2027 Recommendations:** recommendations for the EU strategic plan for 2025-2027, aligning with the strategy to leverage Europe's strengths in robotics, machine vision, and trustworthy AI technologies while addressing the rapid advancements in AI-based robotics globally. Investments in ADR are essential to maintain Europe's leadership and ensure sustainable production of essential resources, such as energy and food, through efficient waste management and increased production capacity. The recommendations emphasise the importance of integrating and connecting the European research landscape, developing a powerful strategy to attract skills and talents, and establishing ADR technologies with high socioeconomic impact.

- **Addressing Societal Challenges:** to tackle societal challenges, several key areas are addressed. Trustworthy ADR technology made in Europe and compliant with regulations, including the AI Act, Data Act, and Data Governance Act, are priorities. Emphasis is placed on supporting SMEs, leveraging Digital Innovation Hubs (DIHs) for tech transfer, and achieving the goals of the Digital Decade. Enhancing European strategic autonomy in ADR technology and supporting strategic autonomy in other areas, such as optimising production costs and relocating production within the EU, are also critical. Additionally, the plan addresses increasing resilience to crises, supporting sustainable development goals, and scaling up education on AI, data, and robotics across professions.

- **Technological Advancements and Collaboration:** several technological concerns and the need for large-scale ADR testbeds, multi-stakeholder development, and collaborative autonomous systems are identified. Metrics for measuring progress in ADR, integrating AI, data, and robotics, and focusing on sector-specific applications are crucial for driving innovation. Collaboration with European Missions and alignment with initiatives like the European Chips Act are vital for boosting competitiveness and resilience in semiconductor technologies. Furthermore, addressing regulatory challenges, providing tools and support for compliance, and creating environments for real-world testing are essential for accelerating the deployment of complex socio-technical systems.

2.8.5 Cooperative, connected and automated mobility (CCAM)

Even though there can be numerous benefits from Cooperative Connected and Automated Mobility (CCAM), the uptake of CCAM development is slow. To co-ordinate research and innovation across Europe, the CCAM Partnership was established in June 2021 and it is co-programmed with the European Commission under the Horizon Europe programme. The ambition of the CCAM Partnership is to provide a safe and inclusive mobility system while also reducing the environmental impact. For the representation of the private sector of the CCAM Partnership, the not-for-profit CCAM Association has been established, also in 2021. The CCAM Association consists of 230 stakeholders and aims to accelerate CCAM development and deployment.

Based on the SRIA [3], the work of the CCAM Partnership is organized in 7 thematic clusters namely: (1) Large-scale demonstration, (2) Vehicle Technologies, (3) Validation, (4) Integrating CCAM in the transport system, (5) Key enabling technologies, (6) Societal aspects and people needs and (7) Coordination. With these defined clusters, technologies that address the societal needs can be developed and demonstrated. Moreover, the proposed timeframe is split into three phases. Phase 1 spans between 2021-2024 and aims to develop the building blocks, Phase 2 spans between 2025-2027 and will focus on the maturing of technologies and finally Phase 3 spans between 2028-2030 and is focused on large-scale demonstrations across Europe.

To enhance the development and deployment of technical solutions, the CCAM Partnership seeks co-ordination with other Partnerships via alignment groups, meetings, workshops and conferences. Figure 8 shows the interfaces between each of the 7 thematic clusters defined in the CCAM Partnership and other European Partnerships. Focusing on the SNS Partnership, 6G-IA has established a collaboration regarding CCAM with stakeholders (ERTICO, GSMA and 5GAA) who are also involved in the CCAM Partnership. This collaboration contributes to the SNS's objective of digitalising vertical industries, which includes CCAM. The

investigation of enhancing the network and the devices to support CCAM is also part of the SNS research agenda. Therefore, a co-operation between the SNS and the CCAM Association is possible in multiple potential areas, which are described in [3].

In relation to CCAM, 6G-IA had a coordination meeting (on 10 November 2022) to pass information about SNS priorities to CCAM that were used during the CCAM-SRG meeting. Via the 6G-IA Working Group 5G/6G for Connected and Automated Mobility, a close collaboration is maintained with various automotive stakeholders including 5GAA, DG-CONNECT representatives and automotive project representatives.

In April 2024, the CCAM Work Programme Calls were announced [4] which fall under the Horizon Europe Cluster 5 call "Safe, Resilient Transport and Smart Mobility Services for Passengers and Goods". The calls are open from 7 May 2024 until 5 September 2024 and the budget is indicated at €52.5 million. There are in total 5 open calls. In total, it is expected that 8 projects will be funded.

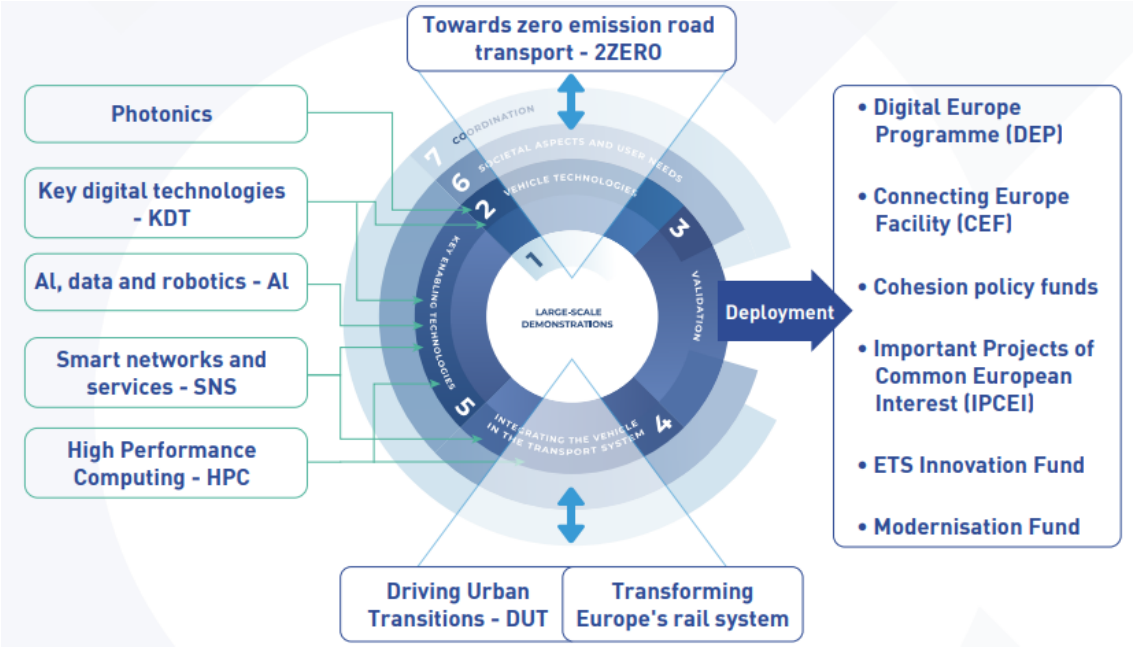


Figure 8: Interfaces between the 7 thematic clusters of the CCAM Partnership and other European partnerships and Programmes, as presented in [3]

The CCAM Partnership is set up as a partnership between the European Commission and the CCAM Association. The CCAM Partnership Board will hold discussions with representatives from both the European Commission and the CCAM Association in relation to the CCAM Work Programme. Regarding the structure of the CCAM Association; there is a General Assembly, an Administration Board and an Executive Group. The General Assembly consists of all CCAM Association Members and interfaces with the Executive Group. The Administration Board consists of the Chair and two Vice-Chairs and it is responsible for day-to-day management of the Association. The Executive Board consists of a maximum of 17 members and it is responsible for achieving the objectives of the 7 thematic clusters. For the representation of the Association within the European Commission services, the Partnership Delegation is established. It consists of a maximum of 25 members, including the Administration Board members and a Cluster Lead for each one of the 7 thematic clusters [5]. There is also a CCAM States Representatives Group, in which representatives of EU Member States provide advise and actively support the achievement of the CCAM objectives.

2.8.6 IPCEI-CIS

The upcoming use of data-driven services and digital society introduces new challenges to the cloud infrastructure, which is expected in the future to also provide computing services and be integrated to the telco infrastructure. To address the new challenges of cloud and edge computing, the EU Commission approved the Important Projects of Common European Interest (IPCEI) in Next Generation Cloud Infrastructure and Services (IPCEI CIS). The main objective of IPCEI CIS is to develop the first "Multi Provider Cloud Edge Continuum" in Europe, with focus on *interoperability, sustainability, cybersecurity* and *standardization* [6]. IPCEI CIS will perform research, development and innovation (R&D&I) as well as first industrial deployment (FID).

Currently, it has been identified that edge computing within the EU is at its infancy and it accounts for less than 13% of the global market [7]. Therefore, there is a possible risk that the EU will depend on non-EU players for its digital transformation. Such a dependency could potentially hinder the European economy and innovation and create concerns about data security and compliance with the General Data Protection Regulation (GDPR). IPCEI CIS, by offering a distributed, openly accessible and interoperable European cloud and edge infrastructure, is contributing in securing digital innovation within the EU. Additionally, IPCEI CIS contributes to other EU initiatives, such as Europe's Digital Decade, the European Green Deal, the European Data Strategy and the 2030 Digital Compass [8].

After a preparation period of about three years, seven EU member states (France, Germany, Hungary, Italy, The Netherlands, Poland and Spain) have been notified for the execution of IPCEI CIS [8]. France and Germany are also acting as coordinators. Overall, there are 19 projects from 19 direct participants from the seven notified member states. Moreover, there are 90 indirect partners, who are also from an additional five member states (Belgium, Croatia, Latvia, Luxembourg and Slovenia). Overall, there are in total 120 projects that have been launched in December 2023. Participants include large, medium and small enterprises, start-ups, research organisations and Universities. Earliest IPCEI CIS projects started in Q1 2023 and will end the latest in Q4 2031. The first results are expected by the end of 2027. Note that each individual project can have its own time duration. On 21 March 2024, the kick-off event of IPCEI CIS was hosted in Brussels, Belgium.

Funding

A public funding of €1.2 billion is provided by the notified member states whereas an additional funding of €1.4 billion is expected by private investments. Thus, the total funding for all projects across Europe is a total of €2.6 billion. IPCEI CIS projects from Germany, Italy, Poland and Spain will be funded from the Resilience and Recovery Facility (RRF). The allocation of budget to the projects has been fixed and no further open calls for projects are expected. Any new topics will need to be addressed in future IPCEI programs.

Organisation of work

The work to develop the "Multi Provider Cloud Edge Continuum" is organized in four workstreams (WS). A detailed description of each WS, including information about the objectives, activities and focus and main contributions of each participant, is provided in [9]. Here we shortly provide the focus and timelines of each WS:

- WS1 - Cloud Edge Continuum Infrastructure: The focus is to ensure that both hardware and software are ready and allow the interconnection of networks, thus providing the infrastructure of the cloud edge continuum. The projects in this WS started the earliest in Q4 2023 and will end the latest in Q1 2028.
- WS2 - Cloud Edge Capabilities: The focus is to create a common reference architecture for constructing and operating the "Multi Provider Cloud Edge Continuum". The projects in this WS started the earliest in Q1 2023 and will end the latest in Q4 2031.

- WS3 - Advanced Smart Data Processing Tools and Services: The focus is to develop services that will be deployed in the cloud edge system and thus will be able to run on top of different networks and have seamless communication. The projects in this WS started the earliest in Q4 2023 and will end the latest in Q4 2028.
- WS4 - Advanced Applications: The focus is to provide use cases from different sectors that can be used to validate the implementation of the "Multi Provider Cloud Edge Continuum". The projects in this WS started the earliest in Q4 2023 and will end the latest in Q3 2029.

The main contributions of each WS are summarized in Table 6, as presented in [9]. Cross-border collaborations concerning a given WS or cross-WSs will also be performed.

Table 6: Main contributions per workstream

	WS1	WS2	WS3	WS4
Interconnection and federation	X			
Quality of Service (QoS) guarantees and workload placement	X			
Open reference designs and implementations	X			
Cybersecurity	X	X		
Sustainability	X	X		
Availability/Accessibility	X	X		
Life cycle management		X		
Data and network management		X		
Workload management		X		
Data Handling			X	
AI services			X	
Orchestration			X	
Information Technology/Operational Technology convergence				X
Industrial digital twins, AI integration in operational processes				X
Data ownership				X

IPCEI CIS is performed in co-operation with the Directorate General for Communication Networks (DG Connect) of the European Commission. The governance structure for the overall implementation and monitoring of IPCEI CIS is summarized in Figure 9. Regarding the strategic vision, a General Assembly and a Supervisory Board are set up. Specifically, the General Assembly consists of all partners as well representatives of the Member States (MS) and the European Commission (EU COM). However, only the partners have voting rights. A General Assembly will be organized at least one a year and during the first General Assembly, the Chair and Vice Chair of the Facilitation Group (FG) are elected. The Facilitation Group further consists of eight coordinators; two coordinators per WS. The goal of the Facilitation Group is to facilitate communication between the partners and the governing bodies and monitor the projects' outcomes.

The Supervisory Board consists of the Member States, the Chair and Vice Chair of the Facilitation Group, who represent the General Assembly members, one observer of the European Commission and the Head of the Coordination Office, who is also acting as an observer. The goal of the Supervisory Board is to overlook the progress of the projects and of the entirety of IPCEI CIS and provide annual reporting to the European

Commission. Moreover, the Supervisory Board is responsible for strategic guidance and conflict resolution. Meetings of the Supervisory Board occur twice a year. Finally, the goal of the Coordination Office is to perform project management and communication and its scope can be catered to the needs of the Supervisory Board.

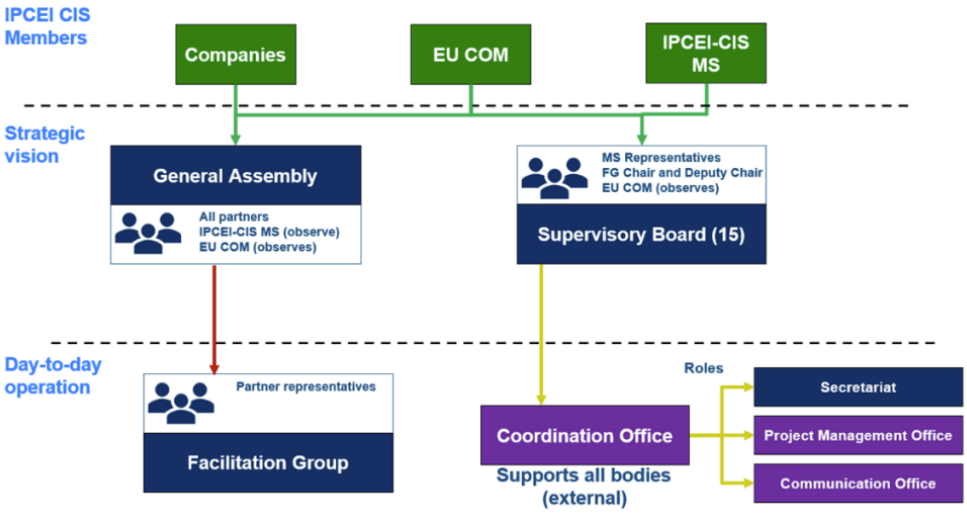


Figure 9: Governance of IPCEI-CIS as presented in [9]

2.8.7 European Alliance for Industrial Data, Edge and Cloud

The goal of the European Alliance for Industrial Data, Edge and Cloud is to secure innovation on cloud and edge technologies in the EU and to ensure that the requirements of processing sensitive data in the EU are met. The Alliance stems from the European Data Strategy [10]. In October 2020, all EU Member States have signed a declaration on building an EU cloud [11]. The Alliance was initiated by the European Commission in July 2021 and started in December 2021 with the kick-off event hosted by the European Commission [12]. As of July 2024, there are 56 members and there is an open application to join the alliance at any time. Private and public organizations can join the Alliance, assuming that they meet the eligibility criteria presented in [13].

In July 2023, the Alliance published the "European Industrial Technology Roadmap for the Next-Generation Cloud-Edge", providing insights on which technologies are important for investment [14]. Moreover, focusing on the telecommunications industry, the "Telco Cloud Thematic Roadmap" has been delivered to the European Commission in June 2024. The roadmap includes various requirements, a presentation of ongoing initiatives, gaps, challenges and recommendations. A digital copy of the roadmap is available in [15].

Funding

The funding to achieve the goals of the Alliance is provided in the context of programmes such as [16]:

- Digital Europe Programme (DIGITAL) [17]: The goal of this programme is the development and implementation of digital technologies for individuals, public services and businesses. The total budget of this programme is over €7.9 billion, and there is a budget allocation of €2.2 billion for supercomputing, €2.1 billion for AI, €1.6 billion for cybersecurity, €580 million for advance digital skills and €1.1 billion for the use of digital technologies. The DIGITAL programme runs from 2021 until 2027.
- Connecting Europe Facility 2 (CEF Digital) [18]: The goal is to bridge the gap between private and public funding for digital connectivity infrastructures. Overall, a total of €252 million have been allocated to

37 projects. The projects concern backbone connectivity for digital global gateways, 5G for smart communities and 5G cross-border corridors. This programme runs between 2021 and 2027.

- European Defence Fund 9 (EDF) [19]: This fund is allocated for research and development in the defence sector. The fund concerns a budget of almost €8 billion and it spans from 2021 until 2027.
- Recovery and Resilience Facility (PRF) [20]: The goal of this facility is to create funding for reforms and investments, aimed to create more sustainable societies. The total funding is €648 billion, from which €357 billion are in grants and €291 billion are in loans.

Organisation of work

Within the Alliance, multiple Working Groups (WGs) on different topics are in operation. Each WG elects a Chair and Vice Chair(s). The WGs are:

- The Cloud - Edge WG provides and keeps updating a strategic roadmap related to cloud and edge technologies. As part of this WG, the roadmap for the next-generation cloud-edge and the thematic roadmap on “Telco Cloud” as a challenge for next-generation edge and cloud have been delivered.
- A WG responsible for the investments for developing and deploying cloud and edge technologies within Europe.
- A WG for advising the European Commission on the EU Cloud Rulebook.
- A WG on public procurement of cloud services, where only public authorities of the Member States can participate.
- A WG specifically on cloud for defence and security, which are sectors that require high security.

The work of the Alliance is facilitated by the Directorate General for Communications, Networks, Content and Technology (DGCNECT). A Steering Committee has been established for coordination of the work and the General Assembly of the Alliance holds regular meetings with the European Commission. The General Assembly or the European Commission may also create new WGs. Moreover, the European Commission could impose restrictions to organisations, related to agenda items that impact the security of the EU [21].

3 Overview of national initiatives

3.1 Introduction

In most EU Member States there are publicly funded 5G/6G R&D or trail activities. These may be EU funded through e.g., the Horizon Europe programme, Connecting Europe Facility (CEF) or European Regional Development Funds (ERDF). In this chapter we provide an overview of initiatives that are funded by Member States national governments[7]. In several European countries, we see large national initiatives with budgets of hundreds of MEuros: Finland, France, Germany, Italy, Spain, and the Netherlands. We focus on these initiatives because the size of these large national initiatives becomes comparable with the budget of SNS. Note furthermore that in this overview we have concentrated on 5G/6G research and innovation funding that has a similar scope as the SNS programme. We have not included national funding for the roll out of 5G, which would be more like the European CEF.

First information on the different national initiatives was collected based on publicly available presentations, websites, et cetera. As the level of detail and type of information publicly available differ significantly between the different national initiatives, we organised structured interviews, where all the national initiatives where asked the same set of questions. Finally, to ensure that the information provided is correct, the national initiatives were asked to review the section describing their national initiative.

To facilitate comparison between activities in the national initiatives and the SNS Programme, we have used a categorization of activities inspired by the SNS work programme. This categorization consists of the following topics:

- 5G evolution R&I;
- System network architecture and Control;
- Edge and Ubiquitous computing
- Radio technology and Signal processing;
- Optical networks;
- Network and Service security;
- Non-terrestrial networks;
- Special purpose networks/sub-networks;
- Opportunities for devices and components;
- Micro-electronics;
- Experimental infrastructures;
- Trials and pilots with verticals;
- Human capital; and
- Policy aspects.

We have asked each of the national initiatives to rate to what extend the topics above are covered in their national initiative. We use a star rate with 3-stars when it is main focus area, 2-stars is relevant area, 1-star means ‘also addressed’ and zero stars means not addressed. Note that Human Capital is not included in the SNS programmes, however, it is a part of several of the National initiatives. It relates to strengthening the

[7] Note that there are also 5G/6G research activities that are funded by local/regional governments (e.g. regional governments, metropolitan areas, or municipalities). Some of these can be found in the Member States Initiatives report (https://5g-ppp.eu/report-in-5g-6g-member-states-initiatives/). None of these qualify as a large initiative.

academia to attract more students and researchers, and/or promotion of spin-off activities and start-up companies.

We see different ways how the large national initiatives are organized. In some cases, the national government directly issues calls for proposals. This implies a very direct control of funding by the government. In other cases, a separate organisation is founded, which organises the national initiative as a program and distributes the funding. There is also a difference on the flexibility of budget allocation. In some countries, budgets are largely pre-allocated for the full duration of the program, whereas in other countries there are regular calls where priority can be given to specific topics per call. These distinctions are relevant when trying to organise collaboration between the national initiatives and between the national initiatives and the SNS Programme.

The remainder of this document describes for each of the 6 countries how the projects are organized, what the approximate budget is, and what kind of topics are addressed. For each of the national initiatives, there is also a section on the view from that national initiative on collaboration within Europe. In section 3.8, we have added a short overall perspective on collaboration, with an overview of all the topics addressed in the different national initiatives and goals and possible actions for collaboration that were collected in earlier discussions on collaboration between national initiatives.

3.2 The Netherlands

3.2.1 Introduction

The Netherlands aims to work on 6G through a national programme called Future Network Services [22]. The Future Network Services (FNS) programme is funded through the National Growth Fund, a fund of € 20 billion for the period 2021-2025 for investments in fields which have the highest potential for structural and durable economic growth. The Dutch government will invest up to 203 M€ in the Future Network Services programme. The programme aims to build a leading position in certain parts of 6G technology, which will strengthen the future earning power of the Dutch economy. Also the core values, ‘digital autonomy’, ‘reliability’, and ‘sustainability’ are important drivers behind the Future Network Services programme.

The proposal for a multi-year public-private Future Network Services (FNS) programme focusses on specific and connected topics in 6G: intelligent radio components and antennas, intelligent networks, and leading applications in key sectors. The details on how the work is organized within this programme can be found in the next section. Table 7 below summarizes some key information for this programme.

Table 7: Key information on the Dutch National Programme

KEY INFORMATION	
Responsible Ministry	Ministry of Economic Affairs and Climate Policy
Total Budget	315 M€ (203 M€ Governmental funding)
Expected Start Date	Q1 2024
Expected End Date	Q3 2030

3.2.2 Funding

The FNS programme will be shaped around two phases; phase 1 runs from Q1 2024 up to the end of Q2 2026 with a budget of 61 million euros. Funding is made available to the programme by the Ministry of Economic Affairs and Climate Policy. At the end of phase 1, the programme is expected to undergo an evaluation and will report on the KPIs agreed upon with the ministry. Although 142 M€ of funding is already earmarked for the second phase of the FNS, the programme still needs to make a proposal for phase 2 and demonstrate at the

end of phase 1 that it can indeed deliver on its promise of economic growth. Phase 2 of the programme will run from Q3 2026 till Q3 2030.

A certain amount of matched funding is expected from the partners within the programme, in line with EU state aid rules. Universities and research centres bring in almost no funding of their own (or a very small percentage) whereas industry is expected to match funding with on average with 50-75% private investment. SMEs enjoy special benefits and receive up to 70% public funding and are expected to bring in the rest of the investment themselves.

Within the second phase of the programme, the intention is to set part of the budget aside for different open calls. Funding needs to be matched by the partners selected. The scope of the open calls will be defined in line with the planned FNS activities. Furthermore, budget is reserved to support academic startups and SMEs, and for development of human capital.

3.2.3 Organisation of work

In FNS, three technical programme lines are linked by a fourth programme line aimed at strengthening the ecosystem.

The four program lines carry the following focus:

- **Intelligent Components**: This programme line is organised in four work packages, namely, Highly efficient transmitters, Joint communication and sensing technology, Over-the-air testing, and Optical wireless communication. This programme line is mainly driven by the microelectronics industry in the Netherlands.

- **Intelligent Networks**: This programme line in organised in three work packages. The first work package focuses on requirements, architecture and integration, WP2 focuses on 6G DevOps platform and digital twin, and lastly, WP3 will work on AI-assisted networking.

- **Leading Applications**: This programme line will focus on developing application demonstrators in various market sectors, such as, transport hubs, collaborative surgery, smart grid, wireless detection, 6G factory, e-commerce, and XR gaming. These are also the verticals or key industry sectors that the programme focuses on.

- **Strengthening the Ecosystem**: This programme line will strengthen the overall 6G ecosystem through various activities, such as, setting up a national 6G testbed, technology-policy co-development, supporting start-ups and SMEs, standardization and international collaboration, etc.

The four program lines are summarized in Figure 10 below.

The overall management of the programme is done by a Programme Board under supervision of the Supervisory Board, which will decide on strategic matters and will provide advice and guidance. In addition to the Supervisory Board, there is also an Advisory Board that has been set up for broader consultation and project steering. The programme lines report directly to the Programme Board on progress, which in turn interfaces with the Advisory Board and the Supervisory Board.

The scope of the programme is more or less fixed, with an opportunity to add new topics or partners only through the open calls in phase 2.

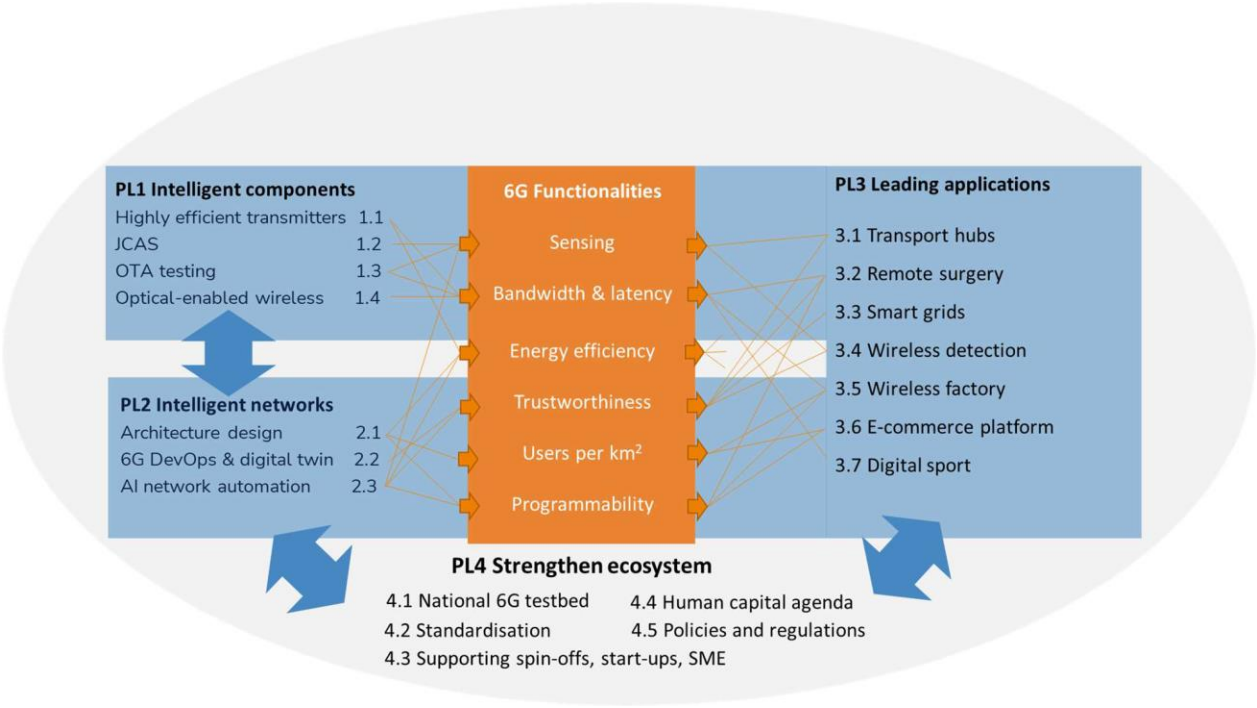


Figure 10: Overview of Program Lines

FNS aims to contribute to standardization through a dedicated work package within programme line 4 on Standardization and International collaboration. In addition, it also aims to contribute to several existing open-source initiatives. The overall project aims to achieve work within the TRL range of 2 – 6.

3.2.4 Topics covered

Using the categorization described in the introduction, we see the Future Network Services programme covering the main topics listed in Table 8.

Table 8: Topics covered in the Dutch national initiative

Topic	Relative Importance
5G evolution R&I	-
System network architecture and Control	***
Edge and Ubiquitous computing	**
Radio technology and Signal processing	***
Optical networks	-
Network and Service security	*
Non-terrestrial networks	*
Special purpose networks/sub-networks	*
Opportunities for devices and components	** (only on the network side)
Micro-electronics	***
Experimental infrastructure	***
Trials and pilots with verticals	***
Human capital	**
Policy aspects	**

In addition to the above topics, FNS also works on several societal and policy aspects such as sustainability, earning power, digital autonomy (same as sovereignty) and trustworthiness. FNS will explore policy aspects such as spectrum, competition in network sharing, urban planning for 6G, etc.

Human Capital is also one of the focus areas within the programme. This is realized through an investment of several million euros into developing learning communities. This will be facilitated through a dedicated open call, which will allow companies to develop courses and trainings for this purpose. The programme also envisions to provide work for about 75 PhD candidates, which ultimately adds to the talent pool in the Netherlands in the future. The programme is also working with a specific organization to develop talent for all areas of technology and at all levels of education (vocational studies as well as university).

3.2.5 Perspective on Collaboration

The Future Network Services initiative has a dedicated work package for Standardization and International collaboration within the Programme line 4. This work package aims to facilitate at a program-level contacts with other national initiatives within and outside the EU in order to allow information sharing. The package also aims to organize and attend workshops to align goals and organize collaboration. FNS also plans use other projects such as the SNS-ICE to establish the right contacts and boost collaboration.

The FNS programme understands the value of collaboration and sees that as the only way to truly achieve a global 6G. In order for industry within a country to access the global 6G market, it must be aligned internationally, and work towards a shared vision on 6G. For Dutch industry it makes sense to start alignment with other European players.

3.3 Spain

3.3.1 Introduction

The Spanish national initiative on 6G, called UNICO 6G R&D, is a part of the Digital Spain 2026 initiative started by the Ministry for Economic Affairs and Digital Transformation as a part of the country's digital transformation roadmap. Within this roadmap, several plans have been launched at national, regional and local level. Initially the 'España Digital 2025' initiative was launched in July 2020, but in July 2022 it was updated to 'España Digital 2026'. For Research and Innovation (R&I), additional bottom-up funding in all digital areas is made available by the Ministry for Science and Innovation in the context of the Spanish 'Strategy for Science, Technology and Innovation 2021-27'. In both cases, the initiatives launched are synchronized with EU strategies / programs[23]. Table 9 below provides some key info about the Spanish national program.

The first phase of public investments in digitalization of "España Digital 2026" is about 20.000 million €. Additionally, 11 strategic projects "PERTE" have been launched, with a public investment of more than 30.000 million €. These comprehensively cover the most relevant digital areas from different perspectives: R&I, technology uptake, deployment, skills, regulation and other investments. However, this report only focusses on the national developments with regards to research and innovation in 6G as well as certain expansions of the 5G technology, and thus will only focus on the UNICO 6G R&D programme.

Table 9: Key information on the Spanish national initiative

KEY INFORMATION	
Responsible Ministry	Ministry for Economic Affairs and Digital Transformation
Total Budget	205 M€
Start Date	2021
Expected End Date	2026

3.3.2 Funding

A total funding of 206 M€ is allocated to the UNICO 6G R&D programme and is distributed to the partners through the means of three open calls, one in 2021, 2022, and 2023 each. Within the 2021 call, a total amount 94.5 M€ was directed to selected entities. The call directly funded 9 public universities and 3 public research centres, all of which had participated in the 5G PPP programme. These entities had to subcontract to other companies a minimum of 70% of the funding received, out of which a minimum of 60% had to go to private companies, and a minimum of 15% had to go to SMEs.

Within the 2022 call, 13 M€ was awarded to private companies for R&D projects and 36 M€ to academia and research centres for equipment and infrastructure. The last call within the programme is in 2023 and carries a total budget of 62 M€. In the 2022 and 2023 calls there are specific areas/themes for R&D projects. Partners that receive the money are allowed to subcontract 50% of their funding, but they have no obligation to do so.

Public universities and research centers receive 100% funding, and thus do not need to provide any matched funding. Private companies have to match the funding received based on European regulations and contribute on average about 36% of funding. SMEs receive more funding than big private players and thus have to put up less of their own money.

Overall, within all the calls there are two subprograms, one for public academia and research centres meant only to fund equipment and infrastructure, and one for R&D projects by private entities. Proposals are accepted from individual applicants (i.e. only one company), but a subcontracting is also allowed for up to 50% of the project.

The funding received for the UNICO 6G R&D is from Recovery and Resilience plan fund (component 15, investment 6) from EU, and within Spain this is handled by the Ministry of Economic affairs and Digital Transformation.

3.3.3 Organisation of work

Figure 11 depicts the organization of work within Digital Spain 2026 programme. There are 10 axes planned to promote high-impact strategic projects through public-private collaboration and joint governance of the Nation and Autonomous Regions. These focus on a broad range of activities that are not all within our scope. But within Axis 2 on ‘Boosting 5G Technology’, there are several measures that are focussed on 5G (figure 3), including R&D on 5G and 6G. This program carries the following goals:

- Achieve digital sovereignty for Europe
- Support at least 200 R&D&I projects to develop the ecosystem of 5G and 6G technologies
- Position Spain as a center of excellence in 5G and 6G R&D

The UNICO R&D 5G Advanced and 6G Program funds public research foundations, Spanish public universities and private organizations for the development of research and innovation projects. It plans to support the creation of a ‘5G+6G R&D&I ecosystem’ that attracts investment, fostering the emergence of start-ups and innovative research companies that will develop products and services in 5G advanced and 6G. This is planned such that it is closely linked to the creation of stable and high-quality employment throughout the country. This program plans to bring about a significant improvement in energy efficiency and decarbonization in the long term, as well as fostering public-private collaboration to favour the creation of a research ecosystem and attract foreign talent. The goal of this initiative is to enable European players to develop R&D&I capabilities for 6G technologies as the basis for future digital services between now and 2030.

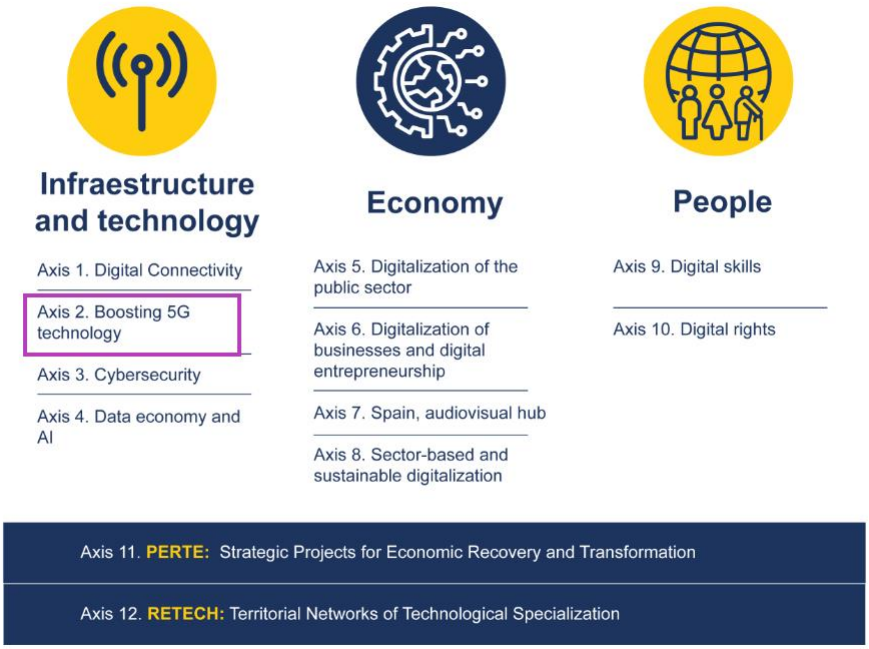


Figure 11: Organization of work within Digital Spain 2026

The UNICO R&D 5G Advanced and 6G Program is organized into three calls:

1. **2021 Call** – This call led to projects being awarded to 12 entities in Nov 2021 for a total amount of 94.5 M€. The duration of the projects will be 3 years with expected TRL levels of 2-4.
2. **2022 Call** – Through this call a total budget of 49 M€ was awarded to 48 projects. The duration of the projects will be up to 3 years with expected TRL levels of 3-6 .
3. **2023 Call** – This call was published in December 2022 and carries an indicative budget of 62 M€. The duration of the projects will be up to 3 years with expected TRL levels of 3-6

The work priorities within the programme are set through the Digital Spain 2026 agenda and the Implementation of the programme is overseen by the Secretariat of State for Telecommunications under the Ministry of Digital Transformation. Beneficiaries that have received the money have to submit a yearly report on milestones achieved, progress, updates, etc. to a dedicated unit that is following up on the progress of the project. There are no yearly evaluations done on whether projects are on the right track (e.g., to provide steering), but financial reporting is expected. Project evaluation is only done once, at the end of the project.

No there is no flexibility within the programme to add new topics or broaden the scope beyond the current call topics. The beneficiaries that have received the money have to get an approval from unit that is supervising when they outsource money to other partners, and this is done through a standard competitive procedure to ensure fair selection. Budget cannot be increased, and new partners cannot be added along the way (once a project has started). Project budgets are typically between 300K and 2M€ per project.

3.3.4 Topics covered

The UNICO R&D 5G Advanced and 6G Program covers the topics depicted in Table 10 with the specified relative importance. The programme also focuses on the societal and policy aspect of Sovereignty. No specific funding is dedicated for this, and is covered within the overall scope of the projects. In addition, 3 M€ was set aside in the 2021 call for promoting telecommunications studies.

Table 10: Topics covered in the Spanish national initiative

Topic	Relative Importance
5G evolution R&I	**
System network architecture and Control	**
Edge and Ubiquitous computing	**
Radio technology and Signal processing	**
Optical networks	**
Network and Service security	**
Non-terrestrial networks	**
Special purpose networks/sub-networks	-
Opportunities for devices and components	-
Micro-electronics	-(addressed in a different programme) PERTE Chip project (axis 11)
Experimental infrastructure	***
Trials and pilots with verticals	-(addressed in a different programme UNICO SECTORIAL 5G)
Human capital	*
Policy aspects	-

3.3.5 Perspective on Collaboration

The Spanish national initiative greatly values collaboration with the SNS. For this purpose, within the 2021 call there was an obligation imposed on the beneficiaries to contribute to the SNS JU work programme for at least 70% of the funds they've received from the national programme, after excluding the funding they've outsourced. Thus, they need to apply with a proposal to the SNS JU with a budget of at least 70% of the aid they've received through the national programme. No such condition was imposed in the 2022 and 2023 calls.

Currently, no collaboration has been initiated with other national initiatives within or outside the EU. The UNICO 6G R&D does not foresee any collaborations being initiated at the program level, but rather encourages partners within the projects to forge their own collaborations as they see fit.

3.4 Italy

3.4.1 Introduction

The national initiative from Italy is called RESTART: 'RESearch and innovation on future Telecommunications systems and networks, to make Italy more smART'. The programme is planned to run from Jan 2023 to Dec 2025, with a funding of 118 M€, and comprising of a total of 25 partners[24]. Key information about the programme are presented in Table 11.

The RESTART partnership includes several research projects, to be jointly carried out by universities, research centres, companies and public administrations. The program includes the following activities: fundamental and applied research; technology transfer and exploitation of research results, including dissemination activities; support for the creation and development of start-ups and spin-offs from research, promoting the activities and services of incubation and venture capital funds; training led in synergy by universities and enterprises,

with particular reference to SMEs, to reduce the mismatch between the skills required by enterprises and those offered by universities; PhDs program.

The focus of the project is the structural improvement of research and development in improving the ability to use telecommunications in a wide variety of sectors: agriculture, trade, energy, finance, industry, media, health, security, transportation, all while strengthening the link between scientific excellence and business.

Table 11: Key information on the Italian National Initiative

KEY INFORMATION	
Responsible Ministry	Ministry of University and Research
Total Budget	118 M€ (116 M€ received from Ministry)
Start Date	Jan 2023
Expected End Date	Dec 2025

3.4.2 Funding

The RESTART project is run by the RESTART foundation, which has been established as an independent legal entity with its own administration. While the total funding of the project is 118 M€, 116 M€ are provided by the Ministry of University and Research, while the remainder amount is coming from the private sector. The scope of this funding includes fundamental research, applied research as well as pre-competitive research.

The RESTART project started with an initial funding of 0% from the Ministry, and in regular cycles of 6 months receives more money from the Ministry, after an evaluation and reporting of the last phase. The RESTART project prepares reports on the work accomplished over the last period which are then submitted to external evaluators for feedback. These external evaluators have been selected by the Ministry. The reports together with the feedback is then submitted to the Ministry for review. If all is in order, money is released for the next phase by the Ministry.

The RESTART foundation only manages the project. Project R&D activities are carried out by partners that contribute also in-kind, such as through personnel, equipment, labs, etc.. There is no mandated matched funding expected by the partners, but the average trend shows that partners bring in about 20% of the funding in-kind.

The current funding of the RESTART project (till Dec 2025) is limited to the funding received by the Ministry as well as the contribution of the partners. However, if the foundation wants to continue beyond 2025, it will seek out other funding instruments in order to continue its work.

3.4.3 Organisation of work

RESTART is organized in a Hub and Spokes structure, where the Hub is the foundation itself and it manages and coordinates the Spokes that carry out the activities to achieve the project goals. There are 8 spokes related to eight major scientific themes. The whole organization will collaborate on the implementation of 32 research projects. The spokes can be seen in Figure 12 below, and are as follows:

1. Spoke 1: Pervasive and Photonic network technologies and infrastructures
2. Spoke 2: Integration of networks and services
3. Spoke 3: Wireless networks and technologies
4. Spoke 4: Programmable networks for future services and media
5. Spoke 5: Industrial and digital transition networks
6. Spoke 6: Innovative architectures and extreme environments

7. Spoke 7: Green and smart environments
8. Spoke 8: Intelligent and Autonomous systems

Figure 12: Organisation of work in the RESTART programme

The 25 partners of the project are considered affiliates, and each affiliate is linked to one or more spokes. Funding is received by the hub, which transfers it to the spokes and to the affiliates. Similarly, reporting for the project starts from the affiliates, moves to the spokes and finally reaches the Hub.

The programme focusses on 7 missions depicted in Figure 13, namely:

1. **Research:** The research mission comprises of 14 structural projects that define the research program and give a structure to the overall work, as well as 18 focused projects which are smaller endeavors. These smaller projects complete the structural projects towards more specific directions (industrial, theoretical).

2. **Laboratories, Proof of Concepts, Demonstrators:** The goal here is to enlarge existing laboratories and creating new, shared, ones.

3. **Innovation and Technology transfer:** This mission carries the goal to increase the TRL of results generated so as to transfer research results into innovation exploited in new products and solutions.

4. **Support to start-ups and spin-offs:** This mission will operate in three main directions, namely, provide cultural and educational instruments, issue program specific calls for research oriented to start-up creation, and offer specific support for the development of proof-of-concepts from initial ideas.

5. **Education and training activities**: Within this mission, RESTART will pursue three main interrelated objectives

a. increase the number of students in STEM (Science, Technology, Engineering and Mathematics) and more specifically in telecommunications engineering and incentivize the access to PhD. programs
b. foster the development of entrepreneur, transversal, and soft skills
c. strengthen the linkage between ICT universities and industry to support the up-skilling and re-skilling process of students and employees.

6. **PhD programs:** This mission includes extensive recruitment, broader research areas, nation-wide cross-fertilization and innovation and product-oriented research training.

7. **Communication, standarisation and open-source solutions:** RESTART will publish and contribute to peer-reviewed publications in top refereed scientific journals and conferences capitalizing the experience from research partners. Blog posts, position papers, white papers, citizen factsheets, podcasts and other non-scientific publications will be also released.

Figure 13: Missions within the Italian initiative

The 14 structural projects are indicated in Figure 14. In addition to the work structure described, there are also open cascade calls. The topics for these cascade calls are decided by an international committee based on the input it receives from the various missions. The input provided by these missions should indicate the work topics which they feel still need to be addressed within their respective missions. This procedure allows for new topics to be introduced into the project, as well as new partners to join. Some of these open calls also specifically target SMEs and offer incentives for them to participate.

There is one call envisioned in 2023 and another one in 2024. The cascade calls offer a funding of 34 M€ from the overall budget. The entities which are awarded projects through one of these calls will become affiliates and will follow a similar reporting structure to the existing affiliates. In addition to the funding available for the cascade calls, there is also a contingency fund available within the project that allows for flexibility to include new topics in the future.

The overall project aims to achieve work within the TRL range of 2 – 6.

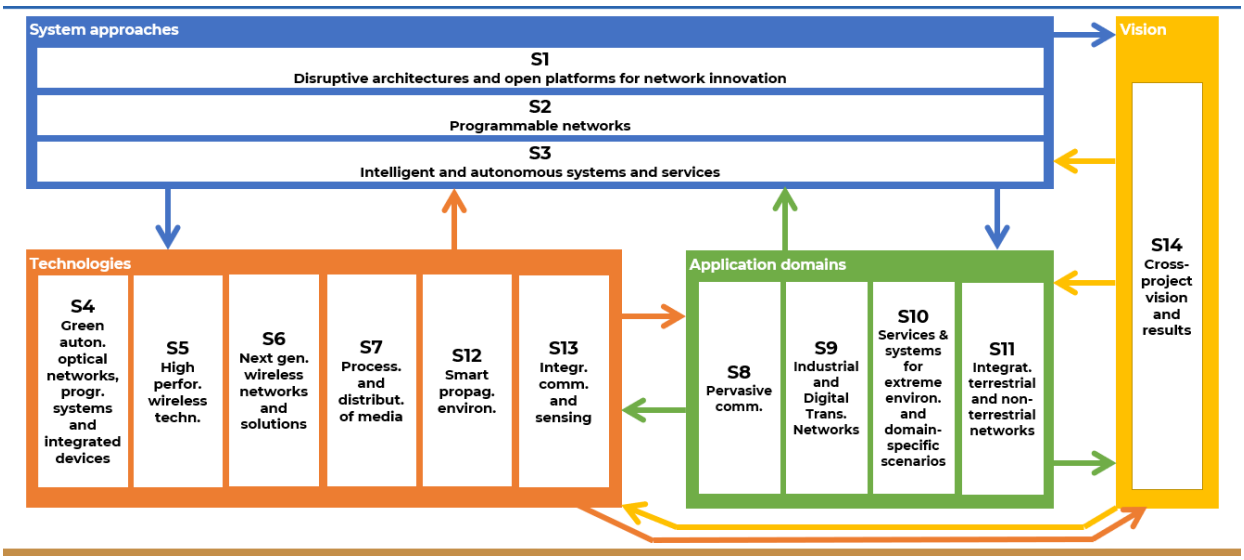


Figure 14: Structural projects within Italian initiative

3.4.4 Topics covered

Using the categorization described in the introduction, we see the RESTART initiative covering the main topics presented in Table 12.

Table 12: Topics covered in the Italian national initiative

Topic	Relative Importance
5G evolution R&I	***
System network architecture and Control	***
Edge and Ubiquitous computing	***
Radio technology and Signal processing	***
Optical networks	***
Network and Service security	* (also addressed in another national programme)
Non-terrestrial networks	***
Special purpose networks/sub-networks	***
Opportunities for devices and components	*
Micro-electronics	*
Experimental infrastructure	***
Trials and pilots with verticals	**
Human capital	*
Policy aspects	*

Aside from the topics addressed above, the project also focuses on sustainability (energy efficiency in particular) and sovereignty. These topics are included in the scope of many structural projects. Aside from this, the project also has a mission dedicated to human capital, which is funded directly.

3.4.5 Perspective on Collaboration

The RESTART project aims to establish collaborations with several other national/international initiatives and European programs in the future. These collaborations can be established both at a program and a project level.

3.5 France

3.5.1 Introduction

The French National Initiative is a part of the 'France 2030' recovery plan which has ecology, competitiveness and cohesion as its three main themes. While the plan aims to transform key economic sectors in the country including energy, automotive, aeronautics and space, the government says 5G and future telecommunications network technologies represent a key lever of competitiveness. Launched in 2021 by the French Ministry of Economy, Finances and Industrial and Digital Sovereignty, this initiative is coordinated at national level by the Directorate-General for Enterprise/Ministry of Economy and Finance, in collaboration with other competent ministries, government agencies and the national telecoms regulatory authority (ARCEP)[25]. Key information about the French Initiative are provided in Table 13.

France 2030 has 10 objectives and 6 conditions for success which make up the plan. One of the conditions for success is to 'Master sovereign and secure digital technologies' and includes the following strategic priorities:

1. Capitalize on France's scientific excellence in the field of quantum technology to fulfil France's potential of becoming a leading technological and industrial player
2. Create a French and European technological alternative that makes France a sovereign economic power in the cloud
3. Develop expertise in the technological building blocks required for 5G and speed up the development of uses while meeting the requirements of 6G
4. Stimulate training, research and uses in artificial intelligence and its adoption by the whole of French society, in accordance with our values
5. Guarantee the security, environmental sustainability and availability of talent in all areas of digital technology (AI, cloud, telecoms, quantum computing, etc.)

Table 13: Key information on the French national initiative

KEY INFORMATION	
Responsible Ministry	Ministry of Economy, Finances & Industrial and Digital Sovereignty
Total Budget	735 M€ (Governmental funding)
Start Date	2021
Expected End Date	2030

3.5.2 Funding

The French national initiative started in 2021 and is funded with 735 M€ from the General Secretariat of the Prime Minister (SGPI), managed by Direction Générale des Entreprises (DGE) of the Ministry of Economy and the Ministry of Research. The whole initiative is divided in four axes. The Axis 2 of the work focuses on the development of French sovereignty on telecom networks and is funded with 1 B€ with 360 M€ of public funding. The Axis 3 focuses on consolidation of research and development forces on future network

technologies and carries a funding of 410 M€ including 203 M€ of public investment and 30 M€ dedicated to SNS. The funding is allocated for the whole duration of the programme from the onset.

With the Call for Proposals, co-funding is expected from the participants. Public funding for industrial research is between 65% and 100%, for academic developments. The Agence Nationale de Recherche (ANR) operates national academic calls for projects, and the funding varies between 30% and 100% for fundamental research projects and between 25% and 100% for experimental development projects. The funding comes from the national acceleration strategy for 5G and future networks technologies via the Banque Publique d'Investissement (BPI), from industrial chairs (Orange's chair on 6G and environmental developments). For industrial projects funding is between 50% and 80%, for experimental developments it is between 25% and 60%, and for academic actors/projects it is up to 100%. It is also possible for projects to take out loans/refundable advances (avances remboursables) from the BPI.

3.5.3 Organisation of work

The French Acceleration Strategy on 5G & Future Network Technologies as 6G is focused on the following goals:

- Development of 5G applications and increased usage of 5G based services by the French ecosystem and society;
- 5G acceleration of deployment and vertical services offer;
- Supporting French companies, including SME and start-ups, working in the telecom industry
- Strong support of R&D and standardization of future telecommunications network technologies, such as 6G;
- Joint European effort to ensure digital sovereignty;
- Development of human resources in the field of telecommunications.

The acceleration strategy is based on 4 axes:

- **Axis 1**: support for the development of 5G uses for the benefit of territories and industry;
- **Axis 2**: the development of French solutions on telecom networks;
- **Axis 3**: consolidation of research and development forces on future network technologies;
- **Axis 4**: strengthening the training offer.

Several projects along all the 4 axes have already been launched and some others will be launched soon. The axis 3 is the axis 4 is most related to 6G R&D and include projects such as:

- The PEPR (Programme et Equipement de Recherche Prioritaire) is a part of the third axis of the national strategy. It is backed by 65 million euros of public support and addresses topics such as enabling technologies for NAN and core networks in 5G+ and future networks such as agile network architectures, cloud based and mobile edge cloud based and SDN, interoperability of heterogeneous systems, new physical layer technologies such as signal processing algorithms, advanced & intelligent hardware, etc. Its goal is to ensure a cohesive research effort on future end-to-end telecom solutions and increasingly great involvement of industrial actors in R&D topics.

- Call for Proposals (CFP): Backed by 221 million euros of public support, CPFs focus on projects which foster an interest for 5G applications, 6G developments, cyber, backhaul and submarine networks. The projects submitted are collaborative and include both industrial stakeholders and academic entities.
  - France's latest CPF 'Innovative solutions (R&D of B5G, 6G, Future networks)' funds projects which mainly focus on 5G, 6G and hybrid solutions.

  - Frame xG. This project is the result of the CFP "Maturation and Pre-maturation". It focuses on technology transfer from research to industry via the creation of a patent factory. This project focuses on the transfer of technologies & the creation of companies, as practiced by research organisms and valorization structures on the one hand. On the other hand, Frame xG will provide guidance to national stakeholders with regards to the standardization of their IP assets.
- France 6G. Various themes and goals are set out as part of the France 6G initiative. That is, for example, the development of cohesive and structured national initiatives for 6G developments, from research to standards, facilitating the exchanges between the academic and the industrial worlds, providing guidance for standardization of IP assets.
  - Announced in July 2023, Ministry of Economy & Ministry of Research are creating a French hub to connect all projects linked to 6G in France, provide guidance regarding 6G developments and coordinate national actions to create a common national position for industrial stakeholders as well as academic.
    - Reinforce cooperation between national actors;
    - Strengthen IP assets valorisation held by stakeholders;
    - Help solidify a national industrial and academic position regarding the development of certain matters.

Also the other axis have activities relevant such as:

- CFP on 5G experimentation: A total of 21 experimental platforms with 163 M€ of investment and 62 M€ of public support (in Axis #1)
- French – German CFPs on 5G private networks: A funding of 20 M€ on 8 projects with 27 companies/entities supported (in Axis #2).
- CFP Skills and Professions of the Future, including projects to design academic training courses of the future in the field of telecoms (in Axis #4)
- EDEC (Engagement du Développement de l'Emploi et des Compétences) is a project dedicated to the development of human resource in telecommunications area. Various stakeholders take part in it (Ministry of Economy and Finance, Ministry of Labour, Infranum, Afnum, industrial actors, laboratories).

In addition to the above, France national initiative also supports work done in the open-source domain. One of France's most active actors is Eurescom, which manages the Open Air Interface Alliance, develops network cores and RAN solutions. This solution is used by academics & startups to build their own activities. France also finances companies whose solutions are based on OAI.

The national initiative also has a heavy focus on industry 4.0. Previous programs in France have heavily contributed to the development of automotive industry, health, agriculture, transportation, mobility and aviation.

The 6G projects targeted by the PEPR vary from TRL 1 to 6, while the BPI's Call for Proposals vary from TRL 4 to 6, for the ANR this is TRL 1 to 4. The projects under France 6G work on TRL is 1 to 6.

3.5.4 Topics covered

Using the categorization described in the introduction, we see the France 2030 initiative covering the main topics presented in Table 14. The French national strategy also addresses sustainability issues, for example within the PEPR in 'Work Package 2: energy-efficiency of future network infrastructures' and 'WP3 : sobriety of EMF exposure and of energy consumption'. It also works on societal acceptance, cybersecurity and sovereignty concerns along with a focus on the development of human resources. France collaborates with the ecosystem to discuss the attractiveness of telecommunications ecosystem to student and workers.

Table 14: Topics covered in the French national initiative

Topic	Relative Importance
5G evolution R&I	***
System network architecture and Control	***
Edge and Ubiquitous computing	***
Radio technology and Signal processing	***
Optical networks	**
Network and Service security	** (addressed in the PEPR : “Network support to global security”)
Non-terrestrial networks	***
Special purpose networks/sub-networks	***
Opportunities for devices and components	**
Micro-electronics	*** (addressed in the national strategy of Electronics)
Experimental infrastructure	*** (PEPR’s project: “An open and integrative experimental infrastructure for 5G and Networks of the future”)
Trials and pilots with verticals	*** (ex. Edge computing in the vehicular context)
Human capital	** (via the Work Group Innovation [GT Innovation] and the EDEC)
Policy aspects	**

3.5.5 Perspective on Collaboration

France views collaboration positively and aims to leverage collaboration for good results and faster development. Collaboration is initiated at the programme level and then implemented within the projects. There are collaboration agreements in place with Germany regarding 5G developments, including a joint CPFs (private networks & industrial 5G) with Germany. Both parties involved fund the activities carried out on their respective side. France 6G also encourages national stakeholders to engage with foreign entities and participate to regional and international programs.

While France values collaboration, it also faces some impediments. The timing of the national & European calls poses a problem since their processes are very different and require different forms of engagement. In order for smaller entities to participate to SNS, they need to be known and pulled into consortiums by bigger actors. This requires considerable efforts in terms of human and financial resources, which smaller stakeholders cannot partake in while applying to national calls. Additionally, in order to submit projects, companies need to deploy significant effort. The prerequisite to do so is to have access to considerable disposable resources, both human and financial. Smaller stakeholders do not necessarily have access to such resources.

An important benefit of collaboration with other initiatives and the SNS program is the opportunity to guide the work towards certain chosen and precise developments.

3.6 Finland

Within the Finnish R&D landscape, there are two large initiatives that are currently active:

- The 6G Bridge
- The 6G Flagship

There is also 6G Finland, an independent network of 6G excellence of key organizations that aims to build the nations' innovation, competitiveness and international standing. It is an active coalition of Finnish 6G R&D organizations, and handles several aspects of 6G technology, such as policy-related work with regards to spectrum sharing and frequency allocation. The coalition helps initiate dialogues with the government in order to realize regulation on several topics of importance for 6G technology. While the 6G Bridge and 6G Finland mostly focus on business and technology, the 6G Flagship focuses on science.

As 6G Finland is not a (large) national initiative that provides funding, it is not further considered here.

3.6.1 6G Bridge

3.6.1.1 Introduction

The 6G Bridge program aims to make Finland the global leader in providing new value with 5G Advanced and 6G technologies for sustainable industries and societies e.g. in smart cities, smart energy, smart ports and smart factories with different ecosystem players. While the 6G Flagship is focused primarily on fundamental research, 6G bridge reduces the gaps between fundamental research and applied research. The two national programmes do not compete with each other but rather offer complementary services and insights [26].

The 6G Bridge offers the following program services:

- Business: innovation funding for Finnish companies for business development
- Internationalization services for Finnish companies
- Research: funding for Finnish research organizations
- Invest in Finland services for foreign companies
- Business: innovation funding for foreign companies that are register in Finland

The 6G Bridge focuses on verticals such as Health, Automotive, Manufacturing, Energy.

3.6.1.2 Funding

The 6G Bridge receives a funding of 130 M€ for a period of 4 years from the Ministry of Economic Affairs and Employment. This money is transferred by the Ministry to Business Finland, a service organisation supporting innovation in Finland, which then distributes the money to various projects in Finland working on 6G technology. Next to funding and managing the 6G Bridge programme, Business Finland offers over 50-80 other services and operates under a total yearly budget of approximately 600 M€. Currently 25 M€ out of the 130 M€ budget for 6G Bridge have been allocated to projects, with 105 M€ remaining.

The partners within the 6G Bridge projects are expected to bring in co-funding but the amount depends on the funding instrument that is being requested. There are two funding instruments available to projects – grants and R&D loans without any collateral requirement (usually for projects that are high TRL/closer to market). The amount of co-funding expected ranges from 25% - 60%, with SMEs receiving a maximum of 75% funding and thus needing to add only 25% of their own funding. For large private companies, the funding provided by Business Finland is about 40-50%. The co-funding by the parties always needs to be a cash contribution, as in-kind contributions do not count towards the co-funding.

The 6G Bridge programme does not directly report to the Ministry on its progress, but to the board of Business Finland. Business Finland in turn reports to the Ministry annually, however, not specifically on the progress of

6G Bridge but on overall KPIs that indicate the state of innovation within Finland. These could be KPIs such as impact on economy through employment, R&D activities, investment in Finland, etc. Finland aims in the future to reach 4% of its GDP through R&D activities.

While the initial funding set out by the Ministry is 130 M€, it is not limited to that. If there are relevant projects that need funding, extra funds can be released. These extra funds can allow for new topics to be addressed and/or new partners to be added to 6G Bridge. Key information about the 6G Bridge programme are summarized in Table 15.

Table 15: Key information on the 6G Bridge initiative

KEY INFORMATION	
Responsible Ministry	Ministry of Economic Affairs and Employment
Total Budget	130 M€
Expected Start Date	2023
Expected End Date	2026

3.6.1.3 Organization of work

The work within the 6G Bridge is guided by the Finnish national Strategic Research and Innovation Agenda which defines the framework for R&D&I activities. Figure 15 below shows the 6G roadmap as set out by the SRIA.

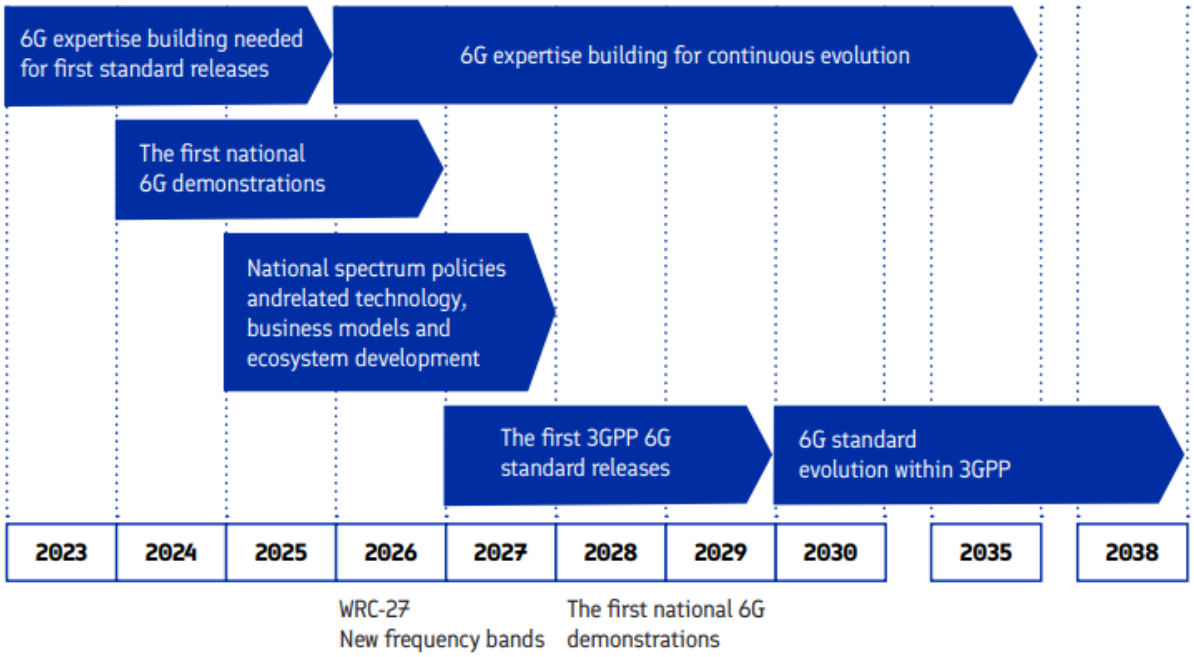
The 6G Bridge program encourages Finnish researchers and companies to increase radically both national and international collaboration – also outside the EU. The program goals will be met e.g. by:

- Increasing ecosystem-driven collaboration in research and innovation for 5GA/6G
- Building future business ecosystems in 5GA/6G and attracting international investments
- Strengthening the key capabilities in 5GA/6G
- Fostering testing and experimentation facilities in 6G

The stakeholders of the 6G Bridge initiative includes 190 organizations, main industry ICT including companies such as Nokia and Ericsson, as well as other Finnish initiatives such as 6G Finland, 6G Flagship, 5G Momentum, Allied ICT Finland, Academy of Finland, Technology Industries of Finland.

The priorities set out by the SRIA along with the internal KPIs of Business Finland allow them to decide which projects are relevant and which are not. Projects can be carried out by a single entity or a consortium, and usually have a budget somewhere between 50k and 3 M€, with a typical length of 1-3 years. Projects are welcome to apply for funding at any time and are not bound by call deadlines. The projects cover a TRL range of 3-8.

Reporting by the projects towards Business Finland has to be done at minimum once at the half-way point and once at the close of the project. The reporting must include a financial update as well as an update on the progress. At the start of the project, Business Finland agrees on KPIs together with the project partners which forms the basis for evaluation of the project. Funding is not withheld based on poor performance, but poor performance may result in hesitation to fund further projects with the same partner/consortium. In general, Business Finland looks for high risk, high reward projects, which implies some projects will not be successful.



2023 – 2025 **6G expertise building needed for the first standard release;** to lay the foundations for 6G basic system, standards, and first national 6G demonstrations etc.

2024 – 2026 **The first national 6G demonstrations;** demonstration of potential 6G technology enablers and sytem components, definition of end-to-end system KPI/KVI validation criteria etc.

2025 – 2027 **National spectrum policies and related technology, business models and ecosystems development**; technology development, setting national spectrum policies, contributions to global 6G regulations and further development of national ecosystem etc.

2026 – 2028 **6G standard first version within 3GPP;** contributions and development of first 6G standards, enhance ment of national 6G demonstration capabilities and use case demonstration of 6G basic system etc.

– 2035 **6G expertise building for continuous evolution;** building the expertise for 6G evolution, technology enabler development, research of use cases etc.

– 2038 **6G standard evolution within 3GPP;** contribution to standardization, development of technology enablers etc.

Figure 15: 6G Roadmap as set out by the Strategic Research and Innovation Agenda

3.6.1.4 Topics covered

Using the categorization described in the introduction, we see 6G Bridge covering the main topics presented in Table 16. 6G Bridge also focuses on policy and societal aspects such as sustainability and sovereignty. There is no dedicated funding for this within 6G Bridge, but is at the core of the whole development. Business Finland , 6G Flagship and 6G Finland collaborate on their views on policies for 6G. While the Ministry guides the overall policy aspects to be considered for 6G technology, Business Finland does not impose any rules on its projects and customers. The projects have their own freedom to pursue policy and societal topics in the manner they see fit.

Business Finland and its internal departments also work on human capital, however, this does not form a part of the 6G Bridge project. Work in Finland is one of the internal departments that focuses on attracting talent to Finland and its projects. Invest in Finland is another department that can aid with companies that would like to

establish themselves in Finland. Other activities focusing on human capital include sharing knowledge with the community and matching research knowledge with industry, and also looking into software and tools needed for 5GA and 6G.

Table 16: Topics covered in the Finnish 6G Bridge programme

Topic	Relative Importance
5G evolution R&I	***
System network architecture and Control	***
Edge and Ubiquitous computing	***
Radio technology and Signal processing	***
Optical networks	-
Network and Service security	***
Non-terrestrial networks	**
Special purpose networks/sub-networks	***
Opportunities for devices and components	*
Micro-electronics	**
Experimental infrastructure	*
Trials and pilots with verticals	***
Human capital	**
Policy aspects	*

3.6.1.5 Collaboration

Business Finland (and in turn 6G Bridge) address collaboration at various levels – national, within the EU, and outside the EU. They actively participate in projects such as KDT, SNS, EUREKA, EUROSTAR etc. in order to work together with like-minded countries. MoUs have been signed with some countries as well as some states in the US, however, Business Finland prefers to realize collaboration through joint projects such as the ones mentioned above, bilateral calls such as under EUREKA or directly within another country to create joint projects for similar R&I.

6G bridge doesn't sign MoUs on its own, this is always done at the Business Finland level. If a project is started on 5GA/6G and funded by Business Finland, then it automatically falls under the scope of 6G Bridge.

Business Finland understands that a major benefit of collaboration is the accumulation of expertise from various countries, to solve the challenges of the future together. However, barriers to such collaborations are the difficulties in finding the right SMEs and deep-tech companies within other countries. It is hard to find the right match within another country and finding the right funding instrument for such collaborations is also a challenge.

3.6.2 6G Flagship

3.6.2.1 Introduction

6G Flagship is a part of the Finnish government's national research spearhead programme from 2018 to 2026. The goal is to create the essential 6G technological components, the tools, and the equipment to build a 6G Test Network, develop chosen vertical applications for 6G to accelerate societal digitization and continue to be

a recognized vision leader and sought-after research partner in worldwide 6G research. The initiative is run by the Centre for Wireless Communications (CWC) at the University of Oulu in Finland[27]. Key information about the 6G Flagship programme are summarized in Table 17.

Table 17: Key information on the Finnish 6G Flagship initiative

KEY INFORMATION	
Responsible Ministry	Ministry for Education and Culture
Total Budget	250 M€ (19.7 M€ Governmental funding)
Start Date	2018
Expected End Date	2026

3.6.2.2 Funding

The programme is funded by the Research Council of Finland (RCoF) for a period of 8 years with an amount of 19.7 M€. University of Oulu contributes 16 M€ to the programme, bringing the total dedicated funding to 35 M€. However, the project operates with a total budget of 250 M€. This is organized such that the rest of the funding is received from faculty of ITEE, external projects, such as those funded by Horizon Europe, SNS, Business Finland, private companies, etc. The dedicated funding of the 6G Flagship (35 M€) is not distributed via projects, but instead contributes to the salaries of the staff working on the programme, such as professors, post-doctoral researchers, PhDs, etc.

The funding received from the RCoF is divided over two grants for the whole duration, given out in three instalments. The first grant is for the first 4 years of the project for an amount of 9.1 M€, and then two instalments over a period of 2 years each contributing a total of 10.6 M€. Since this internal money does not fund any projects, there is no obligation for the partners within the externally funded projects to bring in any co-funding. The co-funding expectations of those projects are set by the body from which the funding is received.

The 6G Flagship has ambitions to continue its work beyond 2026 as well. There are currently discussions ongoing with the Ministry to explore options for additional funding. In case additional governmental funding is not available, the programme can still continue with additional funding received from University of Oulu and through the externally funded projects.

3.6.2.3 Organization of work

This programme carries the following goals:

- **6G Technology Enablers**: 6G Flagship will carry out technology and system pilots for selected verticals by co-creating with companies, ensuring timely relevant wireless expertise availability for industry needs, and enabling economic growth via an early adaption of critical smart society technologies.
- **6G Test Network Development**: creating a nationwide test network environment.
- **6G Vertical Applications**: to gain a deeper understanding of the selected vertical applications: health, energy, automotive, and industry, security and defense; what they will require and how they fit into the 6G ecosystem.
- **6G Vision Leadership**: assessment of future risks and possibilities.

The programme focusses on four strategic research areas, as described in Figure 16.

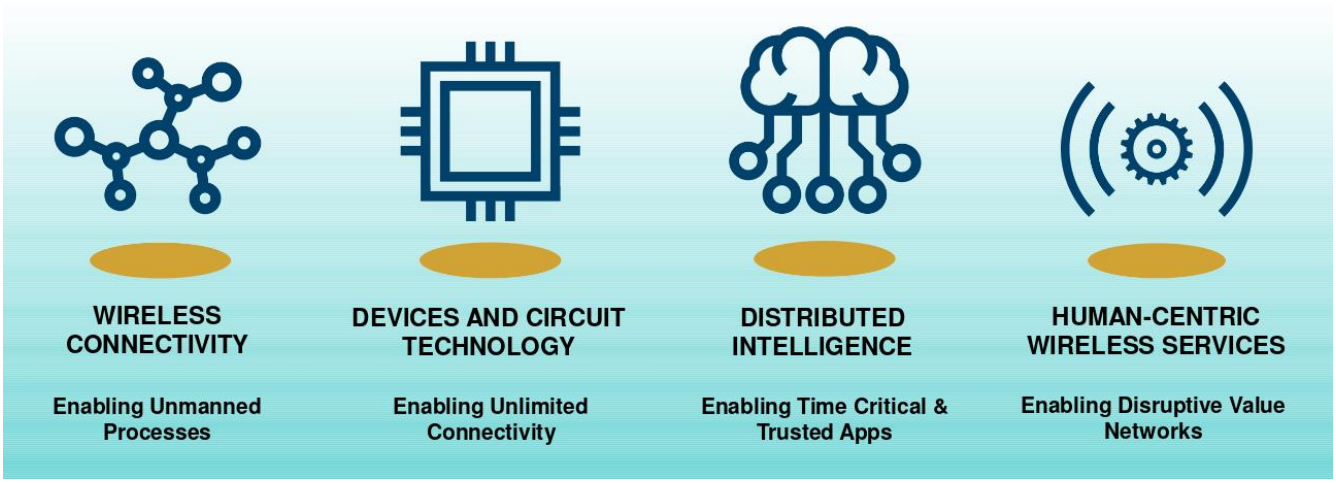


Figure 16: Strategic research areas within the Finnish 6G Flagship initiative

The strategic research areas are further subdivided in research themes as presented in Table 18

Table 18: Research themes in 6G Flagship

Strategic Research Areas	Research Themes
Wireless connectivity	Advanced networking technologies
	Wireless access technologies
	Massive wireless automation
Devices and circuit technology	Radio platforms
	Radio hardware
	Experiments and proofs of concept
Distributed intelligence	Computing on the edge-to-cloud continuum
	Distributed AI
	Multimodal sensing and modelling
Human-centric wireless services	5GTN to 6GTN (experimentation platform)
	Strategic vertical areas
	Sustainability, business, and regulation

The 6G Flagship currently has about 300 externally-funded projects under its umbrella; these are Horizon Europe projects, SNS, KDT, etc. 6G Flagship does not release any calls of its own; partners wishing to start projects must apply for other calls such as the ones mentioned above. As long as the work being done in the project aligns with one of the strategic research areas, the project is accepted as a part of 6G Flagship. In the 6G Flagship ecosystem there are three different levels of partners: an affiliate, a project member and a co-creator i.e. strategic member. Only co-creators (strategic partners) are expected to bring money into the project, but this could also be money in the form of equipment instead of cash.

The 6G Flagship is guided by the 6G Flagship Steering Group and the Research Leadership Group. The Steering Group advises the programme from the point of view of the research strategy of the University of Oulu but is not a decision-making body. The Research Leadership Group on the other hand makes operative decisions and defines and accepts proposed research agendas, including making changes to the usage of the budget. The

individual projects, operating under the 6G Flagship umbrella, report on their progress to the particular Strategic Research Area they are linked to. The SRAs report to the Research Leadership Group, that in turn reports to the Steering Group. Every second year the 6G Flagship has to report to the RCoF on the progress of the programme.

The projects within 6G Flagship work within the TRL range 1 – 6.

3.6.2.4 Topics covered

Using the categorization described in the introduction, we see 6G Flagship covering the main topics presented in Table 19.

Table 19: Topics covered in the Finnish 6G Flagship initiative

Topic	Relative Importance
5G evolution R&I	***
System network architecture and Control	***
Edge and Ubiquitous computing	***
Radio technology and Signal processing	***
Optical networks	*
Network and Service security	***
Non-terrestrial networks	*
Special purpose networks/sub-networks	**
Opportunities for devices and components	***
Micro-electronics	***
Experimental infrastructure	***
Trials and pilots with verticals	***
Human capital	-
Policy aspects	***

Sustainability and UN SDGs are the main driving factors in the research. There is a dedicated project (with its own funding) within the 6G Flagship umbrella, called the 6G-Enabled Sustainable Society (6GESS) program, which capitalizes on 6G Flagship's technological expertise to develop the scientific framework for a data-driven, hyper-connected future society. Additionally, the programme has one dedicated person who specializes in topics on sustainability. Sustainability is considered cross-sectional across all SRAs and verticals.

Human Capital is neither a research area nor a topic within the 6G Flagship, but it is addressed within the Human Centric Wireless Services strategic research area and its projects, where user need is taken into account. The programme also has a global pilot project (funded by the Ministry of Culture and Education) in countries like India, where education is one of the focus areas. The countries involved in these pilots bring their own funding as well.

3.6.2.5 Perspective on Collaboration

The 6G Flagship collaborates with many national and international partners as well as other national programmes though the 300+ projects under its umbrella. They cooperate widely with international science communities, academia and universities across the globe, including many European countries, US, Brazil, Japan, Korea, China, India, Singapore, etc. These collaborations are realized mostly via joint projects and academic cooperations.

The starting point for these collaborations can be an MoU but as soon as it reaches to a joint project, project agreements come into place. Collaboration agreements are always drawn up at the programme level even though work is often pursued with one of the strategic research areas or one of the projects.

6G Flagship recognizes that by working together through collaboration, good results can be achieved faster and they can influence the upcoming standards. However, in some cases collaboration is quite challenging. Some national regulations could be a limiting factor. But a bigger challenge is that not every country, even within the EU, is at a position to start work on 6G yet. There are many countries that are still struggling with 4G deployments. Local readiness within Europe for 6G varies greatly, and this factor influences collaboration.

3.7 Germany

3.7.1 Introduction

The German 6G Programme comprises different kinds of projects. The "6G Platform Germany" or more precisely the "Platform for Future Communication Technologies and 6G" is the so-called "umbrella organization" of the German 6G Programme [28]. It is intended both to make scientific contributions to the content design of 6G and to ensure the scientific-organizational support for the processes that are necessary for the successful implementation of the German 6G program. Key information about the German Initiative programme are summarized in Table 20.

Table 20: Key information on the German 6G initiative (Sept 2023)

KEY INFORMATION	
Responsible Ministry	Federal Ministry of Education and Research
Total Budget	700 M€
Expected Start Date	2021
Expected End Date	2029

The program was announced in April 2021 and is structured as follow (Status September 2023):

- 6G Platform Germany, October 2021 –2025
- Four 6G Research Hubs, 2021 –2025
- Eighteen 6G Industry Projects, 2022 -2025
- Seven Projects on Resilience, 2023 –2025
- AI-NET, 2021 -2024
- Projects on high-speed networks for hyper connectivity, 2024 - 2027

3.7.2 Funding

The 6G Programme is funded by the BMBF or the German Federal Ministry of Education and Research. At the time of writing this report, the total budget of the programme was estimated to be 700 M€, however, since the programme continues to add new projects, the final number cannot yet be ascertained.

The programme officially started in 2021, although the CELTIC-NEXT AI-NET project, which was included under the German 6G programme when the national initiative started, was already active before that. In Sept. 2023, there are already plans to add new projects to the German 6G program (four StartUp Incubators) that might last beyond 2025.

The budget for the hubs is allocated often in two or three phases. Within the allocated budget, the budget is allotted on a yearly basis. The administrative framework for funding – in particular, the need for co-funding -

follows the BMBF standard procedures. Universities don't need to co-fund, research institutes have differing rules, e.g., Fraunhofer doesn't need to provide co-funding, however, the German Research Center for Artificial Intelligence (DFKI) needs to provide co-funding. Private companies are subject to different rules but information on these rules is not public information. These rules also differ for big private companies versus start-ups, SMEs etc. Participation of SMEs is viewed positivity during the evaluation of projects. SMEs can – under specific conditions - receive a higher funding rate of the public funding than big companies , and hubs are encouraged to look for SMEs to be suppliers within the projects.

3.7.3 Organisation of work

Themes and topics for the projects within the scope of the German 6G Programme were defined based on the submissions received in response to open calls. These calls were pretty broad. The submissions were evaluated by an evaluation board and recommendations by this board were made towards the BMBF. However, the final decision of selection and fund allocation rests with the BMBF. There were several calls, including one call for a platform, one call for industry projects, one for research hubs, one for resilience projects, etc.

When a new project is added to the German 6G Programme, it could be linked to an existing project or a hub. A cooperation with the 6G-Platform is mandatory though. Whenever a new topic seems important and budget becomes available, calls might be put out. The new calls allow for new partners and new topics to be added to the current pool, and additional budget could be made available by the BMBF for this purpose.

The overall TRL covered within the German 6G Programme is 1-4, in exceptional cases up to 5. Regarding higher TRL in the areas of 5G evolution and with regard to policy aspects of future 6G, BMBF is closely working together with the German Federal Ministry for Digital and Transport (BMDV).

3.7.3.1 6G Platform

Main instrument of the 6G Platform are "Working Groups". Participation in this Working Groups is open to all participants from partners funded in the BMBF 6G Programme. This part of the programme was initially designed keeping in mind the structure of the 6G-IA / SNS JU working groups and tries to simplify the collaboration with 6G-IA and SNS-JU. Additional Working Groups are set up based on demand. Note that the 6G Platform is not some kind of supervision body for the German 6G Programme. It depends on voluntary contributions of the projects. All other projects have their own governance structure and they operate independently, i.e., there is no reporting to the 6G Platform project, although the 6G Platform aims to keep in touch with all projects.

1. **WG1 Science Communication**: This group is responsible for bilateral communication with all stakeholder groups relevant for 6G. An important motivation is to increase acceptance for 6G networks, services, and applications. Topics that get addressed are concerns about electromagnetic exposition, privacy issues, technological sovereignty, and participation (in particular in rural areas).
2. **WG2 Societal perspective**: This group will focus on sustainability and participation.
3. **WG3 Maximizing impact**: The focus here will be on involving vertical industries, SMEs, and management of innovation.
4. **WG4 Building a global 6G vision**: This group will focus on building the vision, use cases, and roadmaps for 6G.
5. **WG5 Security, Resilience, and Trustworthiness**

Additional working groups are currently set up.

3.7.3.2 6G Research Hubs

Within the German national 6G initiative, four 6G research hubs were started in 2021, with an overall budget of approximately 275 M€. These hubs comprise of about 160 research groups at overall 21 universities and 15 research institutes. More than 40 SMEs are already part of the research network. Figure 17 below shows the location of the coordinating partner.

Figure 17: Research hubs within the German national initiative

3.7.3.3 6G Industry Projects

Within this part of the national initiative, 18 projects were started in 2022 all led by industry. This includes a total of around 70 industry partners, 20+ universities, and 9 research institutes. In total, the funding provided is approximately 150 M€.

Industry participation includes major infrastructure vendors, four major MNOs, test-and measurement equipment and service providers, major semiconductor manufacturers, OEMs in automotive, airplanes, drones, robots, automation equipment, commercial vehicles, medical equipment, infrastructure operators (factories, airport), and more than 40 small and medium companies with products completing the 6G ecosystem or benefiting from 6G connectivity.

The use case scenarios and application areas which will be in focus are:

- Campus networks (automation, campus logistics),
- Medical scenarios (hospitals, emergency, operation theatre)
- Mobility (automotive, commercial vehicles, drones)
- Global coverage (satellites, rural areas, in-X networking)

Germany also constantly evaluates the use-cases included and expands when needed. For example, in discussion with other national programmes Germany identified certain verticals they missed out on, such as tourism.

3.7.3.4 6G Projects on Resilience

These projects focus on the resilience of communication infrastructure and digital systems: System architecture, technologies and modules (Hardware and Software), and network management aspects are addressed. About 24 M€ of funding is provided by the BMBF.

Within this part of the initiative, seven projects were started in January 2023, addressing the cyber(-physical) resilience, security and protection of connectivity infrastructure, data, and data processing. The results from these projects will be input to 6G Platform Working Groups.

The resilience projects could achieve a TRL level 5, while the rest of the programme caps technology readiness at TRL 4.

3.7.3.5 Projects on High-speed networks for hyper connectivity

The funding call was released in March 2023. First projects are intended to start in the first half of 2024. The aim of the funding is to support research into new optical data transmission technologies that can be used to build high-speed networks for the highly networked society in order to create favorable framework conditions for the development of innovative communication systems in Germany.

3.7.4 Topics covered

The German national initiative covers the main topics presented in Table 21, with the assigned relative importance.

Table 21: Topics covered in the German national initiative

Topic	Relative Importance
5G evolution R&I	**
System network architecture and Control	***
Edge and Ubiquitous computing	***
Radio technology and Signal processing	***
Optical networks	***
Network and Service security	***
Non-terrestrial networks	***
Special purpose networks/sub-networks	***
Opportunities for devices and components	***
Micro-electronics	***
Experimental infrastructure	**
Trials and pilots with verticals	*
Human capital	**
Policy aspects	**

The experimental infrastructure within the German 6G programme focuses on building facilities to carry out experimentation on technologies and test certain applications, etc. The programme builds on existing experimental facilities to make them suitable for use within 6G. Trials and Pilots are not yet addressed within the programme, because there are no trials yet for 6G, but this topics remains in the scope for the future.

The German 6G programme already identifies the expressed need for information in 3GPP and will be contributing on topics such as channel models for 6G through the research output of the projects. During the pre-standardization phase, the projects will work mostly on the identification of requirements, use-cases, KPIs, etc. Although the programme itself does not itself engage in any standarisation work, at a later stage, the industry partners and some research partners will contribute to international standardization. Some partners aim to contribute to existing open source initiatives as well as provide its own open source products for results of the hubs.

The programme also focus on several societal and policy aspects such as sustainability, sovereignty, privacy and data protection, EM compatibility, scientific communication and gaining acceptance, trustworthiness, gender equality(women in 6G). The 6G Platform has the dedicated responsibility of working on these topics. In addition, the hubs and industry projects also work on this and the platform has the task to bring it all together and harmonize it.

Human Capital is one of the very strong motivations for the programme as Germany recognizes the need for good qualified talent. However, there are limited funding instruments dedicated to this, as this forms a part of the general activities of the research hubs. The research hubs offer opportunities to researchers from all over the world and also have budget for scientific exchange programs, workshops, conferences, etc.

3.7.5 Perspective on Collaboration

The German initiative addresses collaboration both via the 6G Platform as well as through their flagship project, 6G ANNA. Currently they have collaborations in place with several countries within Europe and outside the EU. They have an MoU with 6G-IA, joint projects with Japan are under discussion, two workshops conducted together with Japan in Berlin and Tokyo, two more planned for 2024, a workshop at the EUCNC on non-terrestrial networks where they invited all parties working on NTN to contribute, planned workshops with Singapore. HEXA-X / HEXA-X II is always invited to the 6G Platform events and presenting their latest results. Further collaborations are planned. The collaborations are initiated mostly at a programme-level but the matchmaking is done at a project-level. Eurescom has been engaged as a subcontractor by the programme to help organize such matchmaking events to find fruitful collaboration opportunities.

Through collaboration the German national initiative aims for a harmonized view on 6G. In addition, they find it to be a useful tool in identifying overlapping areas of work and complementary activities within the projects of other countries. The programme identifies long legal procedures to be a barrier for establishing collaboration, but also recognizes these to be a necessary evil.

3.8 Overview of the topics covered by the different national initiatives

Concerning the collaboration with or among the large national initiatives, it is important to identify what topics each of the national initiatives focuses on and common topics being addressed by multiple national initiatives. Based on the structured interviews with each of the national initiatives, we have summarized the relative importance of each item in a specific list of topics. Every national initiative was given the same list of topics to be scored by them, to make comparison feasible. An overview of the relative importance of the different topics for all interviewed initiatives is presented in Table 22.

Based on the above summary of National Initiatives priorities it can be observed that certain topics are indeed considered more important at this stage of development, attracting the focus of EU researchers from multiple nations. ***System network architecture and Control*** and ***Radio technology and Signal processing*** are at the top of the priorities list of the NIs, which indicates the importance that Europe places on having a leading role in the standardization of 6G. These are the first aspects of any new technology under development, and early insights and results from R&I projects will assist European stakeholders to have a strong voice in the international stage and make meaningful standardization contributions regarding architecture and radio aspects for 6G. A testament to the importance that standardization plays for EU stakeholders is that multiple NIs joined the SNS JU projects and under the leadership of SNS ICE, presented a common EU front in the latest 3GPP SA1 meeting in Rotterdam, The Netherlands (May 2024), for the prioritization of 6G use cases.

Table 22: Overview of relative importance scores from the different national initiatives

Topic	Relative Importance						
	Netherlands	Spain	Italy	France	6G Bridge Finland	6G Flagship Finland	Germany
5G evolution R&I	-	**	***	***	***	***	**
System network architecture and Control	***	**	***	***	***	***	***
Edge and Ubiquitous computing	**	**	***	***	***	***	***
Radio technology and Signal processing	***	**	***	***	***	***	***
Optical networks	-	**	***	**	-	*	***
Network and Service security	*	**	*	**	***	***	***
Non-terrestrial networks	*	**	***	***	**	*	***
Special purpose networks/sub-networks	*	-	***	***	***	**	***
Opportunities for devices and components	**	-	*	**	*	***	***
Micro-electronics	***	-	*	***	**	***	***
Experimental infrastructure	***	***	***	***	*	***	**
Trials and pilots with verticals	***	-	**	***	***	***	*
Human capital	**	*	*	**	**	-	**
Policy aspects	**	-	*	**	*	***	**

Following on the list of priorities of the NIs are ***Edge and Ubiquitous computing*** and ***Experimental infrastructures***. The focus on Edge and ubiquitous computing follows the world-wide trend on merging telecom networks with computing and other networks presenting a unified ubiquitous solution. This trend is also apparent on the EC's position paper on 3C (Connected Collaborative Computing) networks, indicating a common roadmap between the NIs and the EC. Already several NI and SNS JU R&I projects are investigating the full integration of edge computing in various layers of the B5G and 6G systems. Experimental Infrastructure on the other hand is treated as a universal pre-requisite for the further development, testing and validation of

6G enabling technologies in the filed. It is important to invest and build state-of-the-art facilities across Europe in this early stage, to enable immediate proof of concepts, field testing and real-life trials once the technologies are ready. Once again, the roadmaps of the EC, SNS JU and NIs seem to be aligned on this aspect, as they are all heavily investing in creating these experimental facilities.

The alignment between the SNS JU running R&I projects and the priorities of the European NIs is also apparent by comparing the above results/insights regarding the Eu NIs with the outcomes of the annual SNS OPS survey[8] conducted on all SNS JU Call 1 projects in 2023. Figure 18 provides the prioritization in terms of addressed network aspects and/or technologies among the 33 Call 1 SNS JU R&I projects. The prioritization of network architecture, Edge and ubiquitous computing and radio technology is once again crystal clear, while the SNS JU is clearly also prioritizing experimental infrastructure as it has commissioned several projects to create state-of-the-art facilities under a specific stream (Stream C). These four fields highlighted here, are prime candidates for further collaboration between the European NIs and SNS JU stakeholders.

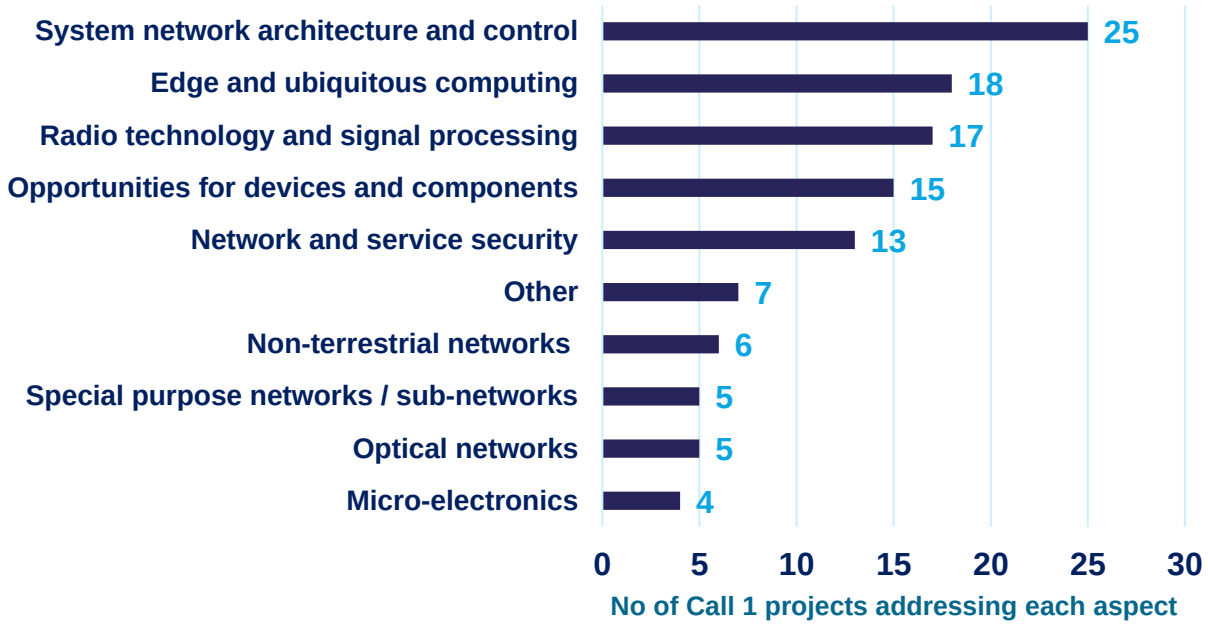


Figure 18: Network aspect/technology investigated by SNS JU Call 1 projects (SNS OPS survey[8])

Almost all other topics from Table 22 seem equally important as they attract the interest of most EU NIs, however the different priorities originating from the different regional, geographic, political and economic landscapes of each country lead to a slightly different prioritization among the NIs. Nonetheless, all topics attract a significant amount of interest, guaranteeing that they will be duly investigated.

[8] https://smart-networks.europa.eu/event/sns-ops-survey-webinar/

4 European Collaboration

4.1 Goals of collaboration

While each country within the Member States has a different way of organizing their B5G and 6G programmes, it has also been recognized that several goals can be achieved through collaboration. The SNS programme can collaborate with the national initiatives to create a stronger 6G ecosystem, as well as collaboration between the different national initiatives can yield productive outcomes. Some of the goals that can be achieved via European collaboration have been identified as follows:

- Ensuring European leadership for 6G: This can be achieved through standardization activities, setting up federated infrastructures to demonstrate EU 6G technology, and establishing an advanced technological solution that receives global acceptance.
- Improving the operation of digital industries: This can be achieved by increasing the uptake of 6G technology by the verticals, creating advanced infrastructure for the verticals to use, and engaging large industry players and well as SMEs to participate in 6G.
- Address societal needs and policy objectives: 6G technology across Europe should focus on addressing societal needs such as sustainability, technological sovereignty, and resilience. Focus should also be on creating a knowledge base of education and training for all member states to access.

In addition to the goals identified above, collaboration between the national initiatives and the SNS should also focus on addressing challenges such as mobilizing the European stakeholders in a synchronized way, combining resources, and creating a critical mass of European solutions and testbeds, and work on minimizing the technological gap among EU countries.

4.2 SNS-ICE proposed collaboration actions

During the National Initiatives co-creation event at 5G Techritory 2023, organized by SNS ICE, multiple experts from EU side (SNS JU, 6G-IA, SNS ICE) and representatives from the various National Initiatives (NI) brainstormed in sub-groups about the next steps that could reinforce collaboration on various fronts. Based on the output of these brainstorm sessions, as well as additional contacts that SNS ICE partners have maintained with EU partnerships, working groups and national representatives, a set of concrete recommendations were established for three main topics, which SNS ICE partners can follow up on. These proposed collaboration actions are described in the below sub-sections focusing on the ***What, Who*** and ***When***, in order to highlight a concrete way forward.

4.2.1 Exchange of Information

In multiple interactions with the National Initiative representatives, as well as during the SNS ICE Techritory 2023 event, it has been highlighted that an improved flow of information between the various EU instruments and (at least) the main EU Initiatives would be desirable. This concept describes the need for a designated convergence point where relevant information may always be available for interested parties, as well as an established way of communication for information exchange among the various EU and NI representatives. The goal of such a “mechanism” would be for NI representatives to be kept up to date with developments regarding SNS JU funded projects and other relevant EU R&I activities, while on the other hand EU officials and representatives would also have an easy way of discovering key information about specific National Initiatives and how these align with the EU roadmap. Further, this mechanism would include a common communications channel, where relevant information (e.g., on upcoming events, webinars/presentations, announcements, etc.) would be easily and efficiently exchanged among the various representatives, hence facilitating dynamic information exchange and ensuring that all key developments, results and events are known to all stakeholders.

With that in mind, the brainstorming session that took place during the National Initiatives co-creation event at 5G Techritory 2023, proposed some concrete steps forward to set in place such a mechanism. These steps were subsequently discussed with the SNS OPS project as they implement most of the information exchange facilities within the SNS JU. The resulting key elements proposed are explained in Table 23.

Table 23: Suggestions to improve information exchange

Information Exchange – Brainstorm Session Outcome			
WHO (Information/service to be provided)	**WHAT**	**DESCRIPTION**	**WHEN**
SNS ICE (Overall organization + Provision of SNS JU information) **National Initiatives Representatives** (Provision of relevant information from NI side)	**Overview shared document with:** • Catalogue of Experimentation Facilities • National Initiatives Key Info	A publicly shared overview document should be created which brings together key information both related to the SNS JU projects as well as related to the various national initiatives in the EU. More specifically the following elements of such a shared document were identified: **Catalogue of Experimentation Facilities:** A catalogue of the available B5G/6G experimentation facilities around Europe (both from SNS JU projects and from national Initiatives) and their key characteristics should be available. This would offer a quick overview of the experimentation landscape in Europe and would provide relevant links for further, more detailed information **National Initiatives Key Information:** A webpage containing key information about the main EU National Initiatives including research topics of focus, available testbeds, available funding, relevant links for more detailed information and contact persons for further inquiries.	Provision of information by SNS ICE, and NI by end of March 2024. Distribution of document by end of April 2024.
SNS ICE (Overall organization) **SNS OPS** (Provision of calendar) **NI Representatives + SNS projects** (enter	Online Calendar for upcoming Events	A common online calendar where each party can enter relevant events, keeping other stakeholders aware of upcoming events. NI representatives and SNS JU representatives (SNS projects, 6G-IA, SNS JU office) may provide information on upcoming events / webinars / sessions, to create awareness and to allow for	Common online calendar implementation by end of April 2024.

relevant events on calendar)		other representatives to join open events.	
SNS ICE (email list creation)	Common list of e-mail contacts	A list of e-mail contacts containing key representatives from the SNS JU (SNS JU office, CSA projects, 6G-IA) and at least 1 representative from each main EU National Initiative, to facilitate communication among stakeholders and widescale reception of relevant announcements. This list can also be used for the organization of common events. *Attention*: caution should be taken by all participants in the list to not misuse the list with intensive messaging (spam) and to treat the list in accordance with GDPR rules.	Email list implementation by end of February 2024.

4.2.2 Aligned approach towards standardization (EU use case input)

As the research and innovation work towards the next generation of networks is progressing around the globe, the availability of timely and effective inputs towards the relevant standardization bodies will become of utmost importance. It is the intention of the SNS JU and the National Initiatives that a certain degree of alignment is achieved among the European stakeholders with regards to specific key issues, to present a "united front" in the relevant standardization discussions and to maximize the potential impact of EU-originated ideas/solutions within global standardization.

One such opportunity is the upcoming 3GPP Workshop to discuss the main use cases that will be considered for next generation (6G) networks. This workshop, which will likely take place in May 2024, will set the priorities with regards to the main use cases to be considered / targeted during the development of 6G features & technologies.

During the NI co-creation event at Techritory 2023, a group of experts from both the SNS JU and the National Initiatives brainstormed on ways to better prepare for this global workshop and on how the various EU stakeholders could potentially align, based on their respective work on 6G use cases, to maximize the impact achieved by EU side during the global 3GPP workshop. The approach proposed in the table could also form a model for future collaboration between the SNS JU and the National Initiatives in other relevant matters. The outcome of this brainstorming session and the agreed next steps are presented in Table 24.

Table 24: Suggestions to align EU approach towards standardization

Aligned EU approach towards global 3GPP workshop on 6G use cases	

WHO (information or service to be provided)	• **SNS JU** (SNS JU office + SNS ICE + 6G-IA)
	  ○ Lead the organization of this exercise, the preparatory work and organize the preparatory meeting
	• **National / Sectoral Initiatives**
	  ○ Provide their experts and views with regards to the 6G use cases
	• **SNS Projects**
	  ○ Provide input based on their work on 6G use cases

	• **6G-IA Pre-Standardization WG** ○ Provide consolidated input based on their expertise *The SRG should also be leveraged to include the view of the EU member states.
WHAT	**A consolidated European contribution to the 3GPP workshop on 6G Use cases:** The goal is to bring all relevant EU stakeholders and experts together, both from the SNS JU side as well as from the NI side, to discuss their priorities with regards to the envisioned 6G use cases and to eventually agree on a common proposal to be supported towards the 3GPP workshop. Input from all the EU experts should be consolidated and all relevant bodies (such as the SNS JU office, the 6G-IA GB, the SNS SB/TB, the SRG) should be included in the process. The resulting contribution to the 3GPP workshop should reflect the needs and priorities of all the key EU stakeholders and should be supported by all relevant EU bodies during the workshop.
WHEN	• **November 2023 – March 2024:** Preparatory work, with offline alignment between experts/stakeholders, exchange of relevant documents and formulation of early draft of EU consolidated contribution. • **March 2024:** Preparatory meeting among all key stakeholders to discuss and generate stable draft of EU consolidated contribution. • **March 2024 – May 2024:** Application of discussed comments/feedback during the meeting, review period and generation of final version of EU consolidated contribution. • **May 2024:** Contribution to the 3GPP workshop & promotion of EU consolidated contribution.

4.2.3 Identification of topics and areas for collaboration

Many of the National Initiatives are interested in collaborating with other national initiatives or with the SNS JU programme. However, it is often not clear which topics would be of mutual interest. The idea is to organise a workshop where different National Initiatives could brainstorm and discuss what specific topics can benefit from joint activities. Topics that are identified may e.g. lead to bilateral or multilateral joint project or could potentially be included in a future edition of the SNS JU work programme. Some key suggestions for potential collaboration topics, based on the insights form the collaboration with the NIs so far are summarized in Table 25.

Table 25: Suggestions to find specific R&I topics for collaboration

Identification of R&I topics for collaboration	

WHO	• **SNS JU** (SNS JU office + SNS ICE + 6G-IA)
	  ○ Organization of a workshop
	  ○ Aim to get workshop on EUCNC agenda or co-located with EUCNC
	• **Large and small National Initiatives**
	  ○ Provide input on possible collaboration topics

WHAT	**A workshop to identify topics for R&I collaboration:** The goal is to identify R&I topics where additional joint activities between national 6G initiatives or between national initiatives and SNS are beneficial. Topics may be identified that address a specific joint interest, or a gap, between national or EU 6G initiatives. Also, topics may be identified that are not currently in the 6G R&I programmes, but now with hindsight of the first

	years of 6G research, deserve to be addressed. The topics that are identified may lead to bilateral collaboration projects or could potentially be included in a future edition of the SNS JU work programme. The workshop should not be exclusive to the large National Initiatives only. Also, smaller National Initiatives should be invited to participate.
WHEN	**EUCNC June 2024:** The idea is to organize a physical workshop to enable brainstorming and discussion. The intention is to co-locate such a workshop with another event of interest to the R&I community (such as EUCNC). Co-locating with an event that already has many researchers attending will stimulate attendance to the workshop. On the other hand, June 2024 will be late to incorporate any results in the SNS JU 2025 work programme.

To influence the SNS JU work programme, a workshop early in 2024 would be preferable. However, it was requested to collocate the workshop with another event (e.g. EUCNC) to allow for more participation, also from smaller national initiatives.

4.3 Additional possibilities for collaboration

Next to the three main actions described in the preceding paragraphs, the co-creation event at 5G Techritory on National Initiatives also identified other possible collaboration actions. These were either identified based on the results of the special SRG workshop, interviews and talks with National Initiatives, or presentations at the Techritory co-creation event. The following possible collaboration actions were not selected as one of the three main actions for SNS ICE to elaborate. Nevertheless, they may be of interest to pursue, e.g. by the National Initiatives themselves.

- Building open and accessible pan-European infrastructures: Investing in infrastructures that may be used by several countries, such as an experimental test network for 6G, could be a great way to increase collaboration at a European level.
- Stimulate National Initiatives to consider not only R&I activities but also raising awareness on 6G: It was noted that during 5G R&I, insufficient resources and focus was laid on raising awareness among the general public, which led to a negative attitude towards the technology. For future technologies and their eventual adoption by the public, it is important to raise awareness in a timely and correct manner.
- Boost the engagement of (deep tech) SMEs: It is important to ensure that SMEs are able to take advantage of the national initiatives to become present at a pan-European level.
- Align timing of calls in national initiative with timing of SNS calls: It would be beneficial to align the timings of the calls such that these opportunities are exploited in an optimal manner.
- Use CELTIC-NEXT framework for specific collaborations between different countries: The CELTIC-NEXT already offers a framework that allows for specific collaborations, and leveraging this might be a great way to collaborate with other national initiatives.
- Leverage the SNS SRG: The State Representative Group consists of representatives from all member states of the EU and meets regularly to discuss matters. This is a common point where all countries collect and could serve as an excellent opportunity to discuss collaboration and derive actionable suggestions.
- Federating universities: universities are the breeding grounds of new ideas and federating universities could serve the larger purpose of more R&D&I collaboration on 6G.

- National initiatives should be able to participate in SNS / 6G-IA Working Groups: Representatives from the NI being included in the regular working groups of 6G-IA is an easy way to increase collaboration between SNS projects and national projects.
- Provide a solution for legal issues that can be a barrier for collaboration (e.g. collaboration agreements): the SNS office can provide a generic template for collaboration agreements, NDAs, etc., that is agreeable for all countries as well as for 6G-IA/SNS such that collaboration between them may be established swiftly and without bureaucratic delays.
- Member states report provides information on national and regional initiatives: This report is published on a yearly basis and provides a comprehensive overview of not only the large national initiatives but also other national and regional initiatives and can help identify suitable areas for collaboration.
- Allow SNS flagship projects to act as a communication booster between the SNS JU and the national initiatives (e.g., roadmaps, match-making opportunities, etc.): The flagship projects of the SNS, such as the HEXA projects, generally include contributions from many countries, and thus serve as an excellent platform for starting collaboration.

5 Conclusions & Way forward

This deliverable provided an overview of the SNS ICE work during its first year of operation, focusing on establishing relations with multiple European National Initiatives and associations. Through the intensive work of the SNS ICE partners that organized several events in key European conferences, online workshops and webinars and executed an extensive survey, important links were created and an abundance of information was collected, processed and analyzed, helping to create an accurate picture of the current European landscape on 6G Research and Innovation Initiatives around Europe.

The analysis of the roadmaps of several European associations, indicated that European stakeholders are focusing on future technologies and the digitatization of the World and consider that 6G networks will play a pivotal role in the digital transformation if Europe. Several of these associations currently have (or soon will have) open calls for research and innovation projects, that can be linked (one way or the other) with the developments in the SNS and the research activities on 6G.

The extensive survey performed with key stakeholders from seven large European initiatives, and the following analysis, indicated that large European countries are heavily investing on 6G SNS research and have established long-term research programmes to ensure continuous research and that they remain relevant within the international telecommunication scene. The analysis and comparison with SNS priorities indicates that the interests and roadmaps of the EU NIs and the SNS JU are pretty well aligned, indicating that potential synergies are possible (something that was positively received by all NI representatives). Moreover, common trends emerged between the NIs and the SNS JU in terms of technology development prioritization, as ***6G network architecture, Edge and ubiquitous computing and radio technology research***, were at the top of the priority list for all entities.

Finally, thanks to the work of SNS ICE, concrete suggestions on how to further improve the flow of information between the SNS JU and the European NIs and how to align the EU approach towards standardization in order to maximize EU impact in global standards, have been agreed and already are beginning to be implemented. Based on these insights, a common EU front was presented at the 3GPP SA1 Workshop in Amsetrdam, NL, on May 2024, where the prioritization of 6G Use Cases was discussed. SNS ICE played a leading role in aligning the European views prior to this meeting, and ensuring a common EU front would be presented.

As next steps, SNS ICE partners are already fully engaged in organizing additional events, both physical and remote, to strengthen collaboration between the SNS JU and the EU NIs, discussing on potential future topics of interest for 6G research. Moreover, additional European National Initiatives will be interviewed and added to the list of contacts, ensuring an as wide consensus as possible within the European 6G community. Finally, detailed analysis on focused topics that emerged as EU priorities, such as the use of Cloud for 6G, will be provided.

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Annex – results of the special SRG session on collaboration

At a special SRG session on collaboration with national initiatives 6th of June 2023 at the EUCNC conference in Gothenburg (see also section 2.4), a list of possible collaboration actions has been identified in group brainstorm discussions. These actions can be both at an SNS-level as well as the level of the national initiatives themselves. These actions are summarized below:

- Align strategies, where possible, to empower EU stakeholders and expand business models (e.g., technological sovereignty, policies on sustainability, societal challenges, etc.)
- Create a complete picture of the EU ecosystem on Smart Networks and Services (identify opportunities, strengths, gaps). The national initiatives can provide contact persons to facilitate this information exchange.
- Build open and accessible pan-European federated infrastructures.
- Disseminate 6G benefits to increase public awareness and engagement and attract new workforce to the ICT technologies. A wider set of actors needs to be engaged (e.g., from the social sciences).
- Steer national initiatives to consider providing resources not only on R&I activities but to raising awareness on 6G (citizens, verticals, etc.)
- Improve communication among the national initiatives and the SNS, through workshops, a common repository, newsletters, and match-making support.
- Exchange information on standardization priorities and opportunities.
- Design a framework to transform 6G knowledge and results into a format suitable for (life-long) learning and training.
- Best practices dissemination activities for verticals to increase their 6G uptake and the verticals' digitization process
- Plan for coordinated efforts on activities to ensure physical resilience of 6G.
- Boost the engagement of (deep tech) SMEs by helping them presenting their portfolio and giving them information on opportunities on SNS and national projects.
- Ensure that SMEs are able to take advantage of the national initiatives to become present at a pan-European level.
- Allow flagship projects to act as a communication booster between the SNS JU and the national initiatives (e.g., roadmaps, match-making opportunities, etc.)